BIRGANJ SUB-METROPOLITAN CITY
SECONDARY TOWNS INTEGRATED URBAN ENVIRONMENTAL IMPROVEMENT PROJECT (STIUEIP)
PROJECT IMPLEMENTATION UNIT (PIU)
BIRGANJ, PARSA, NEPAL

Ref.no. : 245/070/071

Date : 15 Dec 2013

To,
Mr.Mani Ram Gelal
Project Director
Project Coordination office
Babarmahal, Kathmandu

Sub:- Submission of Final Report on Sewage Treatment Plant,

Dear sir,

PIU has received Final report on Sewage Treatment Plant under package-1 on dated 8th Dec, 2013 submitted by the Consultants **[M/s SMEC and Associates]**. While we are reviewing the document, We are submitting the same for final review and approval.

Submitted documents by the consultant are enclosed herewith:
1. Main Report Volume: 2A- 3 Copies
2. Final Drawing Volume 2B- 3 Copies

Regards

Shailendra Shrestha
Project Manager

Project Manager

Ph. No. 0977-51-532186, 51-531900 Fax : 051-521220
E-mail:stiueip.birganj@gmail.com Website : www.birganj.gov.np

Design & Supervision Consultant for Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP)
Birganj Sub-metropolitan City, Nepal

SMEC **In Association with** BRISBANE CITY ENTERPRISES PTY LTD BDA CEMAT CONSULTANTS

Ref. No. – STI -160/070/71 Dates: 8 December, 2013.

TO,

Mr. Shailendra Shrestha.
The Project Manager, STIUEIP
Project Implementation Unit,
Birgunj Sub-Metropolitan City, Birgunj

Sub: **- Submission of Final Report on Sewage Treatment Plant.**

Dear Sir,

We are glad to submit five copies of Final Report on Sewage Treatment Plant for STIUEI Birgunj for your kind review and approval. The repot has been submitted in two volumes as mentioned below;

1. Main Report Volume - 2A
2. Final Drawings Volume - 2B

We will highly appreciate your kind cooperation in this regard.

Sincerely yours,

Nagendra Jha
Team Leader, DSC
STIUEIP,Birgunj

SMEC in association with
BCE/BDA/CEMAT

Reg No. 233/060/069
2060/070

in association with

Brisbane City Enterprise Pty Ltd – Australia
Building Design Authority – Nepal
CEMAT Consultants – Nepal

Final Report: Sewage Treatment Plant Main Report Volume - 2A

Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP), Birgunj, Nepal

Birgunj Sub Metropolitan City, Nepal

September 2013

AUSTRALIA | ASIA | MIDDLE EAST | AFRICA | PACIFIC

Project Name:	Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP), Birgunj, Nepal
Project Number:	5064023
Report for:	Birgunj Sub metropolitan City, Birgunj, Nepal

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
	September 2013	N Jha, Team Leader, S Mandal, Int. STP Specialist and Others.	Pramod Kumar Mafuzur R khan	

ISSUE REGISTER

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Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP), Birgunj, Nepal

ADB-2650-NEP (SF)

For: Birgunj Sub metropolitan City, Birgunj, Nepal

SEPTEMBER 2013

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EXECUTIVE SUMMARY

An Agreement dated 26th October 2010 was entered into between the Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP), Project Implementation Unit, Birgunj Sub metropolitan City, Birgunj Nepal (the Borrower) and the Asian Development Bank (ADB) to provide funding for the provision of consulting services and implementation of urban infrastructure, as well community and institutional development and related activities.

A contract was entered into on 16th January 2012 between the Borrower and SMEC International Pty Ltd., Australia (the DSC Consultant) for the provision of consultancy services. The agreed start date is 17th February 2012. The deliverables include the submission of Interim Report which is the Preliminary Design Report along with tentative cost estimates.

Birgunj Sub-Metropolitan City is situated in the Narayani zone and the district of Parsa in the central development region of Nepal. It is one of the business economic and industrial zone of central region, covering an area of 23.37 km^2. The city lies at 27°02'30" to 26°57'45" North and 84°55'00" to 84°52' 15" East.

The eastern part of this city is bordered by another district – Bara whereas the southern and south western part by Bihar State of India. Birgunj is one of the major gateway towns to India.

Sewerage:

There is no separate sewerage system in Birgunj but most of major existing storm drains are carrying wastewater and sullage from the core area of city and hence there is no centralized or decentralized sewage treatment facility in the City.

In the PPTA study, there is no provision of separate sewerage system. It is included with combined sewerage system. Even if combined sewerage also considered, there is woefully inadequate provision for secondary sewers in the physical and financial allocation for the project, as compared to both the trunk sewer lengths and the number of house connections.

As per PPTA study, the design of the sewerage system will serve the core area only. But it will not serve the basic objective to remove the wastewater from the major area of city.

Wastewater Treatment Plant (WWTP) at Chhapkaiya:

The design capacity of the sewage treatment plant needs to be rationally fixed in relation to the number of connections both physically possible and likely within a reasonable timeframe.

The land area demarcated for WWTP is 6.0 hectare instead of 6.72 hectare indicated by PIU to cater the sewage flow up to design year (20 years) for city area within Sirsiya side catchment but there is no extra land available if further flow beyond 20 years design period diverted towards the same WWTP. Similarly for city area under Singaha catchment area, no future WWTP proposed in PPTA. But there is also requirement of WWTP at the south eastern part of City under Singaha catchment (Ward No. 19) which will be looked into by Birgunj Sub Metropolitan Office in due course.

The Salient Features are given to describe the details of Sewage Pumping Station (SPS) along with Wastewater Treatment Plant (WWTP).

1.1 SALIENT FEATURES

CONCEPT OF SEWAGE TREATMENT PLANT AT CHHAPKAIYA, BIRGUNJ CITY

1.	Name of the Project	Construction of Wastewater Treatment Plant at Chhapkaiya , Birgunj
2.	Project Code	STIUEIP-BIRGUNJ
3.	Town (s) included	BIRGUNJ
4.	Special feature of the town	Industrial Important Town of Nepal and Gateway to India
5.	Name of Agency responsible for	
5.1	Planning & design of project	DSC-BIRGUNJ
5.2	Implementation of project	Birgunj Sub Metropolitan City – Birgunj Municipality
5.3	Operation & Maintenance	Birgunj Municipality
5.4	Revenue Collection	Birgunj Sub Metropolitan City
6.	Project implementation period	Year 2013 To 2015 (18 Months)
7.	Whether the city / town comes Under Government Priority	Yes
8.	Schedule of Rates (SOR) to be followed	Birgunj-Parsa District-SOR
9.	Type of project	Wastewater Management
10.	Population	
a)	Census Population	
(i)	As per 1971 census	12,999
(ii)	As per 1981 census	43,642
(iii)	As per 1991 census	69,005
(iv)	As per 2001 census	1, 12,484
(v)	As Per 2011 census	1, 35,904
b)	Birgunj Projected Population (Geometric Growth Method)	
(i)	Year 2015	150,008
(ii)	Year 2020	171,080
(iii)	Year 2025	196,891
(iv)	Year 2030	228,667

(v)	Year 2035	269,154
c)	Design period	20 years
d)	Projected population	2, 69,154
11.	Existing Sewer Net work	NIL
12.	Existing Pumping Station	NIL
13.	Existing Treatment Facilities	NIL
14.	Proposed Works:	

A. Inlet Works with Wastewater (Lift) Pumping Station-Inlet Chamber, Screen Chamber, Sump well for Pumps & Pumping Units, pumping main

B. Pretreatment Units (Receiving Chamber, Grit Chamber, Parshall Flume) and Treatment Process Units (WSP-Anaerobic Pond and Facultative Pond) , Pond Inlet & Out Let (weir type) arrangement and piping interconnections and Treated effluent disposal.

C. Ancillary Works- Boundary Fence with Gate, Security Cabin, Office cum Lab Building, Work Shop cum Store Room, Generator Room, Transformer Yard, Watchman Quarter, Parking Area, Approach Road, Walkway, Drains and Plantation/Green area and Water Supply System.

D. Electrical & Mechanical Components- Transformer, Generators, Submersible Pumps & Motors with accessories, Electrical & instrumentations, Street Light Poles for area lighting, Sludge Pumps, Water Pumps.

Construction of 10 MLD Wastewater Treatment Plant (WWTP) on Waste Stabilization Pond (WSP) process with following Units.

S. N.	Units	Size (L x B X LD)	No.
1.	Inlet cum Diversion Chamber	3.0m X3.0m X 1.0m	1
2.	Screen Chamber-2 Channels	4.00m X 1.2 m X 0.4m Liquid Depth	2
3.	Sump Well for Pumps	7.5 m diameter x 1.5 m Liquid Depth	1
4.	Receiving Chamber	1.70m X 2.50m X 1.1m Liquid Depth + 0.5 m Free Board	1
5.	Grit Chamber with 2 Channels	9.0m X 1.25m X 0.75m Liquid Depth + 0.3 m Free Board	2
6.	Parshall Flume (Flow Measuring Channel)	5.0m X0.70m X 0.70m Liquid Depth + 0.5 m Free Board	1
7.	Distribution Chamber	3.0m x 3.0 m and 1.0 m Liquid Depth + 0.5 m Free Board	1
8.	Anaerobic Ponds	At Top: 35.0 m X59.0m X 4.50m (Liquid Depth) + 0.5 m Free Board At Bottom: 15.0m x 39.0 m; At Mid-water Depth-24m x 48 m+ 0.5 m Free Board	2
9.	Facultative Ponds	At Top: 62.50 m X 204.0m X 2.0m (Liquid Depth)	2

S. N.	Units	Size (L x B X LD)	No.
		+ 0.5 m Free Board: At Bottom: 52.5m x 194.0 m; At Mid-water Depth-56.5m x 198m	
10.	Inlet to Anaerobic Ponds	4.0 m x 4.0 m x 2.75 m Liquid Depth + 0.5 m Free Board	2
11.	Inlet to Facultative Ponds	4.0 m x 5.0 m x 1.8 m Liquid Depth + 0.5 m Free Board	2
12.	Outlet of Facultative Ponds	4.0 m x 5.0 m x 2.2 m Liquid Depth + 0.5 m Free Board	2
13.	Facultative Pond Outlet Collection Chamber 1	Collection Chamber -1: 2.0 m x 2.0 m x 1.55 m (Liquid depth); Chamber-2: 3.0 m x 3.0 m x 1.8 m (Liquid depth) + 0.5 m Free Board	2
14.	Sludge Drying Beds	20.0 m X 11.0 m; sludge depth 0.3 m + 0.5 m Free Board	8
15.	Office Cum Lab Building	17.20 m x 7.5 m x 3.0 m height	1
16.	Generator Room	5.5m x 4.5 m x 3.5 m height	1
17.	Watchman Cabin	3.0 m x 3.0 m x 3.0 m height	1
18.	Watchman Quarter	7.5 m x 4.5 m x 3.0 m height	1
19.	Workers' Changing Room	4.0 m x 3.0 m x 2.5 m height	1
20.	Under Ground Water Tank & Pump House with 1 no. Tube Well	5.0 m x 2.0 m x 1.5 m Liquid Depth + 0.3 m Free Board	1
21.	Transformer Yard	3.0 m x 3.0 m	1
22.	Parking Area	30 m x 15 m	1
23.	Paved Road	Length 300 m x 4.0 m Width	
24.	Walkway	Length 570 m x 2.0 m Width	
25.	Drains	0.8 x o.6 m -594 m 0.6 m x 0.5 m-300 m	
26	Green Area	0.27 hectare	

15. Estimated Cost for Wastewater Pumping Station and Wastewater Treatment Plant (WWTP) and Allied works at Chhapkaiya, Birgunj:

    1. Civil Works: NRs. 83.587 Million
    2. Electrical & Mechanical Works: NRs. 20.87 Million
    3. Office set-up & Laboratory Equipments: 7.414 Million
    4. Operation & Maintenance (one year): 10 Million

    Total Cost: ***121.871 Million (Land Cost not included as Land is acquired by STIUEIP.)***

1 PROJECT LOCATION

1.1 Birgunj Municipality

Birgunj city was established around 118 years ago. It is believed that the Prime Minister Shree Bir Samsher at that time established this city. As such the city got its name as Birgunj.

Birgunj Sub-Metropolitan City is situated in the Narayani zone and the district of Parsa in the central development region of Nepal. It is one of the business economic and industrial zone of central region, covering an area of 23.37 km^2. The city lies at 27°02'30" to 26°57'45" North and 84°55'00" to 84°52' 15" East. The eastern part of the city is bordered by another district – Bara whereas the southern and south western part by Bihar State of India.

The Pathlaiya to Birgunj corridor is one of the most important manufacturing centres in Nepal constituting many industries including among others steel, plywood, rice mills, sugar mill, agricultural equipment, tanning etc. Birgunj is one of the major gateway towns to India and more than 50% of total foreign trade is carried out via this town.

Political Division and Boundaries:

Birgunj Sub-metropolitan City is the leading business centre of the central Tarai region of Nepal. By virtue of its proximity to the Indo-Nepal border, it functions as an outlet for Nepalese exports and an inlet for imports. The town can be termed as a primary gateway town as it has developed in site of considerable transport significance as the break-of-bulk point in the Tarai region along the Indo-Nepal boarder. The city borders India, Sirsiya dry port and Bishrampur VDC in the south, the Sirsiya River, Ramgadh VDC in the west, Parwanipur and Bahundangi VDC in the north, Parsauni, Itahari VDC and the Singaha River in the east.

According to the census, the population of Birgunj Sub-metropolitan City in 2011 is 135,904 with annual growth rate of 1.91%.

Birgunj sub-metropolitan has a total area of 2337 ha, divided into 19 wards with their areas in a range of 6.57 ha (Ward No. 11) to 509.47 ha (Ward No. 19). Ward locations are shown in **Figure 1.1**. The city has an elongated shape with a maximum north-south length of 8 km and east-west width of 4 km. The altitude ranges from about 78m in the south near the border area to 87m in the north.

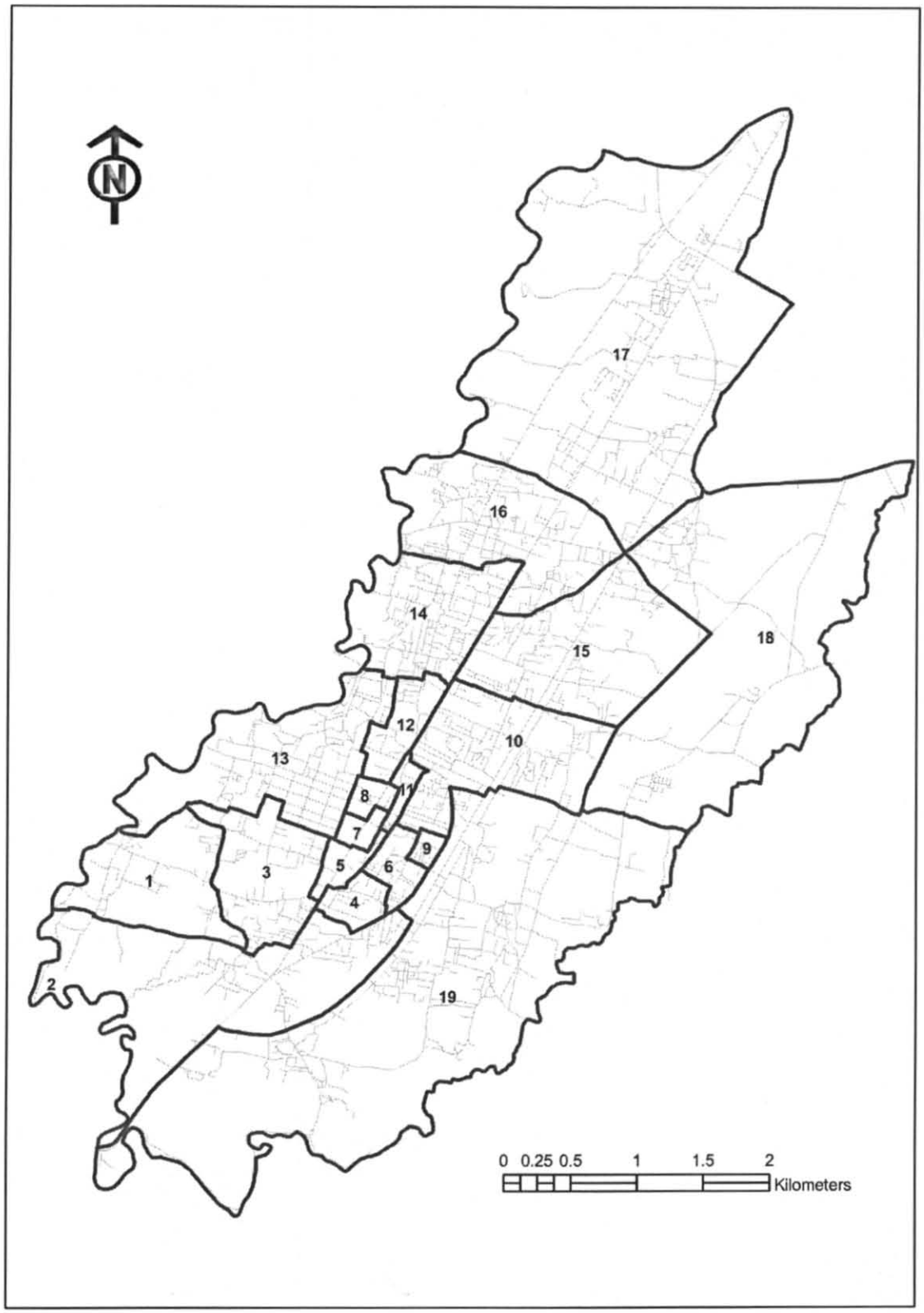


Figure 1 - 1: Ward Locations in Birgunj

Cultural and Socio-economic Aspects:

Birgunj sub-metropolitan city is an old city, inhabited by the Muslim, Tharu, Kurmi, Yadav, Kanu, and Teli and others.

The town is experiencing a high level of in-migration. This has resulted into the emergence of squatter settlement in several areas of the town.

Surface and Ground Water:

The area is drained by two rivers – the Sirsiya River in the west and the Singaha River in the east. On the north, there is Gandak Canal running along Gandak Road from the northwest to the southeast. This canal prevents surface runoff from the areas to the north of Gandak Road flowing into Birgunj. The Singaha River originates about 4 km upstream from the northern border of the municipality whereas the Sirsiya River originates from far northern area. These rivers are flooded during summer monsoon and river bank cutting particularly at the meander bend during flooding is common. The water in the river during dry period is very low. Groundwater table depth is estimated to be between 3.5-4.5 m deep with 1-2 m fluctuation during wet and dry season.

Topography:

The topography exhibits a gradual slope of about 1:900 from north to southeast resembling Tarai plain (northward extension of Indo-Gangetic plain). The altitude ranges from about 78m in the south near border area to 87m in the north. However there is high micro-topographical variation. Two major rivers are features of Birgunj, namely, the Sirsiya River to the west and the Singaha River to the east. In addition to these two rivers there is Gandak Canal in the north. The land is fertile soil with mix of clay, silt and sand.

Geology:

The Tarai usually has thick alluvial sediments comprising of boulder, gravel, silt and clay. The width of Tarai Zone varies from 10 to 50 km and forms a nearly continuous belt from east to west except at Chitwan and Rapti valleys, where the Tarai Zone is interrupted by Siwalik for 70 km and 80 km respectively. The Tarai Zone is an active foreland basin consisting Quaternary sediment originated from peaks of Northern part. To the north, this zone is separated by an active thrust system called as the Main Frontal Thrust (MFT) with Siwalik. At some places along the MFT, the Siwalik rocks are observed to rest over the recent sediments of the Tarai. The Tarai Region of Nepal is further divided into Northern Tarai or Bhabhar Zone, Middle Tarai and Southern Tarai.

The proposed sewage treatment plant lies in the Southern Tarai zone of Nepal.

Southern Tarai Zone:

The Southern Tarai Zone is southernmost part of Tarai up to Nepal-India border and also continues into India. This zone consists of sediments of Gangetic Plain. Sand, silt and clay are the main sediments of this zone. This zone is composed of finer sediments than the Middle Tarai Zone. To the extreme south bordering the Indian Plains, the sediments become finer.

Hydro-Geology:

The area consists mainly of quaternary sediments. It is composed of very fertile soil mixed of clay, silt and sand.

Climate:

The climatic condition is tropical type monsoon with very hot and wet summer. The mean annual temperature ranges from 23.8^{0}C to 24.5^{0}C. The maximum extreme daily temperature recorded is 41.6^{0}C in May and minimum is 4.5^{0}C in January. The annual rainfall ranges from about 1300 mm to 2800 mm with an average of 1800 mm. More than 82 % precipitation occurs

in 4 summer months (June to September). Average sunshine duration ranges from 7.26 -7.50 hr/d and average wind speed ranges from 1.95-2.31 km/hr (reference: PPTA report)

1.2 Municipal Infrastructure

Transportation:

Birgunj is quite accessible. It is linked with different places via the Tribhuvan Rajpath and East-West Highway. There are 115 km of black toped road, 83 km gravelled and 82 km earthen roads and a number of trails within the municipality. Overall roads in Birgunj are in a poor condition. Simara Airport is located about 22 km to the north of the city. There are more than 5,200 Rcikshaw, 313 Tempu and 456 Tanga in Birgunj providing transportation services. There are about 12 locations with major traffic congestion in the city centre.

Water Supply:

The main source of drinking water in Birgunj is the deep tube well ground water. At present there are four pumping stations operated by Nepal Water Supply Corporation that supply 8 million litters of water to the sub-metropolitan city. Nearly 6,067 households have piped water supply facility, 1,210 households have drinking water facility from public shallow tube wells and 7,819 households have drinking water facility from shallow tube wells. The water quality from deep tube wells is reported to be safe for drinking water but from shallow tube wells is usually contaminated by surface water and seepage of wastewater.

Storm Water Drain:

According to Municipality Profile (2007), there are approximately 4.7km main storm water drains and 40.5km secondary storm water drains in Birgunj. Open drains have been constructed in all the wards except in the areas from Ghantaghar to the hospital and Aadarsnagar areas where drains are covered.

The main drains referred as MD1 run in a general direction from the north to the southwest in the core area to the west of Main Road in Birgunj. Most secondary drains in the core area to the west connect MD1. The drainage networks in areas to the east of Main Road in Birgunj have inadequate hydraulic capacity to drain surface runoff effectively during monsoon seasons and they end up swamp areas without drainage outfalls.

Most open drains in Birgunj do not function properly due to the lack of maintenance as well as their misuse by the local people as waste dump sites. These drains are fully filled with debris and wastes all the time and overgrown weeds are covered entire cross sections in most earthen sections.

Wastewater disposal:

There are neither public centralized sewerage network systems for sewage collection nor sewage treatment plants for sewage disposal in Birgunj. At present the open drains are being used for waste water collection and disposal which is against the prudent engineering on sanitation. The on-site sanitation with septic tank and soak pits has been adopted for the sewage disposal from settlements. About 51% households have modern toilets, additional 22% households have ordinary toilets but 25% households do not have any toilets.

Though most of the houses have septic tanks, but very few have soak pits. As such, the septic tank effluents from most houses are directly discharged into the open road-side storm water drains. The municipality does not have facilities for the collection and disposal of septic tank solids. Generally the private operators provide these kinds of services and they have been found to dispose the solids in the road-side drains or on the vacant land.

As reported in the Birgunj Initial Environment Assessment, the town is seriously short of public toilets. Based on a copy of the Birgunj Facilities map, there are only seven public toilets in the

city. Most of the residents living in settlements belong to slum and squatter areas without toilet facilities have to sort to defecating either in the open fields or in open drains. Most of the existing public toilets have not been maintained after their constructions.

Solid Waste Management:

Solid waste is collected by Birgunj Municipality. It provides waste collection and sweeping services. The containers/bins are placed at different strategic locations which are used by households, institutions and the commercial sector in the town. There is no organized door-to-door collection system in Birgunj. Majority (78%) of the households dispose their wastes to public places and only 10.5% households use fixed places or containers. Wastes are transported using tractors and open trailers. In the absence of a permanent sanitary Landfill site, about 60 tons of garbage a day are being dumped haphazardly along river banks, ponds, by-pass road and open spaces. Nearby areas of those places are prone to serious health hazard.

Birgunj City Urban Development:

Urbanization in Birgunj:

Birgunj Sub-Metropolitan City is Nepal's principal trade centre. The city has experienced rapid growth especially in the past decade, due to migration to the city from peripheral districts and VDCs for security reasons, or other reasons such as for a better livelihood. There is consequently environmental deterioration resulting from inadequate sanitation and drainage, and mounting traffic congestion mainly in the main road leading to poor air quality in the city. The individual institutional efforts of both the sub-metropolis and sectoral agencies in addressing these issues, has remained uncoordinated and grossly inadequate. Most of the fertile agricultural fields are rapidly converting into residential and commercial areas. The eastern part of the sub-metropolis which lies in the flood-prone area of the Singaha River is also being changed to residential and commercial areas due to pressure of an increase in the population in the sub-metropolitan city. Most buildings are being constructed in Wards 18 and 19. The infrastructural facilities such as roads, sewer and storm-water drains and water supply, need to be developed to match the current rate of other development, which remains a major future concern.

Population Growth:

The current population growth rate for year 2001-2011 is estimated to be 1.91% in Birgunj. This rate is lesser than average growth rate (5.01%) for year 1991-2001 and the average growth rate of 3.6 % in Nepal.

Planning Efforts in Birgunj:

A number of planning documents have been prepared for development of Birgunj city, such as Structure Plan, Integrated Action Plan and concept of Greater Birgunj. The latest development is the Periodic Plan of Birgunj Sub-Metropolitan City.

Population:

According to the Census and of Birgunj Sub-Metropolitan City town profile, the population of Birgunj in the past was as follows:

Table 1 - 1: Population of Birgunj Sub-metropolitan City

Census Year	Population	Households
1971	12,999	
1981	43,642	
1991	68,764	
2001	112,484	19.910
2011	135,904	30,962

Source: National Population Census (Central Bureau of Statistics) 2048 and BSMC town profile

Table 1 - 2: Classification of Population on the Basis of Household

Ward No.	Area (ha)	Household No.		Population	
		Year 2001	***Year 2011***	***Year 2001***	***Year 2011***
1	146.46	985	1,323	6341	8005
2	149.3	1008	1,605	6694	9012
3	57.15	983	1,706	5510	7083
4	18.92	497	353	2537	2297
5	9.48	370	313	1940	1807
6	15.63	1064	694	5453	3685
7	9.92	360	272	2367	1648
8	5.61	257	203	1721	1115
9	13.43	810	923	4486	4597
10	42.91	1175	1,539	6163	6535
11	6.63	375	347	1913	1656
12	26.41	685	806	3357	3302
13	109.26	2393	3,225	13030	14720
14	95.6	2031	2,653	10647	12372
15	56.77	1440	1,736	7732	8493
16	129.22	1362	4,098	6833	10903
17	454.33	1162	1,366	7684	8550
18	482.2	1004	1,593	5832	9540
19	507.79	1939	6,207	12278	20584
Total	**2336.96**	**19910**	**30,962**	**112484**	**135,904**

Source: National Population Census (Central Bureau of Statistics) 2011.

The Population Projection has been carried out by Consultant based on the parameters set out by PCO/PIU. The agreed projected population is given in Annexure-1.

2 PROJECT BACKGROUND

The Department of Urban Development and Building Construction (DUDBC), under the Ministry of Physical Planning and Works (MPPW), through the Government of Nepal, has received Loan 2650-NEP: Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP, or the Project), from the Asian Development Bank (ADB). MPPW is the executing agency for the Project, working through DUDBC, and Biratnagar, Butwal and Birgunj and Kavre municipalities are the implementing agencies (IAs).

The project will implement urban environmental improvement on an integrated basis in these areas, including sewerage and drainage, solid waste and urban roads and lanes in the Biratnagar, Birgunj and Butwal municipalities, and water supply development in the Kavre valley. It will also include:

- community development programs such as awareness-raising on health and hygiene;
- 3R (reduce, reuse, and recycle);
- investment in small-scale community facilities in the municipalities; and
- capacity strengthening of the municipalities and central government in the field of project management and operation.

The project will be implemented over a four years (Year 2012-Year 2013) period.

3 OBJECTIVES OF THIS REPORT

The expected outputs of the project in Birgunj are as follows;

- Improved drainage and sewerage systems.
- Improved urban roads and lanes.
- Improved solid waste management.
- Community development program undertaken, including health and hygiene education, 3R (reduce, reuse and recycle) of solid waste, promotion, skills training and investment in small scale community facilities.

Reference to the deliverables identified in the MS Project Gantt Chart attached to the Inception Report, submitted on 16 April 2012, indicates that there are a number of deliverables related specifically to the design aspects of the above infrastructure improvements, as follows:

- Design Criteria Report
- Catchment Concept Plan for the whole catchment
- Interim Report (Preliminary Design and Tentative Cost Estimates)
- Draft Final Reports (including tender documents with Draft Final Report) and
- Final Report

This Draft Final Report (DFR) is prepared in fulfilment of the third item listed above. The sector wise DFR has been prepared in various Volumes and Wastewater Treatment Plant with Wastewater (Sewage) Pumping Station has been considered one of the number of Volumes and this has been considered as single package for wastewater management for Birgunj City.

4 CATCHMENT AREA

Overall catchment plan for whole city of Birgunj is not indicated in PPTA study. Hence sewerage concept for whole City is incomplete.

4.1 Planning of Sewerage System

As per conceptual Master Plan prepared by DSC and topographical survey, there is two major sewerage catchment divided in TRP Highway, one is whole western part of whole Birgunj city under Sirsiya catchment and other one is eastern part of whole Birgunj city under Singaha River catchment. Major core area falls under western part (Sirsiya) catchment. The estimated catchment area for Sirsiya is about 1106.50 hectare and for Singaha it is 1230.5 ha. The developed area is about 904.0 ha in Sirsiya side and 867.0 ha towards Singaha side. The undeveloped area is about 202.50 ha towards Sirsiya and 363.50 ha under Singaha side catchment.

There are 115 Km black toped road, 83 Km gravelled road and 82 Km earthen road within the municipality. There is no centralized separate sewerage system within municipality except storm water drains. House hold septic tank effluent is directly discharged to open surface drains made for storm water flow.

The basic concept of separate sewerage system is to cater the wastewater flow only and for separate drainage system is to carry only storm water. But depending on situation narrow road where so many infrastructure facilities/utilities are difficult to construct within a confined and limited space. In this situation, combined sewerage is only feasible option. And accordingly in some core area of Birgunj city like Aadarshanagar, the combined sewerage system may be proposed which is being finalized as the detailed topographic survey has been completed. Other areas where Road width is more, separate sewerage and separate storm water drainage are proposed. In this principle, major area of Sirsiya catchment will be served by separate system.

The present project area under STIUEIP will be towards catchment of Sirsiya side only.

The water supply rate has been considered 80 lpcd and sewage generation will be 80 % of water supply. About 10 % institutional and industrial wastewater will be added for sewerage system design. Infiltration quantity will be added as 10,000 litre/hectare/day as Birgunj water table is high during monsoon season for design of sewerage system but infiltration reaching to WWTP site will be reasonable considered to avoid unnecessary increase the capacity of wastewater treatment plant.

4.2 Conceptual Planning for Sanitary Sewerage System

The Consultant has prepared concept planning for sanitary sewerage system. It mainly consist of network of main trunk sewer with main, branch and lateral sewers and serves the area west of TRP highway and half of the area in east/south from TRP highway. The project area is being delineated based on limitation in the survey work agreed with the client, PPTA report and the area available for WWTP. It is expected that remaining part of the area (Catchment which falls towards Singaha River side) will be served by another separate catchment area with a separate Wastewater Treatment Plant based on availability of land.

The project area has been delineated based on limitation in the survey work agreed with the client, PPTA report and the area available for STP. The areas form both side of the existing natural drain MD-1 are planned with main collectors, branch and lateral sewers with junction in the south of the catchments and outfall to the sewage treatment plant site at Chhapkaiya area. The existing natural main drain (namely MD-1) is about 4.9 km long open drain, with width varying from approximately 2.0 m to 7.5 m or more with very irregular shape (as per survey

conducted by DSC) and it is reaching to Sirsiya River. The boundary line in the east is the TRP highway from Power House Chowk to Ghantaghar Chowk. On the south of Ghantaghar Chowk the delineated area for sanitary sewerage coverage is the Railway Road in the east of TRP road.

On the west side of the road the terrain is usually flat till it reaches Sirsiya River. Hence, most of the Birgunj area on the west side of the trunk sewer will also be served by the proposed trunk sewer.

4.3 Sewage Disposal

PPTA report has suggested service of completion for the treatment of the wastewater such Anaerobic Pond, Facultative Pond, Maturation Pond etc. The Consultant has proposed Waste Stabilization Pond comprising of Anaerobic Pond (A.P) and Facultative Pond (F.P.) as it needs huge land area which is not available at proposed STP site. Maturation Pond are required to achieve desired coliform level in treated effluent as it will not remove significantly organic pollution except pathogens/ coliforms. It can be noted that in wastewater, BOD up to 300 mg/l (Reference Duncan Mara Design Manual for Waste Stabilization Ponds in India), Anaerobic Ponds and Facultative Ponds are sufficient to treat the sewage to the desired BOD level of treated effluent (BOD less than 50 mg/l) without Maturation Pond.

5 SEWAGE TREATMENT PLANT CAPACITY

The project area is being delineated based on limitation in the survey work agreed with the client, PPTA report and the area available for WWTP. It is expected that remaining part of the area (Catchment which falls towards Singaha River side) will be served by another separate catchment for sewerage with a separate Wastewater Treatment Plant based on availability of land. The areas from both side of the existing natural drain MD-1 are planned with main collectors, branch and lateral sewers with junction in the south of the catchments and outfall to the wastewater treatment plant site at Chhapkaiya area.

The boundary line in the east is the TRP highway from Power House Chowk to Ghantaghar Chowk. On the south of Ghantaghar Chowk the delineated area for sanitary sewerage coverage is the Railway Road in the east of TRP road. On the west side of the road the terrain is usually flat till it reaches Sirsiya River. Hence, most of the Birgunj areas on the west side of the trunk sewer are also served by the proposed trunk sewer

The wastewater generation for two Catchments (one is for Sirsiya and other for Singaha Catchment) are mentioned in Table 5.1. Wastewater for Sirsiya catchment will be diverted to centralized WWTP at Chhapkaiya (location identified and area is acquired already) and wastewater generated from Singaha catchment will be diverted towards ward no.19. Another centralized WWTP location will be identified by department in due course for 20 years business plan. Apart from these two WWTP at Birgunj there will be onsite sanitation system for Slum & Squatter area and low pocket area where use of septic tank will be in practice. That wastewater/sewage should not be included in the capacity of WWTP.

Table 5 - 1: Sewage Quantity for Sirsiya & Singaha Catchment of BIRGUNJ City (Year 2035)

Description	Unit	Sirsiya Catchment	Singaha Catchment
Total Area	ha	1,106.50	1,230.52
Undeveloped area Area	ha	202.93	364.00
Effective/developed Area	ha	903.57	866.52
Population	Inhabitants	140,219	128,935.39
Water Supply rate	l/s	80	80
Sewage Return Factor	%	0.80	0.80
Domestic sewage quantity	l/s	103.87	95.51
Institutional/industrial Wastewater	%	10%	10%
Institutional/industrial Wastewater	l/s	10.39	9.55
Average Wastewater Quantity	**l/s**	**114.25**	**105.06**
	MLD	**9.87**	**9.08**
Peak Factor		2.50	2.50
infiltration rate to WWTP (due to ex-filtration also) considered.	%	10%	10%
infiltration Quantity	l/s	11.42	10.50
Design WWTP Capacity (2035)	**l/s** **MLD**	**125.67** **10.85**	**115.56** **9.98**

5 Years interval wastewater generation for whole Birgunj City also calculated based on ward wise population projection. The details are tabulated in Table 5-2.

Table 5 - 2: Five Years Interval Wastewater Generation for the Whole BIRGUNJ City

Year-Phase	Sirsiya- Catchment		Singaha -Catchment		Total Catchment	
Wise	(Effective area 904 ha)		(Effective area 867 ha)		(Effective area 1,771 ha)	
	Population	Wastewater Generation	Population	Wastewater Generation	Population	Wastewater Generation
Year	No.	MLD	No.	MLD	No.	MLD
Year 2015	95,097	6.70	54,911	3.87	150,008	10.56
Year 2020	103,813	7.31	67,267	4.74	171,080	12.04
Year 2025	113,863	8.02	83,028	5.84	196,891	13.86
Year 2030	125,499	8.84	103,167	7.26	228,666	16.10
Year 2035	140,219	9.87	128,936	9.08	269,154	18.95

Note: Sewage generation includes 10 % nondomestic/institutional flows

Reference Table 5.2 is enclosed.

The requirement of WWTP capacity for whole Birgunj is estimated and mentioned in Table 5.3.

Table 5 - 3: WWTP CAPACITY FOR WHOLE BIRGUNJ CITY :

Year-Phase wise	Sirsiya- Catchment (Gross Area Served 1106.50 ha)			Singaha -Catchment (Gross Area Served 1230.52 ha)			Total Birgunj (2337 Ha)
	Population	Reqd. WWTP Capacity MLD	Reqd. WWTP Land Area-WSP (ha)	Population	Reqd. WWTP capacity MLD	Reqd. WWTP Land Area-WSP (ha)	WWTP capacity MLD
Year 2015	95,097	7.36	6.90	54,911	4.25	3.98	11.61
Year 2020	103,813	8.03	7.53	67,267	5.20	4.88	13.23
Year 2025	113,863	8.81	8.26	83,028	6.42	6.02	15.23
Year 2030	125,499	9.71	9.11	103,167	7.98	7.48	17.69
Year 2035	140,219	10.85	10.17	128,936	9.98	9.36	20.83

Note: 10 % of wastewater flow as infiltration quantity has been included with the WWTP Capacity.

Also ward-wise population and actual wastewater generation served by the WWTP has been calculated for both catchments and given in Table 5.4 based on topographical survey. The design of outfall sewer (Incoming sewer) reaching to WWTP site is 800 mm diameter RCC NP3 pipe with design invert level 74.3 m at inlet chamber of Sewage Pumping Station. (Reference-Sewerage Report submitted in separate Volume).

Table 5 - 4: Catchment Concept & Wastewater Flow & Wastewater Treatment Plant Capacity

Sr. No.	Ward No.	Area (Ha)	Sirsiya River Catchment (Chhapkaiya WWTP Catchment), ha	Singaha River side Catchment (ha)	Census Population Year 2011	Projected Population Year 2015		Projected Population Year 2020		Projected Population Year 2025		Projected Population Year 2030		Projected Population Year 2035	
						Chhapkaiya WWTP	Singaha WWTP	Chhapkaiya	Singaha	Chhapkaiya	Singaha	Chhapkaiya	Singaha	Chhapkaiya	Singaha
1	Ward -1	146.46	146.46		8,005	8788		9875		11097		12470		14013	
2	Ward-2	149.3	149.3		9,012	10151		11779		13668		15860		18404	
3	Ward-3	57.15	57.15		7,083	7831		8877		10063		11408		12932	
4	Ward-4	18.92	18.92		2,297	2297		2297		2297		2297		2527	
5	Ward-5	9.48	9.48		1,807	1807		1807		1807		1807		1988	
6	Ward-6	15.63	15.63		3,685	3685		3685		3685		3685		3685	
7	Ward-7	9.92	9.92		1,648	1648		1648		1648		1648		1813	
8	Ward-8	5.61	5.61		1,115	1115		1115		1115		1115		1227	
9	Ward-9	13.43	13.43		4,597	4641		4697		4754		4811		4869	
10	Ward-10	42.91	14.28	28.63	6,535	2227	4464	2293	4598	2362	4735	2432	4877	2505	5022
11	Ward-11	6.63	6.63		1,656	1656		1656		1656		1656		1822	
12	Ward-12	26.41	26.41		3,302	3302		3302		3302		3302		3632	
13	Ward-13	109.26	109.26		14,720	15458		16432		17468		18568		19739	
14	Ward-14	95.6	95.6		12,372	13136		14158		15260		16447		17727	
15	Ward-15	56.77	11.67	45.1	8,493	1812	7005	1899	7340	1990	7691	2085	8060	2185	8446
16	Ward-16	129.22	89.67	39.55	10,903	9120	4022	11518	5080	14547	6416	18373	8103	23204	10234

17	Ward-17	454.33	327.08	127.25	8,550	6423	2499	6774	2636	7144	2780	7535	2931	7946	3092
18	Ward-18	482.2	0	482.2	9,540	0	11614	0	14851	0	18990	0	24283	0	31051
19	Ward-19	507.79	0	507.79	20,584	0	25307	0	32763	0	42416	0	54913	0	71091
	Sub-Total	**2337.0**	**1106.5**	**1230.52**	**135904**	**95097**	**54911**	**103813**	**67267**	**113863**	**83028**	**125499**	**103167**	**140218**	**128936**
	Total		**2337**		**Total population**	**150008**		**171080**		**196891**		**228666**		**269154**	
Note: 10% Institutional/industrial flow is added to WWTP					**Waste water (MLD)**	**6.69**	**3.87**	**7.31**	**4.74**	**8.02**	**5.85**	**8.84**	**7.26**	**9.87**	**9.08**
For WSP Process units, Land Required is 0.75 ha/MLD					**STP AREA REQD. (ha)**	**5.02**	**2.90**	**5.48**	**3.55**	**6.01**	**4.38**	**6.63**	**5.45**	**7.40**	**6.81**
For Buffer, Roads, Parking, Office, Workshop, Guard Room etc.					**Additional 25%**	**1.26**	**0.72**	**1.37**	**0.89**	**1.50**	**1.10**	**1.66**	**1.36**	**1.85**	**1.70**
				Total	**WWTP-LAND AREA REQD. (ha)**	**6.28**	**3.62**	**6.85**	**4.44**	**7.51**	**5.48**	**8.28**	**6.81**	**9.25**	**8.51**

Note: Sewage Flow Generation has been calculated based on the population density of the respected area.

6 SELECTION OF WASTEWATER TREATMENT PROCESSES

6.1 Selection of Wastewater Treatment Process

One of the most challenging aspects of a wastewater treatment system design is the analysis and selection of the treatment process and technology capable of meeting the requirements.

The methodology of selecting the technology and process generally includes several evaluation steps that will vary depending upon the complexity of the project, the wastewater influent conditions and the desired treatment levels required.

Table 6 - 1: Effluent Discharge Standards (as per norms practice in NEPAL)

Discharge of Effluent	BOD_5	TSS
Into the River/Watercourse	50 mg/l	50 mg/l
On land for irrigation purposes	100 mg/l	200 mg/l

Industrial Effluent discharge Quality as per National (Nepal) Standards is given in Annexure-4.

In order to select the feasible alternatives the process requirements must be known. Apart from construction and running costs, factors that need to be taken into account in selecting appropriate processes for Birgunj include:

Following 9 criteria have been considered to be the most important for selecting the appropriate wastewater treatment technology; the same are universally applied in the technology selection:

(i) Consistent Effluent Quality: The most important criteria for the selection of process is the maximum availability of the plant to give consistent treated sewage within the prescribed quality and ultimate total discharge of the pollutant is minimum.

(ii) Total Plant Power Requirements: The lower the better.

(iii) Land Requirements: Space needed for adopting the plant based on the selected process should be within the available area. The lower the better.

(iv) Capital Cost of Plant: The lower the better.

(v) Operation & Maintenance (O&M) Cost & Requirements: The lower the better.

(vi) Process Flexibility: Flexibility of the process should be enough to take care of the uncontrollable fluctuation in sewage characteristics.

(vii) Reliability: Ability of process to deliver the desired effluent quality on a consistent basis.

(viii) Treatment Residuals (Sludge): The lower the better but the residuals to be stabilized.

(ix) Aesthetics with Surroundings: The Plant should be compatible with surroundings i.e. socially acceptable, economic viable, environmental friendly and sustainable.

6.2 Pre-Selection from Various Types of Processes for Sewage Treatment

At present following off-site Wastewater treatment processes are working in Asian countries successfully apart from On-site Treatment options (Septic Tank, Imhoff Tank, Sand Bed, Decentralized WWTP, DEWATS etc.) and all these centralized process can meet the guarantee limit in quality independently or with combination of processes.

1. Land Treatment
2. Constructed Wetlands (Reed Bed)
3. Facultative Lagoons
4. Aerobic flow through lagoons
5. Aerobic lagoons, with recycling of solids
6. Oxidation Ponds
7. Waste Stabilization Ponds (WSP)
8. Conventional Activated Sludge process (CASP)
9. High Purity Oxygen Activated Sludge
10. Deep shaft activated sludge
11. Conventional Trickling filters (CTF)
12. Trickling Filter/Solids Contact (TF/SC) or (High Rate Trickling Filter, HRTF)
13. Biological Aerated Filter (BAF)
14. Hybrid Activated Sludge / Attached Growth like Fluidized Bed Bio Reactor / Moving Bed Bio Reactor (MBBR)
15. Extended Aeration (EA)
16. Oxidation Ditch (OD)
17. Sequencing Batch Reactors (SBR)
18. Rotating Biological Contactor (RBC)
19. Membrane Bio-Reactors (MBR)
20. UASB plus fixed film polishing process

6.3 Recommendations

Among the above Wastewater Treatment Processes, Waste Stabilization Pond (WSP-) has been selected as per recommendation of PPTA.

Main Advantages are:

1. Simplest Wastewater Treatment Technology
2. High degree of treatment efficiency about 90% above 20^0 C temperature and above. (Reference Duncan Mara)
3. High coliform and nutrient (as N) removal efficiency 99.999% with Combination of Anaerobic Pond, Facultative Pond and Maturation Pond and more than 95% without Maturation Pond for temperature above 20^0C. (WSP Manual by Duncan Mara & Manual of WSP by Power & Water Corporation, Australia.)
4. No electric power requirement for process as it is natural process
5. Equipment requirement is less
6. No skilled manpower is required
7. Flexible to hydraulic surge load
8. Operation is simplest and reliable
9. O & M expenditure will be less
10. Construction is simple as Ponds are earthen basins only.
11. Maturation pond (if provided) can be used as fish farming for revenue generation
12. No regular desludging operation from Anaerobic Pond and Facultative Pond

13. Stabilized and naturally digested sludge from Anaerobic Pond can be used directly for agriculture as soil conditioner or can be used after drying from Sludge Drying Yard. It can be sold to farmers and some revenue generation expected.
14. Dried sludge generated from WWTP can be used as filling the depression area
15. Facultative Pond can be easily altered to Mechanically Aerated Lagoon for highest degree of treatment
16. WSP area can be easily reclaimed as if land will be required for other purpose

Disadvantages are the following:

1. High land requirement
2. Mosquito breeding
3. Depends on solar radiation
4. Chances of contamination in high flood zone areas.

Detailed description of the (WSP) technology is presented hereunder.

6.4 Waste Stabilization Ponds Process Description

6.4.1 Introduction

Stabilization ponds are open flow through earthen basins, especially designed and constructed to treat the sewage and bio-degradable industrial and domestic wastewaters. Such ponds provide comparatively longer detention periods, extending from few days to several days, during which time the wastes get stabilized in the pond through a symbiotic relationship between bacteria and algae. Under many situations in warm climate countries, pond systems are cheaper to construct and operate compared to conventional methods. They also do not require skilled operational staff and their performance do not fluctuate from day to day. Stabilization ponds comprise of a single string of anaerobic, facultative and maturation ponds in series, or several such series in parallel. In essence, anaerobic and facultative ponds are designed for removal of Bio-chemical oxygen demand (BOD), and maturation ponds for pathogen removal, although some BOD removal also occurs in maturation ponds and some pathogens removal in anaerobic pond and facultative pond. In most of the cases, only anaerobic and facultative ponds will be needed for BOD removal when the effluent is to be used for restricted crop irrigation and fish pond fertilization, as well as when weak sewage is to be treated prior to its discharge into surface waters. Maturation ponds are only required when the effluent is to be used for unrestricted irrigation, thereby having to comply with the WHO guideline of <1000 fecal coliform bacteria /100ml.

Anaerobic Pond: These ponds are generally used as pre-treatment for high strength of industrial wastewaters and sometimes municipal wastewaters. Such ponds are constructed with a depth of 2.5-5.0m; can withstand a high organic loading 100-350 g/m3/d. They normally do not contain dissolved oxygen or algae. In anaerobic ponds, BOD removal is achieved by sedimentation of solids, and subsequent anaerobic digestion in the resulting sludge. The process of anaerobic digestion is more intensive above 15^0C. The anaerobic bacteria are usually sensitive to pH < 6.2. Thus, acid water must be neutralized prior to its treatment in anaerobic ponds. A properly designed anaerobic pond will achieve about a 40% removal of BOD at 10^0C and more than 60% at 20^0C. A shorter retention time of 1.0-1.5 days is commonly used.

Facultative Pond: In these ponds the upper layer works under aerobic condition, while anaerobic conditions prevail at the bottom. The upper aerobic layer of the pond acts as a good check against odour evolution from the pond. The treatment effected by this type of pond is comparable to that of conventional secondary treatment processes. Hence, it is best suited and

most commonly used for treatment of sewage. The optimum range of depth for these ponds is 1.0-2.0m.

There are of two types of facultative ponds: primary facultative ponds, which receive raw wastewater, and secondary facultative ponds, which receive settled wastewater (usually the effluent from anaerobic ponds). Facultative ponds are designed for BOD removal on the basis of a relatively low surface loading (100-400 kg BOD/ha/d at temperature between 20°C and 25°C) to permit the development of a healthy algal population as the oxygen for BOD removal by the pond bacteria is mostly generated by algal photosynthesis. Due to the algae facultative ponds are colored dark green, although they may occasionally appear red or pink (especially when slightly overloaded) due to the presence of anaerobic purple sulphide-oxidizing photosynthetic bacteria. The algae that tend to predominate in the turbid waters of facultative ponds are the motile genera (such as *Chlamydomonas, Pyrobotrys* and *Euglena- Reference: WSP by Prof. Mara*) as these can optimize their vertical position in the pond water column in relation to incident light intensity and temperature more easily than non-motile forms (such as *Chlorella*), although this is also fairly common in facultative ponds). The concentration of algae in a healthy facultative pond depends on loading and temperature, but is usually in the range 500-2000 µg chlorophyll *a* per litre.

6.4.2 Mechanism of Purification of Facultative Pond

Effluent entering the facultative pond is converted into carbon dioxide, water and new bacterial and algae cells in the presence of oxygen, i.e., aerobically.

Algae populations within the aerobic pond require sunlight. They develop and produce oxygen in excess of their own requirements. It is this excess of oxygen that is used by bacteria to further break down the organic matter within the effluent. The algal production of oxygen occurs near the surface of aerobic ponds to the depth to which light can penetrate (i.e. typically up to 500 mm). Surface aeration can also be introduced by wind.

Aerobic pond is more accurately termed "facultative", as in practice the pond usually has an aerobic upper layer and anaerobic lower layer. This facultative condition occurs because high oxygen levels cannot be maintained to the total depth of aerobic ponds. So, a fully aerobic surface layer develops along with an aerobic/anaerobic intermediate layer, and a fully anaerobic layer on the pond bottom. Oxygen is unable to be maintained at the lower layers, if:

- The pond is too deep, and the color too dark, to allow light to penetrate fully.
- The demand for oxygen in the lower layer is higher than the supply. Demand is increased with high levels of organic matter. The anaerobic layer will be deeper in an aerobic pond where there is an extremely high organic matter content of the inflowing effluent.
- The surface layer, rich in oxygen, is not adequately mixed with the bottom layer.
- There is a combination of these conditions.

As a result of the photosynthetic activities of the pond algae, there is a diurnal variation in the concentration of dissolved oxygen. For a typical facultative pond, the water column will be predominantly aerobic at the time of peak sun radiation and predominantly anaerobic at sunrise. After sunrise, the dissolved oxygen level gradually rises to a maximum in the mid-afternoon, after which it falls to a minimum during the night. The position of the oxypause (the depth at which the dissolved oxygen concentration reaches zero) similarly changes, as does the pH since at peak algal activity carbonate and bicarbonate ions react to provide more carbon dioxide for the algae, so leaving an excess of hydroxyl ions with the result that the pH can rise to above 9 which kills fecal bacteria. The wind has an important effect on the behavior of facultative ponds, as it induces vertical mixing of the pond liquid. Good mixing ensures a more

uniform distribution of BOD, dissolved oxygen, bacteria and algae and hence a better degree of waste stabilization. In the absence of wind-induced mixing, the algal population tends to stratify in a narrow band, some 20cm thick, during daylight hours. This concentrated band of algae moves up and down through the top 50 cm of the pond in response to changes in incident light intensity, and causes large fluctuations in effluent quality (especially BOD and suspended solids) if the effluent take-off point is within this zone. The operation of the facultative pond is shown in Fig. 6.1.

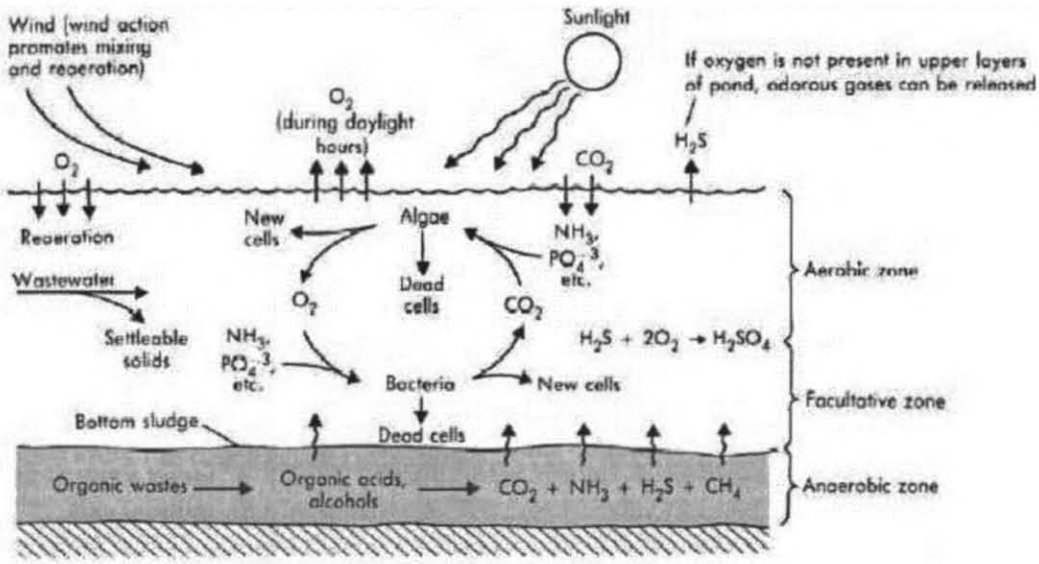


Figure 6 - 1: Operation of the Facultative Pond (Reference: Wastewater Treatment by Soli J. Arceivala & Indian CPHEEO Manual on Sewerage & Sewage Treatment)

The facultative pond will remove odor and kill most pathogenic microorganisms. As a complete process, the facultative pond serves to:

- Further treat the effluent anaerobically through separation, dissolving and digestion of organic material.
- Aerobically break down most remaining organic solids near the pond surface.
- Reduce the amount of disease-causing microorganisms.
- Allow the loss of 20% to 30% of the ammonia, contained within the effluent, into the air.
- Store residues from digestion, as well as non-degradable solids, as bottom sludge.
- Allow treated effluent to pass out into a waterway or additional treatment system (i.e. an additional pond, wetland system or for land application).

Sometimes two or more consecutive smaller facultative ponds are constructed instead of a very large one. This may be more practical for effective desludging and stirring or when the pond is too long for the site and interferes with existing structures.

In primary facultative ponds (those that receive raw wastewater) the above functions of anaerobic and secondary facultative ponds are combined. This type of pond is designed generally for the treatment of weaker wastes and in sensitive locations where anaerobic ponds odour would be unacceptable.

Maturation Pond: The maturation ponds, usually 1.0-1.5m deep, receive the effluent from the facultative ponds. Their primary function is to remove excreted pathogens. Although maturation

ponds achieve only a small degree of BOD removal, their contribution to nutrient removal also can be significant. These ponds usually show less vertical biological and physicochemical stratification, and are well –oxygenated throughout the day. The algae population is much more diverse than that of the facultative ponds, with non-motile genera tending to be more common. The algal diversity generally increases from pond to pond along the series. Although fecal bacteria are partially removed in the facultative ponds, the size and number of the maturation ponds especially determine the numbers of fecal bacteria in the final effluent. There is some removal of solids associated bacteria in anaerobic pond, principally by sedimentation. The principle mechanisms for fecal bacteria removal in facultative and maturation ponds are known to be

1. Time and temperature
2. High pH (>9)
3. High light intensity, combined with high dissolved oxygen concentration.

In many instances only anaerobic and facultative ponds will be required: for example, prior to restricted crop irrigation and fishpond fertilization, and also when a relatively weak wastewater (up to 150 mg/l) is to be treated prior to surface water discharge. In general maturation ponds will be required only when the treated wastewater is to be used for unrestricted irrigation and has to comply therefore with the WHO guideline of > 1000 faecal coliforms per 100 ml, and when stronger wastewaters (BOD >150 mg/l) are to be treated prior to surface water discharge. (Restricted irrigation refers to the irrigation of industrial crops, such as cotton and sunflower, and food crops not for direct human consumption, such as wheat. Unrestricted irrigation covers vegetable crops, including those eaten uncooked, such as salad crops.) However, if WSP effluents can be accessed on the basis of filtered BOD, anaerobic and facultative ponds will be sufficient without the need for maturation ponds for the treatment of wastewaters with a BOD up to 300 mg/l.

Nutrient removal: In anaerobic pond organic nitrogen is hydrolyzed to ammonia, so in anaerobic ponds usually have high concentration of ammonia than in raw sewage. In facultative and maturation ponds, ammonia is incorporated into new algal biomass. Eventually the algae become moribund and settle to the bottom of the pond; around 20 percent of the algal cell mass is non-biodegradable and the nitrogen associated with this fraction remains immobilized in the pond sediment. That associated with the biodegradable fraction eventually diffuses back into the pond liquid and is recycled back into algal cells to start the process again. At high pH, some of the ammonia will leave the pond by volatilization.

There is little evidence for nitrification (and hence denitrification, unless the wastewater is high in nitrates). The populations of nitrifying bacteria are very low in WSP due primarily to the absence of physical attachment sites in the aerobic zone, although inhibition by the pond algae may also occur. Total nitrogen removal in WSP systems can reach 80 percent or more, and ammonia removal can be as high as 95 percent.

Phosphorous removal in WSP is associated with its uptake by algal biomass, precipitation and sedimentation. The best way to remove much of the phosphorous in waste water by WSP is to increase the number of maturation ponds. However, both nitrogen and phosphorous must be removed in order to prevent eutrophication in receiving water bodies. The common practice in the design of WSP is not based on the nutrient removal, rather, it is based on BOD and fecal coli form removal.

7 SUMMARY OF BASIC DESIGN PARAMETER FOR STP

7.1 Summary of Basic Parameters for Design of Chhapkaiya STP:

Project Horizon	:	20 Years Base Year : 2015 Intermediate Year : 2025 Design Year : 2035
Population for Chhapkaiya STP Catchment	:	Base Year-2015 : 95,097 Base Year+5-2020 : 103,813 Intermediate Year-2025 : 113,863 Year 2030 : 125,499 Design Year : 140,219
Water Supply Rate	:	Domestic : 80 lpcd
Sewage Generation Rate	:	80% of water supply +10% Institutional + Ground Water Infiltration for Sewer design only (but infiltration excluded in STP capacity due to ex-filtration also)
Wastewater Generation for Chhapkaiya STP Catchment	:	Base Year-2015 : 7.36 MLD Base Year+5, 2020 : 8.03 MLD Intermediate Year, 2025 : 8.81 MLD For Year 2030 : 9.71 MLD Design Year-2035 : 10.85MLD
House Sewer Connectivity Envisaged:	:	Base Year-2015 : 50% Base Year+5 -2020 : 60% Intermediate Year-2025 : 70% Year 2030 : 80% Design Year-2035 : 90% (Slums & Squatter Pockets excluded as Onsite Sanitation)
Actual Sewage Collection Envisaged for Chhapkaiya STP	:	Base Year-2015 : 3.68 MLD (Say 4 MLD) **Base Year+5 : 4.82 MLD (say 5 MLD)** Intermediate : 6.17 MLD **(say 6 MLD)** Year 2030 : 7.77 MLD (say 8 MLD) **Design Year-2035 : 9.77 MLD (say 10 MLD)**
Peak Factor	:	**Adopted Peak Factor 2.50**
Sewage Treatment Plant Capacity Proposed	:	**Two module of each 5 MLD proposed immediately to cater flow up to year 2035.**
Sewage Treatment Technology	:	Natural Process: Waste Stabilization Pond Process (Anaerobic Ponds + Facultative Ponds) ***but without Maturation Pond*** as Land Area is restricted to 6.0 ha. For desired effluent BOD, M.P not required for raw sewage BOD up to 300mg/l as per Duncan Mara Manual.
Land Area Acquired	:	***6.0 ha (Available with Birgunj Municipality)***

Treated Effluent Discharge Point	:	MD-1 to Water Body (SIRSIYA RIVER)			
High Flood Level (HFL)	:	Near effluent discharge point at MD-1 after treatment:78.0 m			
Nearest Road Level	:	80.118 m			
Existing Ground Level of STP Site	:	79.2 m to 78.5 m (confirmed through survey)			
Trunk/Outfall Diameter	:	800mm RCC NP-3 (Sewerage design)			
Trunk/Outfall Invert Level	:	74.3 m (Sewerage design)			
Discharge Point Level	:	79.0m			
Peak Flow for both Modules of STP	:	25,000 m^3/day (=10 mld x 2.50 =25 mld =25,000 m^3/d)			
Raw & Treated Sewage Quality	:	Parameter	Influent (assumed)	Effluent (Reqd.)	Removal Ratio
		BOD (mg/l)	300	50	83.3%
		SS (mg/l)	450	100	78%
		Coliforms MPN/100ml	5.0 X 10^7	10,000	Duncan Mara WSP-Manual

Note: For Fecal coliforms control in Treated effluent, Chlorine contact basin with Chlorine dozing facility is required in absence of series of Maturation pond but it is not desirable on operation and maintenance point of view due to high recurring cost for chemicals. But this is also not recommended as cost can not be affordable.

7.2 Assumptions:

7.2.1 Water Supply Rate: 80 lpcd

Per capita BOD_5 contribution=40 gm /capita /day

Therefore BOD_5 = 40x1000/80= 500 mg/l

BOD degradation (Practically water consumption high thereby diluted BOD and BOD reduced in Septic Tank and longer sewer network. overall about 40% bio degradation assumed (as per Consultants experience and judgment as BOD removal in Septic Tank more than 50% and dilution of water will reduce the BOD level).

Hence design BOD value becomes 300 mg/l

Per capita suspended solids contribution is considered 70 gm/capita/day.

Therefore SS = 70 x 1000/80 = 875 mg/l= say 900 mg/l.

Hence design SS value becomes 450 mg/l

But Wastewater Sampling has been carried out for actual result of design parameters. Test results (Attached in annexure-2) show BOD value is 294 mg/l; Hence design BOD 300 mg/l is ok.

Other information: Birgunj Location

Latitude L_N= $26^0$57'45"- $27^0$02'30";

27^0 North latitude will be considered in Facultative Pond design.

Mean Annual temperature 24.5^{0}C; Maximum recorded 41.6^0 C and minimum recorded 4.5^{0}C

Altitude at WWTP Chhapkaiya is 79 m-78.90 m approx.

7.3 Process Scheme, Design Guideline and Detail Scope of Work

7.3.1 Process Scheme

Design Basis

Sewage Treatment Plant Capacity shall be:

Average Flow	:	10 MLD
Peak Factor	:	2.5 of average flow
Peak Flow	:	25 MLD

Raw Sewage Quality

An abstract of Raw Sewage Characteristics assumed for standard wastewater parameters are as follows: Also few Wastewater Sample Test results are attached in Annexure-2:

Parameters	**Values**	**Unit**
Biochemical Oxygen Demand (BOD_5)	300	mg/l
Total Suspended Solids	450	mg/l
Fecal Coliforms	5.0 X 10^7	MPN/100ml
pH	6.8 to 8.0	

(For development of methanogenic bacteria in Anaerobic Pond, Lime/ soda ash to be applied to maintain pH around 7.0 if pH is less and sewage is very acidic after testing of composite sewage samples)

7.3.2 Treated Sewage Quality

Treated Sewage Quality (as per SAARC Countries norms for discharge into water body)

BOD	<50 mg/l
TSS	<100 mg/l
pH	5.5-9.0
Fecal Coliform	<Less than or equal to 10,000 /100 ml

7.3.3 Detailed Scope of Work

The project shall have following major units:

1. Inlet Chamber for Incoming Sewer
2. Screen chamber with Screenings Storage facility
3. Sump Well/Lift Pump House

4. Grit chamber with Grit storage facilities
5. Flow Control Channel/ Parshall Flume
6. Distribution Chamber
7. Anaerobic Pond (A.P)
8. Facultative Pond (F.P)
9. Maturation Pond (M.P)
10. Inlet and Outlet Structures for the ponds
11. Treated Effluent Channel/pipe to towards water body
12. Sludge Drying Bed for Ponds Sludge Treatment
13. Administration Building (Office, Meeting room, Wash room, Workshop /Tool room, Laboratory room)
14. Security cabin/ Toilet Block
15. Interconnecting Piping
16. Plant Utilities- Plantation, Horticulture, Landscaping and gardening.

Pretreatment Units: The pretreatment units are designed for the peak flow of sewage generated by the year 2035. The sewage is to be pumped from the sewage pumping station located adjacent to WWTP.

Inlet Channel: Two nos. Inlet Channel are proposed to cater for the same discharge independently (peak flow for each channel). Each Channel will be provided with Sluice gate independently. Sluice gates are proposed to be submerged orifice of 12.5 mld each (total 25 mld) with size of each. Two bar racks each controlled by sluice gate on the inside wall of Receiving chamber

Bar Screens: Two no. bar racks has been proposed for peak discharge of 25 mld for the year 2035 with independent channels of 25 mld each keeping clear spacing between the bars 30 mm and width of bar 10mm. Two screens (one mechanical-working and one manual-Stand-by) are proposed for peak load of sewage considering the clogging of bars as 50%. Flow will be diverted towards sump well of Pumping Station.

Receiving Chamber: The Receiving Chamber will receive sewage from the Lift/pumping station. It has been designed to cater for 15-20 sec. of peak flow of sewage for the year 2035 considering detention period of liquid as 15 sec.

Grit Chamber: Two units of grit chambers have been proposed for peak load of sewage for the year 2035 for collection of grit up to depth o.25m. The capacity of grit chambers has been worked out after considering the practical settling velocity (0.019m/sec) which is governed by size (0.15mm) and specific gravity (2.65 for inorganic) of grit to be separated and the viscosity of sewage. The correction for surface overflow rate due to practical factors i.e turbulence, short-circuiting, index of performance and removal efficiency has been made.

Parshall Flume: The Parshall Flume will work as discharge measuring device as well as flow control device for range 0-45 mld which will cover 25 mld peak sewage flow for STP for year 2035.

Distribution Chamber: Flow from Parshall Flume/ Flow measuring channel will pass through the distribution box for distributing the required quantity of flow to each anaerobic Pond through RCC Pipe with a control valve attached with the discharge measuring devices so that only required quantity of sewage may flow to each tank.

7.4 Process Design Parameters

a. Anaerobic Pond:

Retention Time: Min. 1 day, Volumetric loading for temperature 20^{0}C and above 300-350 gm//m^3/d. BOD removal 60%-70%

b. Facultative Pond:

Retention Time: Min. 5 days for temperature below 20^{0}C and 4 days for above 20^{0}C, BOD loading for temperature 20^{0}C and above 250-400 kg/ha/d and BOD removal 70%-80%.

c. Maturation Pond:

Retention Time: Min. 4 days for temperature below 20^{0}C and 3 days for above 20^{0}C. BOD removal 25% of BOD of effluent from Facultative pond in each Maturation Pond when in series but BOD removal is insignificant. Maximum permissible Faecal Coliforms in treated effluent 10,000nos. /100 ml for unrestricted irrigation.

7.5 Process Design Method:

7.5.1 Anaerobic Pond

The sewage from distribution chamber shall be taken into anaerobic ponds through RCC channel/pipes. These ponds shall be designed for an average flow of 10 MLD. These anaerobic pond can be satisfactorily designed and without risk of odour Nuisance on the basis of volumetric BOD loading (λ_V, g/m^{3}d), which is given by Duncan Mara- Design Manual on WSP in India.

$\lambda_V = L_iQ/V_a$. (Manual Equation No. 4.2)

where

L_i = influent BOD, mg/l (= g/m^3)

Q = flow, m^3/d

V_a = anaerobic pond volume, m^3

The following table gives recommend the design values permissible volumetric BOD loadings on and percentage BOD removal in anaerobic ponds at various temperatures +which may be safely used for design purpose. Retention times in anaerobic ponds less than 1 day should not be used.

Design values of permissible volumetric BOD loadings on and percentage BOD removal in anaerobic ponds at various temperatures (Reference: Table 4.1 of Duncan Mara –Design Manual on WSP in India)

Temperature(°C)	Volumetric loading(g/m^3-d)	BOD removal (%)
<10	100	40
10-20	20T-100	2T+20
20-25	10T+100	2T+20
>25	350	70

It is necessary to bypass anaerobic ponds so that facultative ponds may be commissioned first and also during desludging operations. Figure shows schematically a by-pass arrangement for two series of WSP in parallel.

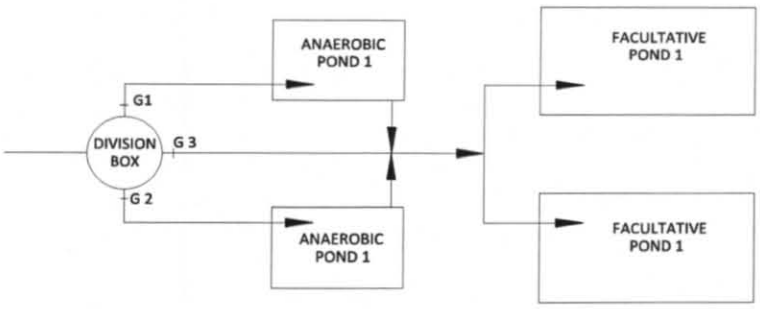


Figure 7 - 1: Bypass Pipe Work for Anaerobic Ponds

Note: Anaerobic pond sludge annually should be cleaned and can be directly transported to solid waste land fill site (LFS) for further treatment or it can be used as soil conditioner by farmers or it can be placed in the depression area in the vicinity.

7.5.2 Facultative Pond

The treated water from anaerobic pond shall be carried to facultative ponds. It is recommended that they should be designed on the basis of surface BOD loading (λ_S, kg/ha d), which is given by:

$\lambda_S = 10L_iQ/A_f$ (Manual Equation 4.4)

Where

L_i = influent BOD, mg/l (= Kg/m^3)

Q = flow, m^3/d

A_f = anaerobic pond area, ha

Variation of design BOD loading on facultative ponds with latitude (Table 4.3 Duncan Mara)

Latitude (°N)	Design BOD loading (kg/ha day)
36	150
32	175
28	200
24	225
20	250
16	275
12	300
8	325

$\lambda_S = 375 - 6.25*L$ (Manual equation 4.5)

The latitude for the Birgunj town is 27°N (Equivalent degree is considered)

The design BOD loading rate based on Latitude is about 200 kg/ha-day

The design BOD loading rate based on Latitude and Elevation is given by

$= \lambda_S / (1+0.0003*E)$

Where

E= elevation above mean sea level in m

The design BOD loading rate based on design Temperature is given by Duncan Mara

$\lambda_s = 20T - 120$ (Manual Equation 4.7)

The design BOD loading rate based on Temperature for Global Design equation is given by Prof. Duncan Mara

$\lambda_s = 350\ (1.107-0.002T)^{T-25}$ (Manual Equation 4.8)

A conservative loading rate shall be adopted.

Thus the facultative pond area is given by the equation

$A_f = 10L_iQ/\lambda_S$

The retention time (θ_f, day) for the facultative pond is given by the equation

$\theta_f = 2A_fD/(2Q_i - 0.001A_fe)$ (Manual Equation 4.12)

Where

θ_f = retention time, day

A_f = Facultative pond area, ha

D = Pond depth in m

Q_i = influent flow in m^3/day

e = rate of evaporation in mm/day

The permissible design value of λ_S shall be taken one based on latitude, and one based on temperature. A minimum value of detention time of 5 days should be adopted for temperatures below 20°C, and 4 days for temperatures above 20°C. This is to minimize hydraulic short-circuiting and to give the algae sufficient time to multiply (i.e. to prevent algal washout).

The cumulative filtered BOD removal in the anaerobic pond and facultative pond is 90% for temperature more than 20°C.

7.5.3 Maturation Pond (Cannot be accommodated with available

Maturation ponds (1-1.5m deep) receive the effluent from a facultative pond, and the size and number of maturation ponds is governed mainly by the required bacteriological quality of the final effluent. Maturation ponds usually show less vertical biological and physicochemical stratification and are well oxygenated throughout the day. Their algal population is thus much more diverse than that of facultative ponds. The primary function of maturation ponds is the removal of excreted pathogens, and this is extremely efficient in a properly designed series of ponds. Maturation ponds achieve only a small removal of BOD, but their contribution to nutrient (nitrogen and phosphorus) removal can be significant.

7.5.4 Inlet and Outlet Structures for the Ponds

The inlet to anaerobic and primary facultative ponds should discharge well below the liquid level so as to minimize short-circuiting (especially in deep anaerobic ponds) and thus reduce the quantity of scum (which is important in facultative ponds). Inlets to secondary facultative and maturation ponds should also discharge below the liquid level, preferably at mid-depth in order to reduce the possibility of short-circuiting.

The outlet of all ponds should be protected against the discharge of scum by the provision of a scum guard. The take-off level for the effluent, which is controlled by the scum guard depth, is important as it has a significant influence on effluent quality. In facultative ponds, the scum guard should extend just below the maximum depth of the algal band when the pond is stratified so as to minimize the daily quantity of algae, and hence BOD, leaving the pond. In

anaerobic and maturation ponds, where algal banding is irrelevant, the take-off should be nearer the surface: in anaerobic ponds it should be well above the maximum depth of sludge but below any surface crust, and in maturation ponds it should be at the level that gives the best possible microbiological quality. The following effluent take-off levels are recommended:

Anaerobic ponds: 300 mm
Facultative ponds: 600 mm
Maturation ponds: 50 mm

The installation of a variable height scum guard is recommended, since it permits the optimal take-off level to be set once the pond is operating.

The outlet from the final pond in a series should discharge into a simple flow-measuring device such as a triangular or rectangular notch. Since the flow into the first pond is also measured, this permits the rate of evaporation and seepage to be calculated or, if evaporation is measured separately, the rate of seepage.

7.5.5 Effluent Channel

Treated sewage shall be taken to the nearest drain/river through RCC channel. The length of the channel shall be as per site condition. Capacity of the channel should be such that it can carry peak flow. The channel shall be constructed in M 25 grade concrete (Sulphate Resistant Cement). RCC platform 1000mm wide with railing as per specifications shall be provided.

7.6 Process Design of WSP

1. Stable and impermeable embankment shall be constructed
2. Pond will seal naturally k< 10^{-8} m/s and pond must be lined when k<10^{-6} m/s
3. Embankment Slope are commonly 1:2 to 1:3 internally and 1:1.5-2 externally.
4. External embankment should be protected with adequate drainage
5. Internal embankment should be protected with lining either in precast concrete slab or stone rip-rap at Top water level to protect against erosion due to wave action.
6. Length to width ratio for Anaerobic/Primary Facultative Pond 2-3:1 and for Secondary Facultative Pond / Maturation pond max. 10:1 for plug flow.
7. Free Board shall be 0.5m for area below 1 ha and 0.5-1m for area 1ha-3 ha plan area at TWL.
8. Anaerobic pond depth 2-5m, Facultative pond 1-2 m and maturation pond 1-1.5m

Note: All other parameter shall conform to standards and good engineering practice.

7.7 Design Summary of Operational Units & Process Units

7.7.1 Inlet Chamber with pH Adjustment

Total Average flow	10 MLD
Peak factor	2.50
Peak Flow	25 MLD=0.289 m^3/sec
Number of Units	(1) One
Detention period	30 sec
Min Free board	0.5m
Size of inlet chamber	3.0 m x 3.0 m x 1.0 m water depth + 0.5 m FB

7.7.2 Primary Screen Chamber

Number of screen channels	2 nos.
Number of Screens	1Mechanical (Working)+ 1 Manual Standby
Design flow (Peak) considered to channel	25 MLD=0.289 m^3/sec
Screen Bar width	10 mm (size 10mm x 50 mm)
Screen Bar Opening	30mm
Design Approach velocity	1 m/sec
Each Channel Size (Tentative)	4.0 m long x 1.2 m wide x 0.5 m water depth (LD) + 0.5 m Free board
Angle of inclination	45^0 for manual & 75^0 for mechanical
Operation	Mechanically & Manually operated

.Note: Screenings will be collected regularly (0.015m^3/mld) and 7 days storage will be considered in screenings storage area (2m x 2m x 0.5m height). Disposal is usually done by incineration and or burial at the plant site as quantity is small.

7.7.3 Sump Well for Pumps

Total Average flow for 20 years Design period for Sump (year 2035)	10 MLD
Peak factor	2.50
Peak Flow	25 MLD=0.289 m^3/sec
Number of Units	(1) One
Detention period at av. Flow and Peak flow at Sump Well	Should not exceed 30 minutes at Average Flow but adopted 9.55 minutes at average flow and 3.82 minutes at peak flow which is justified with 4 numbers of pumps starts/stops per hour.
Size of Sump Well	7.50 m diameter x 1.5 m Effective water depth + minimum 0.5 m Suction depth
Pumping Main DI-K9	500 mm diameter, 15.0 m length

7.7.4 Pumps and Pumping Main

Total Average flow for 15 years design period- Year 2030 for pumps	8.985 MLD (104 LPS)
Peak factor	2.50
Peak Flow	22.46 MLD= 0.26 m^3/sec
Number of Total Pumps	(5) Five
Capacity of Pumps provided	3 Nos. (2 W + 1 SB) pumps @380 m^3/hour with Head 12 M and 2 Nos. Pumps (1 W + 1 SB) @190 M^3/hour with Head 12 M
Pumping Main DI-K9	250 mm diameter-3 nos. and 200 mm diameter 200 mm, each 15.0 m length has been kept.

7.7.5 Grit Chamber

No. of grit channels	2 nos. channels (both manually working)
Design flow (Peak) consider for grit channels	0.289 m^3/s
Type	Rectangular type RCC construction
Detention Time at Peak flow	Minimum 60 Sec
Particle size to be removed	0.15 mm or more
Horizontal Velocity	0.15 m/sec (Range0.15-0.3m/sec)
Grit storage space	250 mm
Free board to be provided	300 mm
Each Dimensions	9 m x 1.25 m x 0.75 m ht + 0.30 m Free Board+0.25m dead storage for silt

Note: Grit production is 0.1m^3/mld and grit storage area (3mx3m x1m height of storage) will be considered for 7 days. Disposal of grit is generally done by filling low lying areas in the vicinity.

7.7.6 Parshall Flume/Flow Control Channel

No. of Chambers	1 No.
Design flow considered	0.289 m^3/s
Type	Long Channel RCC construction
Throat Width	300mm
Depth of Channel in u/s leg of Flume	0.70m
Width of Channel	0.70m
Free board to be provided	0.3m
Dimensions	5.0 m x 0.75 m x 0.75m LD + 0.3 m Free Board

7.7.7 Distribution Chamber

No. of Chambers	1 No.
Design flow considered	0.289 m^3/s
Type	Circular RCC construction
Detention Time at Peak flow	30 Sec
Free board to be provided	0.5m
Dimensions	3.0 m x 3.0 m x 1m LD + 0.5 m Free Board
MOC	RCC

7.8 Waste Stabilization Ponds

7.8.1 Anaerobic Pond

Total design Flow	10 MLD
No. of Ponds	2 Nos.
Design flow consider for each A.P.	5 MLD
Type	Rectangular
Minimum Detention Time	Minimum 1 Day adopted
Designed Volumetric BOD Loading	330 g/m3/d (Range 100-350g/m3/d)
Top Dimensions of each pond	At Top: 59 m x 35 m x 4.5m LD + 0.5 m Free Board; Bottom: 39 m x 15 m

7.8.2 Facultative Pond

Total design Flow	10 MLD
No. of Ponds	2 Nos.
Design flow consider for each F.P	5 MLD
Type	Rectangular
Detention Time	Minimum 4 Days for Temperature less than 20^0 C and 5 days for Temp above 20^0C but adopted average 4.5 days
Designed BOD Surface Loading Rate	322 kg/ha/d (Range 100-400 kg/ha/d)
Top Dimensions of each Pond	204 m x 62.5 m x 2.0m LD + 0.5 m Free Board At Bottom: 52.5m x 194 m

Note: Design is safe for temperature 20^0C and above but when temperature is less than 20^0C, BOD removal efficiency will be affected mainly in winter/cold season. Land area is not sufficient for 2 days detention time for Anaerobic Pond and 5 days detention time for Facultative Pond.

7.8.3 Maturation Pond (Design Purpose but Will Not be Provided due to Shortage of Land)

Total Design Flow	10 MLD
No. of Ponds	2 Nos.
Design flow consider for each grit chamber	5 MLD
Type	Rectangular
Detention Time	Minimum 3 Days
Dimensions	At Top: 205 m x 55 m x 1.5m LD + 0.5 m Free Board; At Bottom 197 m x 47 m.

7.8.4 Treated Effluent Channel

After sewage/ wastewater treatment through Waste Stabilization Pond process (Anaerobic Facultative Pond/Maturation Pond), treated wastewater is to be channelized to nearest water body/ drain (MD-1 to Sirsiya River). Treated Effluent can be disposed off through pipe or rectangular channel and Cascade type outfall will be provided.

7.9 Interconnecting Arrangement

S.No.	From	To	Material and class
1.	Inlet Chamber	Coarse Screen Chamber	RCC M25 Channel
2.	Coarse Screen Chamber	Sump Well/Wet Pump Well	RCC M25 Channel
3.	PUMP WELL	Medium Screen Chamber	500 mm dia. Pumping Main (DI)
4.	Receiving Chamber	Medium Screen Chamber	RCC M25 Channel
5.	Medium Screen Chamber	Grit Chamber	RCC M25 Channel
6.	Grit Chamber	Parshall Flume	RCC M25 Channel
7.	Parshall Flume	Distribution Chamber	RCC M25 Channel
8.	Distribution Chamber	Anaerobic Pond	500 mm dia. PVC Pipe
9.	Distribution Chamber	Facultative Pond Bypass with Gate	500 mm dia PVC Pipe
10.	Anaerobic Pond	Facultative Pond	350mm dia. PVC Pipe
11.	Facultative pond	Outlet Collection Chamber1 & 2	350 mm PVC Pipe
12.	Outlet Collection Chamber -1	Outlet Collection Chamber-2	350 mm dia PVC Pipe
13.	Collection Chamber-2	Main Drain MD-1	500 mm PVC Pipe/RCC M25 Channel (0.80m W x 0.4 m D)

Note: It is also necessary to bypass the Anaerobic Pond for two reasons:

a. In case the sewage is very weak or its flow is low due to less sewer connections or volume loading is less than 30 g/m^3/day.

b. It is also necessary to by-pass the Anaerobic Pond whilst it is being desludged.

7.10 Anaerobic Pond Sludge Treatment

7.10.1 Sludge Lagoon (Generally Recommended by Soli. J. Arceivala & Duncan Mara Design Manual on WSP in India)

As desludging will be done when one third volume of Anaerobic Pond will be full of sludge deposition.

(Desludging frequency (n) = Va /(3 x Population x 0.04m^3/capita/year sludge generation).

Population Equivalent (PE) for 10 MLD STP is 1, 56,250

Sludge generation will be 6250 m^3/year.

De-Sludge Frequency is at least once in a year but recommended six months interval for satisfactory performance of Anaerobic Pond.

Consolidated Sludge /year will be 3125m3/year.

Sludge lagoon Size: 20 m (L) x 15 m (W) x 4 m (D) - 3 Nos.

As suggested by PMSC, Sludge Drying Beds 11.0 m x 20 m-8 Nos. instead of 24 Nos. SDB required as per calculation have been provided due to land constraints. For WSP usually SDB is not recommended generally as desludging frequency is not daily basis/regular): 20m x 11.0m-8 Nos. (can be kept as insisted by PMSC but this is not adequate).

7.10.2 **Sludge Handling Options:**

a. *This treated sludge of Anaerobic Pond will be transported to either Solid Waste Land Fill Site for further treatment or wet sludge can be sold to farmer for use as soil conditioner as it can be directly applied to agricultural land..*
b. *Desludging is required when it is one third full of sludge by volume.*
c. *It can be noted that Sludge Drying Bed (SDB) is not recommended for Waste Stabilization Pond (WSP) Process as it needs huge land Area as desludging frequency is generally once in a year (frequent desludging not required) for Anaerobic Pond and 6-8 years in Facultative Pond. Advantage of WSP (Anaerobic Pond) Sludge that it is basically digested and stabilized sludge. It can be directly used as soil conditioner.*
d. *Good revenue generation will be done in case of sale of consolidated sludge.*
e. *SAARC Country Manual also recommends emptying the Anaerobic Pond up to the top water level and allowing it for drying for some time in pond itself. Then pond can be desludged.*
f. *As per Soli J. Arceivala, during high flood situation, stabilized sludge of Anaerobic Pond will be pumped directly to flood water during high flood situation.*

7.10.3 **Other Requirement**

Office cum Laboratory Building with Workshop/Tool Room, Generator Room, Transformer Yard, Under Ground Water Tank with Pumps & Tube Well, Security Cabin, Watchman Quarter.

7.10.4 **Plant Utilities**

A. Compound Wall and Gate

Compound wall or proper Fencing with Gate is to be provided surrounding the WWTP site as per drawing.

B. Storm Water Drainage:

Site development will be made such a way; there will be no water logging within the WWTP site. Proper storm water drainage is to be provided.

C. Approach Road, Pathways

An access road through the site along with a network of pathway provided to link the existing approach road and permit access to the WWTP site for necessary maintenance, delivery of consumables and personnel access.

D. Fire Extinguishers

The portable fire extinguishers of approved make shall be provided at the Office room.

E. Yard Lighting

Effective yard and building lighting systems shall be provided within the treatment plant site in order to provide sufficient illumination for proper operation and maintenance during day and night periods. In addition, the entire treatment plant site shall have sufficient street lights and perimeter lights for various operations, safety and security reasons.

F. Plantation, Horticulture, Landscaping and Gardening

Landscaping involves beautification of Wastewater Treatment Plant site by cultivating suitable Plants and Trees of environmental value and suitably modifying the appearance of WWTP site. It shall add scenic value to the WWTP site to obtain maximum visual impact apart from abatement of pollution.

8 HYDRAULIC DESIGN OF OPERATIONAL UNITS

8.1 Design of Sewage Pumping Station

8.1.1 Inlet chamber

Ultimate Average flow (2035)	10.0	MLD
	0.12	m^3/s
Peak Factor	2.5	
Peak Flow	0.289	m^3/s
Detention Time	30	Sec
Capacity	8.7	m^3
Liquid Depth	1.0	m
Area	8.6806	m^2
Free Board	0.5	m
Size	3.0 x 3.0x 1.0	m^3

8.1.2 Outfall channel

Ultimate Average flow (2035)	10	MLD
	0.12	m^3/s
Peak Factor	2.5	
Peak Flow	0.289	m^3/s
Velocity	1	m/s
Area	0.29	m^2
Economic hydraulic section is where d=b/2*		
Breadth(b)	0.7607	m
Depth(d)	0.3804	m
Free Board	0.3	m
Channel Size	0.8 x 0.4 x Length	m^3

*When pipe is provided, it shall be 500 mm diameter RCC NP-3 Pipe.

8.1.3 **Screen chamber**

(Ref: CPHEEO Manual on Sewage Treatment, Dec 1993, Pg 200 to 203)

No. of Units	2	(1W+1S)
Material of construction	RCC	
Design Average Flow (Ultimate)	417	m3/hr
Design Peak Flow (Ultimate)	1041.7	m3/hr
Clear opening of bars	30	mm
Size of bars	10mm x 50mm	mm
Type of screen	1 no. manually cleaned & 1 no. mechanically cleaned	
Velocity through the screen at peak (design) flow	1.0	m/s
Area of flow considering peak flow: [(1041.7/3600) /1] x40/30	0.39	m^2
Velocity through the screen at average flow	0.6	m/s
Area of flow considering average flow: [(416.7/3600) /0.6] x 40/30	0.26	m^2
Therefore area of flow	0.390	m^2
Considering width of screen chamber	1.2	m
Liquid Depth of Screen Chamber arrived	0.4	m
Let no. of bars be	n	
Clear opening of bars	30	mm
Size of bar	10 mmx 50	mm
Therefore (n +1) 30 + 10n	1200	
30n + 30 + 10n	1200	
40n	1170	
No of bars	33.43	
say	33	bars

Length of manual screen chamber is calculated as follows:		
Liquid depth	0.4	m
Free board	0.5	m
Total depth	0.9	m
Angle of inclination	45	degrees
Slant height : (0.9/sin45)	1.27	m
Length of manual screen chamber required = 2.5 x Slant height = 2.5 x1.27	3.175	m
	3.2	m (say)
Length of mechanical screen chamber is calculated as follows :		
Liquid depth	0.4	m
Free board	0.5	m
Total depth	0.9	m
Angle of inclination	75	degrees
Slant height : (0.9/sin75)	0.93	m
Length of manual screen chamber reqd.: (2.5 x Slant ht.) : (2.5 x0.93)	2.325	m
	2.4	m (say)
However for uniformity, length of mechanical screen chamber is kept equal to that of the manual screen chamber		
Size of each screen chamber provided: 4.0 m (L) x 1.2m(W) x0.4m(LD)+0.5 m(FB)		
Velocity above screen , v = 3/4*V	0.750	(m/sec)
Head loss through the screen, H_{L1} = 0.0729(V^2 - v^2)	0.032	(m)
If the screen openings are half clogged the velocity through the screen is double		
Head loss through the screen, H_{L2} = 0.0729((2*V)^(2) - v^2))	0.251 m	< 0.30 m O.K. (Ref: Indian CPHEEO Manual)

8.1.4 Design of Wet well/Sump & Pumps

S. No	Description	Unit	Designed Value					
1.00	Flow at sump well (SPS)		Average Flow			Peak flow		
			2015	2030	2035	2015	2030	2035
		mld	6.75	9	10	16.9	22.2	25
		lps	78	104	115	194	256	286
2.0	Level Information (From survey data)							
2.1	Average ground level of SPS	m	GL		79.0			
2.2	Lowest Invert level of incoming sewer to the SPS	m	IL		74.4			
2.3	Water Level in Pipe in sump	m	WL		74.6			
2.4	Max. Water Level in Sump	m	WL		73.6			
2.5	Highest Level in the force main alignment	m	HGL		83.5			
3.0	Design of Sump							
3.1	Designed average discharge to Sump in 2035	lps	Q_{2035}		115.0	considering average flow of 2035		
3.2	Max.Capacity to be provided in cum for 30 minutes detention period	m^3	V		207.0			
3.3	Minimum Sump Capacity	m^3	$V_{min}=Q_{peak}/4$		64.27	Assuming pumps start & stop/hour=4		
3.4	Provide following dimensions for the sump							
3.4.1	Area of Sump Well	m^2	A		42.84			
3.4.2	Dimension of Circular Sump Well	m	Dia.		7.4			
3.4.3	Thickness of wall	m	T_{min}		0.3			
3.4.4	Effective depth of Liquid at Wet Well/Sump	m	LD_{min}		1.5m			
3.5	Capacity of the proposed sump	m^3	V		66.23			
3.6	Min. level of Wet Well/Sump	m	BL = WL- LD		72.10			
3.7	Provide min. 0.5 m depth for suction chamber	m	SL		71.60			
3.8	Suction level of bell mouth of the pump	m	SUL=SL+0.2		71.80			

4.00	Design of Sewage pumps	Unit			**Remarks**
4.10	Designed average sewage discharge for 2030 at sump well	lps	Q_{2030av}	104.0	
4.20	Designed peak sewage discharge for 2030 at sump well	lps	$Q_{2030peak}$	256	
4.30	Length of pumping main	m	LRM	12	From survey data
4.40	Dia of pumping main proposed	mm	d_{max}	250	250 mm -3 nos. & 200 mm dia. 2 nos.
4.50	RL of Minimum Water Level	m	WL_{min}	72.1	
4.60	RL of terminal point/highest point of pumping main	m	HGL	83.25	
4.70	Total head for pumping	m/s	v	2.12	
4.7.1	Static head	m	Hs = HGL - SUL	11.15	
4.7.2	Friction loss	m	$H_f = 4flV^2/2gd$	0.81	
4.7.3	Other losses	m	H_o = 10% of H_f	0.08	
4.7.4	Total head	m	$H = H_s + H_f + H_o$	12.0	
4.80	Combination of pumps are proposed to be provided				
4.8.1	For Peak flow (256 lps)		NIL		
4.8.2	For average flow (104lps)		3 Nos. (2W + 1SB)	This combination will give at least 50% Flow Standby on Peak Flow (Reqd. 1.50 xPeak Flow =1.5x260=384 lps) but capacity provided 416lps, hence OK	
4.8.3	For lean flow (52 lps)		2 Nos.(1W + 1 SB)		
4.90	Desired HP of pumps (assuming 60% efficiency)				
4.9.1	For Peak flow	HP	68.46		
4.9.2	For Av. Flow	HP	27.38		
4.9.3	For Lean Flow	HP	13.69		

8.2 Design of Pre-treatment Unit (PTUs)

All units from Receiving Chamber to Parshall Flume are designed for ultimate peak flow (year 2035). Design ultimate average and peak flows are 10 MLD and 25 MLD respectively.

8.2.1 **Receiving chamber**

Particulars	Unit	Quantity	Material	Remarks
No. of Units	No.	1		
Material of construction			RCC	
Design Average Flow (Ultimate)	MLD	10		
	m^3/hr	416.7		
Peak Factor considered as per PCO	-	2.5		
Design Peak Flow (Ultimate)	MLD	25		
	m^3/hr	1041.7		
The velocity of sewage through the stilling/Receiving chamber shall be low enough in the range between 0.05 m/s and 0.07 m/s to avoid any turbulence to the incoming water.				
Velocity considered at peak flow	m/s	0.07		
Area of Receiving chamber required	m^2	4.13		1041.7/(3600 x 0.07)
Width of Receiving chamber considered	m	2.50		
Length of Receiving chamber arrived	m	1.70		
Actual area provided	m^2	4.25		
Detention time considered for peak flow	seconds	15		
Receiving chamber Volume	m^3	4.34		(1041.7/3600) x15
Liquid depth arrived :4.34/4.25	m	1.1		
Free Board considered	m	0.5		
Size of Receiving Chamber provided 1.7m (L) x 2.5m (W) x 1.1m LD + 0.5m FB				

8.2.2 **Grit Chamber**

Particulars	Unit	Quantity	Remarks	
Peak Design Flow , Q	MLD	25.0		
	m^3/sec	0.289		
Detention Time	s	60		
Horizontal Velocity, V	m/s	0.150	Range 0.15-0.3	
Specific Gravity of Particles		2.65		
Diameter of particles	m	0.00015	15mm	

Design Temperature	°C	20		
Settling Velocity of particles as per Hazen William's modified Equation (Vs = 60.6 (Ss-1) x d x (3T+70)/100	m/s	0.0193		
Surface Over Flow Rate (SOR) for 100% removal efficiency in an ideal grit chamber for particle size o.15mm and specific gravity 2.65 ; v_s =((0.707(Ss-1)d^1.6v^-0.6))^0.714	$m^3/m^2/d$	1555.0		
Stokes law $v_s=g/18(Ss-1)d^2/v$; where kinematic viscosity $v=1.14x10^{-6}m^2/s$	m/s	0.018		
Actual SOR due to turbulence and short-circuiting based on Index of performance and removal efficiency	$m^3/m^2/d$	1111.825		
		1110.0	say	
Total Plan Area of Grit Channel (Q_{peak}/SOR)	m^2	22.523		
No. of Grit Channel	no.	2		
Plan Area of each Grit Channel	m^2	11.261		
Total Volume of Grit Chamber	m^3	17.361		
depth of grit chamber	m	0.771		
	m	0.750	say	
Length of each Channel (Horizontal Velocity x detention Time)	m	9.000		
Width of each Channel	m	1.251		
Provide Width of Channel	m	1.250		
Allowable Head loss	m	0.030		
Free Board	m	0.30		
Grit/Silt depth	m	0.25		
Size of Grit Channel (2 Nos.) each 9 m x 1.25 m x 0.75 m (LD)				
Horizontal Velocity v_h = Q/(1000*b*D)	m/s	0.154	Ok	

8.2.3 Parshall Flume (Flow Measuring Channel)

Particulars	Unit	Quantity
Flow Measurement Range	MLD	0-45
Average Flow , Q	MLD	10.0
	m^3/s	0.116
Peak Factor		2.5
Peak Design Flow	MLD	25.0
	m^3/s	0.289
No. of Channel	no.	1
Flow through channel	lps	289.352
$Q = 2264\ W\ (Ha)^{3/2}$		
Throat Width (W)	m	0.23
Depth of flow in Upstream leg of flume (Ha)	m	0.7
Velocity	m/s	1.0
Width of Channel		0.7
Depth of flow in downstream leg of flume (H_2) for $H_2/H_1=0.7$	m	0.5
Length of Throat	m	0.45
Length of Straight Channel at upstream side 3 x Ha	m	2.0
Length of Straight Channel at downstream side 2 x Ha	m	1.5
Dimension		
Length (L)	m	5
Throat Width (W)	m	0.23
Width of Channel	m	0.7
Liquid Depth (D)	m	0.7
Free Board	m	0.3

8.2.4 Distribution Chamber

Particulars	unit	Quantity
Ultimate Average flow (2035)	MLD	10.0
	m^3/s	0.12
Peak Factor		2.5
Peak Flow	m^3/s	0.289
Detention Time	s	30
Capacity	m^3	8.7
Liquid Depth	m	1.0
Area	m^2	8.6806
Free Board	m	0.5

Size	3.0 m x 3.0 m x 1.0 m	
Ultimate Average flow (2035)	MLD	10
	m^3/s	0.12
Peak Factor		2.5
Peak Flow	m^3/s	0.289
Velocity	m/s	1
Area	m^2	0.29
Economic hydraulic section is where d=b/2		
Breadth(b)	m	0.7607
Depth(d)	m	0.3804
Free Board	m	0.3
Channel Size	m^3	0.8 x 0.4 x Length

When pipe provided it shall be 500mm diameter RCC/PVC pipe.

9 HYDRAULIC DESIGN OF PROCESS UNITS

9.1 STIUEIP-Birgunj: Design of 10 MLD wastewater treatment plant, waste stabilization pond (WSP) system

Location: Chhapakaiya

Description	Unit	Value	Remarks
Design Flow (Q)	MLD	10	
	m^3/d	10000	
	m^3/hr	416.67	
No of Module	no.	2	
Design flow in each Module	m^3/d	5000	
Relevant Design Parameter			
Influent BOD_5 at $20^0C(L_i)$	mg/L	300	
No of Faecal coliform in influent (Ni)	per 100 ml	50000000	
Max. ambient Temperature (T_{max})	^0C	41.6	Collected data
Min. ambient temperature (T_{min})	^0C	4.5	Collected data
Avg. ambient temperature (T)	^0C	23.05	
Elevation above MSL	m	79	Survey data
Latitude of the place (L_t)	^{0}	27	Collected data
Avg. rate of evaporation (e)	mm/d	5	Collected data

Design of anaerobic pond

Description	Unit	Value	Remarks
Permissible Volumetric BOD loadings at 23.05^0C (L_p)	$g/m^3.d$	330.5	Manual Table 4.1
Volume of Pond Required $V_a = (Q \times L_i)/L_p$	m^3	4538.58	Manual equation 4.2
Detention time $t = (V_a/Q)$	day	0.91	Manual equation 4.3
Adopted Detention time	day	1	Minimum
Adopted Volume of Pond , V	m^3	5000	
Assume Depth of water , D	m	4.5	Manual 2-5 m
Area of Pond Required $A_a = (V/D)$	m^2	1111.11	
Calculated width $B = (A_a/2)^{\wedge}0.5$	m	23.57	
Adopted width	m	24	
Adopted length	m	48	
Adopted area , A	m^2	1152	
Actual Volumetric Loading $La = (Q \times L_i)/(A \times D)$	$g/m^3.d$	289.35	
At 23.05^0C Percentage of BOD Removal is 66.1%	mg/L	198.30	66.1
BOD in anaerobic pond effluent is $L_{ea} = 0.34 \times L_i$	mg/L	101.70	

Design of facultative pond

Description	Unit	Value	Remarks
Permissible BOD loading rate	kg/ha-day		
A) Based on Latitude			Duncan Mara
$L_{sl} = 375 - 6.25 \times L_t$		206.25	Manual equation 4.5
After modification for elevation			
After modification for elevation $L_{slm} = Lsl/[1 + 0.0003 \times MSL]$		201.48	Manual equation
B) Based on temperature			
$L_{st} = 350[1.107 - 0.002T]^{(T-25)}$		311.89	Manual equation 4.8
Adopted BOD loading value	kg/ha/d	312	Say
Pond area required $A_f = (10 \times L_i \times Q)/L_s$	m^2	16298.08	Manual equation 4.4
Adopt depth (D)	m	2	Manual 1 - 2 m
Retention time of Facultative Pond $t = (2 \times A_f \times D)/(2 \times Q - 0.001 \times A_f \times e)$	day	6.57	Manual equation 4.12
Adopt retention time	day	4.5	above 20^0C min.4 days
Adopted area	m^2	11124.85	Manual equation 4.12
The cumulative BOD removal in anaerobic and facultative pond is assumed to be 90 %			
Actual BOD Loading	kg/ha/d	322	within range 100-400
Hence effluent BOD $L_{ef} = 0.10 \times L_i$	mg/L	30	less than 50 mg/l

Pond sizing: considering slope of the embankment1:2 (inner)

Anaerobic Pond	Unit	Value
Mid depth area required (A_{am})	m^2	1111.11
Depth (D)	m	4.5
Free Board provided	m	0.5
Top width of the embankment (T)	m	3.0
Slope of the embankment		
Inner (1:2)		0.50
Outer (1:2)		0.50
Calculated width		
$B = (A_a/2)^{0.5}$	m^2	23.57
Adopted Mid depth length L	m	48
Adopted Mid depth width B	m	24
Bottom Dimension of the Pond		
Length	m	39
Width	m	15
Area of the Bottom Portion (A_b)	m^2	585
Top Dimension of the Pond at water depth		
Length	m	59
Width	m	35

Area of the Top Portion at water depth (A_b)	m^2	2065
Required Volume	m^3	5000
Provided Volume	m^3	5623.65
Top of the Pond		
Top level Length	m	59
Top level width	m	35
Area required including bund	m^2	2065

Facultative pond	Unit	Value
For anaerobic pond sludge volume=0.04/capita/year	m^3	6250.00
Population Equivalent (PE) to 10 MLD at 64 LPCD wastewater	m^3	156250
Consolidated sludge (50%)volume per year	m^3	3125.00
Sludge volume provided in A.P.=	m^3	1828.28
Cleaning required	years	0.59
Say	years	0.5
Sludge produced for SDB	m^3	1562.50
Sludge Application Thickness	m	0.30
Area Required for Sludge Drying Bed	m^2	5208.33
Each SDB Size 20 m x 11 m	m^2	220.00
No. of SDB Required	nos.	24
No. of SDB Provided due to land constraints	nos.	8

Sludge storage and cleaning requirement

Description	Unit	Value
For anaerobic pond sludge volume=0.04/capita/year	m^3	6250.00
Population Equivalent (PE) to 10 MLD at 64 LPCD wastewater	m^3	156250
Consolidated sludge (50%)volume per year	m^3	3125.00
Sludge volume provided in A.P.=	m^3	1828.28
Cleaning required	years	0.59
Say	years	0.5
Sludge produced for SDB	m^3	1562.50
Sludge Application Thickness	m	0.30
Area Required for Sludge Drying Bed	m^2	5208.33
Each SDB Size 20 m x 11 m	m^2	220.00
No. of SDB Required	nos.	24
No. of SDB Provided due to land constraints	nos.	8

9.2 Other miscellaneous hydraulics design

Distribution chamber for anaerobic pond

Description	Unit	Value
Flow height above weir, H, $Q=(2/3)*C_d*L*H^{1.5}*((2g)^{0.5})$, $C_d=.6$,		
Q per tank	m^3/s	0.289
Assume weir length	m	1.5
H	m	0.24
Allow free fall of 10 cm	m	0.10
Total Head loss	m	0.34
Free Board	m	0.30

Pipe from distribution chamber/valve chamber to anaerobic pond

Description	Unit	Value
Flow when one tank not working	m^3/s	0.145
Pipe dia 500 mm, velocity	m/s	0.74
Length of pipe Max.	m	30.00
head loss $flq^2/10*d^5$	m	0.003
entry/exit loss	m	0.042
Total Losses	m	0.044

Pipe from facultative pond inlet to facultative pond

Description	Unit	Value
Average flow when one tank not working	m^3/s	0.058
Pipe dia 350 mm, velocity	m/s	0.60
Length of pipe	m	30.00
head loss $flq^2/10*d^5$	m	0.001
entry/exit loss	m	0.028
Total Losses	m	0.029

Pipe from facultative pond-1 outlet to common outlet collection chamber 1

Description	Unit	Value
Average flow	m^3/s	0.058
Pipe dia 350mm, velocity	m/s	0.60
Length of pipe	m	20.00
head loss $flq^2/10*d^5$	m	0.001
entry/exit loss	m	0.028
Total Losses	m	0.029

Pipe from facultative pond-2 outlet to common outlet collection chamber

Description	Unit	Value
Flow	m^3/s	0.058
Pipe dia 350 mm, velocity	m/s	0.60
Length of pipe	m	30.00
head loss $flq^2/10*d^5$	m	0.001
entry/exit loss	m	0.028
Total Losses	m	0.029

Pipe from facultative outlet chamber to MD-1 drain

Description	Unit	Value
Flow	m^3/s	0.116
Pipe diameter	mm	500
Velocity	m/s	0.59
Length of pipe	m	70.00
head loss $flq^2/10*d^5$	m	0.030
entry/exit loss	m	0.027
Total Losses	m	0.057

Alternately provide RCC channel

Description	Unit	Value
Velocity	m/s	1.000
Area	m^2	0.116
Taking, Width=2*Height, H=	m	0.24
Say	m	0.40
Width	m	0.48
Say	m	0.80
Slope required, $v = (R^{2/3}S^{1/2})/n$, n=0.013, S=		0.00146
Say		1 in 700

10 OPERATION & MAINTENANCE

10.1 Operation & Maintenance

Operation and maintenance aspect of a Wastewater/Sewage Treatment Plant decides the functional efficiency of the plant to a great extent.

The waste stabilization process of treatment involves minimum operational and maintenance functions, as no mechanical components are installed.

10.2 Operation & Maintenance Needs

In this plant, no significant operational activities are required. Maintenance functions, involve a member of activities both preventive as well as corrective. Preventive maintenance activities are as follows:

-Cleaning of inlet chamber at an interval of once a year.

-Skimming of floating matters from the facultative pond on a continuous basis.

-Sludge/Silt removal from Anaerobic (primary pond i.e. Anaerobic Pond) once in one year but recommended for six months interval.

Other preventive maintenance requirements are watering and upkeep of horticulture components, annual repair and maintenance of buildings, fittings and fixtures, exposed pipes and fittings etc.

Corrective maintenance is required to cater for occasional damages like embankment failure, structural failure, electrical problems, etc. which need be repaired as and when required. Some amount of spares and materials should be kept stored along with working equipments.

10.3 Staff Requirement

10.3.1 Staff Requirement

Following Staffs are required for proper operation and maintenance of Wastewater/Sewage Pumping Station (SPS) and Wastewater Treatment Plant (WWTP).

Table 10 - 1: Staffs for Operation and Maintenance

Sr. No.	Category of Staff	SPS	STP	TOTAL
1.0	Junior Engineer	1 (common)		1
2.0.	Supervisor	1 (common)		1
3.0	Pump Operator	3	-	3
4.0	Pump Mechanics	1	-	1
5.0	Electrician	1 (common)		1
6.0	Laboratory Technician	-	1	1
7.0	Laboratory Assistant	-	1	1
8.0.	Labourers	2 (common)		2
9.0.	Watchmen	3 (common)		3
10.0.	Sweeper	1 (common)		1
11.0	Gardener	-	1	1
	Total			**16**

10.3.2 Operation Control

Routine Flow Measurement along with the characterization and performance of the ponds to be monitored and recorded. Periodic measurements indicating the influent and effluent of sewage parameters like BOD, COD, TSS, Coliform organism etc. to be regularly monitored. Fiber Glass boat shall be provided for carrying 500 kg load for maintenance of ponds. Arrangement is made for cleaning and jetting of ponds and watering arrangements for landscaping by treated effluent from sewage.

10.3.3 Control of Insects

The degree of mosquito infealation in ponds is in direct proportion to the extent of emergent vegetation. Filling of Ponds up to operational levels, cutting of undesirable vegetation in pond or on embankment and using of suitable herbicide, using larvicides, breeding certain fishes are some of the measures that can be used to control mosquitoes. Fly control will be achieved by breaking the scum floating on the pond surfaces. Midges are to be controlled by increasing the organic load on the pond.

10.3.4 Embankment Maintenance

Embankments need to be inspected regularly for erosion due to wind, wave action, surface runoff or burrowing animals. Repaired should be carried out immediately the damage occurs. The embankment should be seeded with grass, fertilized and mown. Long rooted plants impair the water retaining capacity of the embankment and hence should not be used.

10.3.5 Control of Odour

Frequently odour is caused by the decay of mats of algae that have been blown to a bank or the corner. During the periods of high water temperature in shallow ponds, sludge mats rise from the bottom and accumulate in the corners. The entire mass gets covered with blue green algae and this gives rise to over pondering odours. The mat is to be dispersed by agitating or by the jetting of water.

10.3.6 Recognition of Characteristic Colours

An Anaerobic Pond looks greyish black and the Facultative Pond most frequently appears green or brownish green. A change in colour is a warning of the major change in the performance of the pond system. Changes in the Volume, organic load, temperature, light, turbidity etc. may cause changes in the algal pattern and hence change in colour.

If the sulphide and sulphate concentration in wastewater is high, coloured microorganism develops particularly in Facultative pond during summer and ponds develop a pink colour. A colour change from green to black accompanied by floating mat of material from bottom of pond and usually indicates rapid fermentation of bottom sediments. Presence of coloured microorganisms seems to indicate some prior overloading, stratification or operational deficiency. Sulphides in the pond can be oxidized by coloured photosynthetic bacteria which are found in stabilization pond in large numbers and impart to the pond a characteristics brown or red colour.

10.3.7 Control of Tree

Large trees impede the natural wind and may reduce the light intensity at the surface of the pond. And thus interfere with the performance of the ponds. Leaves falling into the pond will interfere with photosynthetic processes and add to the box load, and possibly create insect control problems. Hence systematic tree control at WSP site is mandatory.

10.4 Overall Operation & Maintenance of WWTP

Pond system is to be commissioned preferably in start of summer season for quick stabilisation process. Pond pH shall be always maintained above 7 (applying lime or soda ash) to develop methanogenic bacteria. The routine maintenance tasks are:

a. Removal of screenings and grit from the inlet works
b. Use of slow growing grass and cutting grass regular interval
c. Removal of Floating scum and floating microphytes
d. Spraying the scum on anaerobic pond
e. Removal of accumulated solids in inlet and outlets
f. Repair of damage to the embankment
g. Repair of damage to external fences and gates
h. A pond maintenance record sheet (enclosed) to be filled at weekly interval
i. Staffing level shall be adequate to operate the system smoothly.
j. Desludging is required annually by using a raft mounted sludge pump and disposal is to be made in landfill site or agricultural land but as Client insisted for Sludge Drying Bed (SDB), sludge will be dried at SDB and disposal will be made accordingly.

10.5 Sludge Handling Options

a. This treated sludge of Anaerobic Pond will be transported to either Solid Waste Land Fill Site for further treatment or it can be sold to farmer for use as soil conditioner.
b. Desludging of Anaerobic Pond is required when it is one third full of sludge by volume.
c. Bypass Pipe should be organized from Distribution Chamber of Anaerobic Pond towards Facultative Pond Inlet to By-pass Anaerobic Pond during Desludging of Anaerobic Pond.
d. It can be noted that Sludge Drying Bed (SDB) is not recommended for Waste Stabilization Pond (WSP) Process as it needs huge land Area as de-sludging frequency is generally once in a year (frequent de-sludging not required) for Anaerobic Pond and 6-8 years in Facultative Pond. Advantage of WSP (Anaerobic Pond) Sludge that it is basically digested and stabilized sludge. After one year of period It can be directly used as soil conditioner.
e. Good revenue generation will be done in case of sale of consolidated sludge in Anaerobic Pond after one year of time as sludge quantity will be more rather than daily sludge production in other treatment process.
f. SAARC Country Manual also recommends emptying the Anaerobic Pond upto the top water level and allowing it for drying for some time in pond itself. Then pond can be desludged.
g. Facultative Pond Sludge generation will be less and It is required to be cleaned 5-6 years of interval.

10.6 Effluent Quality Monitoring and Plant Performance

Monitoring and evaluation programme is to be established once WSP is commissioned.

10.6.1 Effluent Quality Monitoring Plan

After commissioning of the plant, a routine monitoring programme has to be established to assess whether effluent is complying with the discharge standards. Moreover if the pond system suddenly fails or its effluent starts deteriorating, the monitoring programme will give some insight into the cause of the problem and generally indicate remedial action to be taken.

For Effluent Quality Monitoring two level effluent quality monitoring is proposed:

-Level I: representative samples of the final effluent should be taken at least daily and they should be analyzed for those parameters for which effluent discharge or reuse requirements exist.

-Level 2: when level 1 monitoring shows that effluent is failing to meet its discharge or reuse quality, a more detailed study is necessary. The following Table 10.2 gives a list of parameters whose values are required together with directions on how they should be obtained.

10.6.2 Evaluation of Pond Performance

Evaluation of plant performance and behavior, although a complex procedure than routine monitoring, is extremely useful as it provides information on:

1. whether the system is under loaded or overloaded
2. how much loading can be safely increased on the system to serve the expanding community.
3. Whether further ponds (parallel or series) are required
4. How design of future pond installation in the region might be improved to take account of local conditions.

Table 10 - 2: Parameters to be determined in a "Level 2" Effluent Quality Monitoring Program

Parameter	Sample Type[a]	Remarks
A. Influent and Effluent		
Flow	-	Measure both raw wastewater and final effluent flows
BOD	C	Unfiltered samples[b]
COD	C	Unfiltered samples[b]
Total Suspended solids	C	
Total solids	C	
Total Dissolved solids	C	
Volatile Suspended solids	C	
Alkalinity	C	
pH	G	Take two samples, one at 08.00-10.00 h and the other at 14.00-16.00 h
Temperature	G	
Faecal coliforms	G	Take sample between 08.00 and 10.00 h
Total nitrogen	C	Only when effluent being used (or being assessed for use) for crop irrigation. Ca, Mg and Na are required to calculate the sodium absorption ratio[d]
Total phosphorus	C	
Chloride	C	
Electrical conductivity	C	

Parameter	Sample Type[a]	Remarks
Ca, Mg, Na	C	
Boron		
Helminth eggs[c]	C	

[a]C = 24-hour flow-weighted Composite Sample: G = Grab Sample.

[b]Also on filtered samples if the discharge requirments are so expressed.

[c]Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale and Necator americanus.

[d]SAR = $(0.044Na)/[0.5(0.050Ca + 0.082 Mg)]^{0.5}$ where Na, Ca and Mg are the concentrations in mg/l

As it suggests evaluation of plant performance is more of a research work than routine monitoring and involve lot of time and cost. But at the same time, it is the only means by which pond designs can be optimized for local conditions. It is most likely to be beyond the capabilities of local organization and need to be carried out by a State or National Body.

Samples should be taken and analyzed on at least five days over a week at both the hottest and coldest times of the year. Samples are required of the raw wastewater and of the effluent of each pond in the series and so as to take into account most of the weekly variation in influent and effluent quality.

Composite samples are necessary for most parameters. Grab samples are required for pH and faecal coliforms. Samples of the entire pond water column should be taken for algological analyses (chlorophyll a and algal genera determination), using the pond column sampler. Pond column samples should be taken from a boat or from a simple sampling platform (or the outlet structure) that extends beyond the embankment base. Data on maximum and minimum air temperature, rainfall and evaporation should be obtained from the nearest meteorological station.

On each day that samples are taken, the mean mid-depth temperature of each pond which closely approximates the mean daily pond temperature should be determined by suspending a maximum and minimum thermometer at mid-depth of the pond at 08.00-09.00 h and reading it 24 hours later.

On one day, during each sampling period, the depth of sludge in the facultative ponds should be determined using the "white towel" test. White towelling material is wrapped along one third of a sufficiently long pole, which is then lowered vertically into the pond until it reaches the pond bottom, it is then slowly withdrawn. The depth of the sludge layer is clearly visible since some sludge particles will be entrapped in the towelling material. The sludge depth should be measured at least 5 points in the pond, away from the embankment base and the average depth is calculated.

It is also useful to measure on at least three occasions during each sampling season the diurnal variation in the vertical distribution of pH, dissolved oxygen and temperature. Profiles should be obtained at 08.00, 12.00 and 16.00 h. If submersible electrodes are not available, Samples should be taken manually every 20 cm.

From the data collected in each sampling season, mean values should be calculated for each parameter values, based on these mean can then be calculated for:

i) Hydraulic Retention time

ii) Surface BOD and COD loading on facultative pond and

iii) Percentage removals of BOD, COD, suspended solids, ammonical nitrogen, total phosphorus, faecal coliforms and helminth eggs in each pond and in each series of ponds.

10.7 Safety Equipments:

The following safety facilities are required for the team personnel for smooth running of pond operation.

1. First Aid Kit
2. Protective Clothes
3. Grass Cutter
4. Scum Removal Equipment
5. Life Jacket
6. Life-Buoys
7. Fibre Glass Boat for Sampling and Maintenance of Ponds

11 PARTICULAR SPECIFICATIONS FOR WWTP-WSP

A. PARTICULAR SPECIFICATIONS ON WWTP-PROCESS & CIVIL

11.1 Process Scheme

11.1.1 Design Basis

Sewage Treatment Plant Capacity shall be:

Average Flow : 10 MLD

Peak Factor : 2.5 of average flow

Peak Flow : 25 MLD

11.1.2 Raw Sewage Quality

An abstract of Raw Sewage Characteristics are as follows:

Parameters	Values	Unit
Biochemical Oxygen Demand (BOD5)	300	mg/l
Chemical Oxygen Demand (COD)	600	mg/l
Total Suspended Solids	600	mg/l
Total Nitrogen	35	mg/l
Fecal Coliforms	5×10^7	MPN/100ml
pH	7.2 to 7.4	

Location Information:

a. Latitude L_N= $26^0$57'45"- $27^0$02'30";

27^0 North latitude will be considered in Facultative Pond design.

b. Mean Annual temperature 24.5^0C;

c. Maximum recorded Air Temperature 41.6^0 C and minimum recorded 4.5^0C

d. Average Design Temperature is 23.05^0C in absence of mean temperature of cold season quarter.

e. In winter water temperature will warmer than Air temperature by 2^0C -3^0C

f. In summer, water temperature will be lesser than Air temperature by 2^0C-3^0C.

g. Altitude at WWTP Chhapkaiya, Birgunj is 79.0 m.

h. Highest flood level in nearest drain MD1 is 78.55m as information collected from local people and it should be reconfirmed by bidder.

i. The evaporation data is assumed for design purpose 5mm per day.

11.1.3 **Treated Sewage Quality**

The contractor shall design the process in such a way that the treated effluent quality attains the following limits or even better:

Treated Sewage Quality (as per NEPAL norms for discharge into water body)

BOD	<50mg/l
TSS	<100mg/l

11.2 Detailed Scope of Work

The project shall have following major units:

1. Inlet cum Diversion Chamber
2. Screen Chamber
3. Sump Well for Pumping Units & DI Pumping Main
4. Receiving Chamber
5. Grit chamber
6. Flow control channel/Parshall Flume
7. Distribution Chamber
8. Anaerobic Pond
9. Facultative Pond
10. Inlet and Outlet Structures (Weir Type) for the ponds
11. Outlet Collection Chambers
12. Treated Effluent Pipe/Channel
13. Sludge Drying Bed
14. Administration Building (Office, Conference room, Wash room, Workshop /Tool room, Laboratory room)
15. Security Cabin/ Toilet Block
16. Generator Room
17. Watchman Quarter
18. Interconnecting Piping
19. Plant Utilities
20. Plantation, Horticulture, Landscaping and gardening

11.2.1 **Inlet cum Diversion Chamber**

The gravity outfall sewer of 800 diameter RCC NP3 pipe will discharge the raw sewage into a Inlet chamber. The function of the Inlet chamber is to distribute the flow to screen chamber of Sewage Pumping Station. Inlet chamber is designed for average flow of 10 MLD with a peak factor of 2.50. The inlet chamber shall consist of sluice gate on downstream for flow regulation. Sluice gate shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining and circumventing the inlet chamber. There shall be a provision of one bye pass channel along with gates. The inlet chamber shall be of adequate size to meet the requirements of workability inside it. The inlet chamber shall be open to sky and shall be water tight to prevent seepage of the sewage out of the inlet chamber. The entire construction is in M25 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC access platform minimum 1000 wide with railing as per specifications shall be provided on one side of the chamber. Information related to receiving chamber is summarized below. From Inlet Chamber there will be Bypass/overflow arrangement pipe to nearest Drain MD-1 at suitable level for excess flow and to bypass the flow without back up into the sewer line.

Total Average flow	10 MLD
Peak factor	2.5
Peak Flow	0.289 m3/sec
Number of Units	(1) One
Detention period	30 sec
Min Free board	0.5m
Size of inlet chamber	3.0 m x 3.0 m x 1.0 m water depth + 0.5 m FB

11.2.2 **Primary Screen Chamber before Sump Well of Pumping Station**

One mechanical screen of working with one manual standby screen is proposed in the screen chamber. The screen channels are designed for peak flow. The clear opening for mechanical screen shall be 30mm. The mechanical and manual bar screens shall be made of 10 mm thick Stainless Steel (SS304) flats. Conveyor Belt and chute arrangement shall be provided to take the screenings to the screenings dropped from chute will be collected in a container of approx. 1.5 m^3 capacity. This trolley will be housed in a roofed enclosure with proper access, screen washing arrangement and drain. Manually operated Sluice gates are provided at the upstream and downstream ends to regulate the flow. RCC Platforms shall be provided at the upper level to enable operation of the railings shall be provided around the entire periphery of the as well as for the platform. The entire structure is to be M 25 sulphate resistant concrete and as per IS 3370 including the platform for the gates.RCC staircase minimum 900 mm wide shall be provided for access from the ground level to the top of the unit and to the operating platforms. Information related to screen and screen channel is summarized below:

Number of screen channels	2 nos.
Number of Screens	1 Mechanical working + 1 Manual standby
Design flow considered to each channel	0.289 m3/s
Approach Velocity at Peak Flow (m/sec.)	1.2
Velocity through Clear Screen at peak Flow (m/sec.)	1.0
Velocity through Screen at 50% clogging (m/sec.)	2.0
Screen Bar size	10 mm thick & 50 mm width
Screen Bar Opening	30mm
Each Channel Size	4.0 m long x 1.20 m wide x 0.4 m water depth + 0.5 m Free board
Angle of inclination	45^0 for manual operated & 75^0 for mechanically operated
MOC- Mechanical	SS 304 with proper coating
Operation	Timer operated
Reduction Gear Box Type	Worm / helical
Reduction gear Material of Construction	Standard
Motor HP	0.5 HP
Accessories	Conveyor belt for conveying away the screened materials, 2 Wheeled trolleys

11.2.3 **Sump Well for Submersible Pumps**

Sump Well is designed for peak flow of 25 MLD (Average flow with a peak factor of 2.50).

Pumping Stations Type adopted as per good engineering practice is submersible type pumps in wet pit.

Wet well

The storage capacity of the wet-well shall be determined to meet the following conditions:

- Detention time in the wet well shall not exceed 30 minutes at average flow.
- Cycle of operation of each pump shall not be less than 5 minutes.
- Pump start/ stop shall be restricted to 12 nos./hour for submersible pumps and 4 nos./hour for horizontal centrifugal pumps as per pumps supplier/manufacturer

Highest sewage level inside the sump not exceeds 0.8 full position of incoming sewer. Also it is essential to provide overflow arrangement from sump well to convey the flow out of pump house on operation & maintenance point of view.

The entire construction is in M25 grade concrete (Sulphate resistant Cement) and as per IS 3370. Information related to Sump Well is summarized below.

Total Average flow	10 MLD
Peak factor	2.5
Number of Units	(1) One
Detention period	Should not exceed more than 30 minutes at average flow and Minimum Pump Cycle time 5 minutes
Min Free board	0.5m
Size of Sump Well	7.5 m diameter + Minimum 1.5 m Effective Liquid Depth + Min. 0.5 m Free Board

11.2.4 **Receiving Chamber**

The Wastewater pumping main will discharge the wastewater/sewage into a Receiving Chamber (Stilling Chamber) where velocity should be low enough (0.05m/sec-0.07m/sec to avoid any turbulence to incoming water) during peak flow condition. The function of the Receiving Chamber is to distribute the flow to Screen Chambers. Receiving chamber shall be designed for average flow of 10 MLD with a peak factor of 2.50. The inlet chamber shall consist of sluice gate on downstream for flow regulation. Sluice gate shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining and circumventing the inlet chamber. There shall be a provision of one bye pass channel along with gates. The inlet chamber shall be of adequate size to meet the requirements of workability inside it. The inlet chamber shall be open to sky and shall be water tight to prevent seepage of the sewage out of the inlet chamber. The entire construction is in M25 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC access platform minimum 1000 wide with railing as per specifications shall be provided on one side of the chamber. Information related to receiving chamber is summarized below.

Total Average flow	10 MLD
Peak factor	2.5
Peak flow	0.289 m3/sec
Number of Units	(1) One
Detention period	15 sec
Min Free board	0.5m
Size of Collection Chamber	1.7 m (L)x 2.5 m (W) x 1.1 m water depth + 0.5 m FB

11.2.5 **Grit Chamber**

Two mechanical grit chambers, both working, and one manual grit chamber standby are proposed after screen mechanical unit. The grit chambers shall Square/Rectangular Mechanical Detritus Tank each designed for average flow of 10 MLD with a peak factor of 2.5.

Sluice gates shall be provided at the entrance and at the outlet of the chamber. To enable easy operation of the gates, RCC platforms with GI railing shall be provided at the upper level. The entire construction shall be M25 grade concrete (Sulphate resistant Cement) and as per IS 3370. RCC staircase minimum 900 mm wide shall be provided for access from the ground level to the top of the unit and to the operating platforms. Information related to grit chamber is summarized below.

No. of grit chambers	2 nos.(1 Mechanical working+1 Manual)
Design flow consider for each grit chamber	0.289 m3/s
Type	Rectangular type RCC construction
Detention Time at Peak flow	60 Sec
Particle size to be removed	0.15 mm or more
Specific Gravity of inorganic particles	2.65
Maximum Settling velocity	0.018m/sec=1.8cm/sec
Horizontal velocity	0.15-0.30m/sec
Grit storage space	250 mm
Free board to be provided	300 mm
Dimensions	9.0 m x 1.25 m x 0.75 m ht + 0.30 m Free Board+0.30m dead storage for silt
MOC	RCC
Accessories	Vertical Grit drainage Channel operated through Gate Valve; Weir Plate SS 304, 3mm thick material

11.2.6 **Flow Control Channel/ Parshall Flume**

Suitable velocity control device preferable flow control device is proposed as per Indian CPHEEO Manual/latest IS specifications or Relevant Handbook.

No. of Chambers	1 No.
Design flow considered	0.289 m^3/s
Type	Long Channel RCC construction
Throat Width	300mm
Restricted velocity	0.3m/sec
Depth of Channel in u/s leg of Flume	0.75m
Width of Channel	0.75m
Free board to be provided	0.3m
Dimensions	5.0 m (L) x 0.70 m (W) x 0.70m LD + 0.3 m Free Board

Flow measurement is achieved by Parshall Flume and Ultrasonic transmitter to detect changes in level at the Flume. Indicator, Recorder and Totalization is to be provided.

11.2.7 **Distribution chamber**

The sewage from Grit chamber will be conveyed to distribution chamber from where it will be distributed to main treatment units i.e stabilization ponds. Suitable size of distribution chamber should be proposed so that collected sewage is conveyed to main treatment unit separately and also it should be capable to handle the peak or extra flow of other division during repair if required. Information related to distribution chamber is tabulated as below.

No. of Grit Channels	2 No
Design flow consider for each grit channel	0.289 m3/s
Type	Rectangular RCC construction
Detention Time at Peak flow	30 Sec
Free board to be provided	0.5m
Dimensions	3.0 m x 3.0 m x 1.0 m LD + 0.5 m Free Board
MOC	RCC

From the Distribution Chamber, Bypass to Anaerobic Pond is required for low volumetric loading and desludging of Anaerobic Pond. This Bypass 500 mm dia RCC pipe with suitable Sluice gate will be connected to Inlet Chamber of Facultative Pond

11.2.8 **Anaerobic Pond**

The sewage from distribution chamber shall be taken into anaerobic ponds through RCC pipes. These ponds shall be designed for an average flow of 10 MLD. These anaerobic pond can be satisfactorily designed and without risk of odour Nuisance on the basis of volumetric BOD loading.

Since there are two Anaerobic ponds (A.P.), the flow will be equally distributed by providing weirs in the distribution chamber. From distribution chamber, the flow will be conveyed to each Anaerobic pond through the Inlet chamber to A.P. by RCC pipe. Overflow weir will be provided for each anaerobic pond for uniform withdrawal of flow. For this purpose special structure will be constructed for each pond. From overflow weir the flow will be conveyed to Inlet Chamber of facultative ponds through outlet chambers of Anaerobic ponds.

Retention times in anaerobic ponds less than 1 day should not be used.

Information related to anaerobic pond is summarized below.

No. of Ponds	2Nos
Design flow considered in each pond	5 MLD
Type	Rectangular
Detention Time	1 Day
Dimensions	At Top: 59 m x 35 m x 4.5m ht + 0.5 m Free Board; At Bottom: 39 m x 15 m

11.2.9 **Facultative Pond**

The partially treated wastewater from anaerobic pond shall be carried to facultative ponds. It is recommended that they should be designed on the basis of surface BOD loading.

The permissible design value of λ_s shall be taken one based on latitude, and one based on temperature as per prudent engineering practice. A minimum value of detention time of 5 days should be adopted for temperatures below 20°C, and 4 days for temperatures above 20°C. This is to minimize hydraulic short-circuiting and to give the algae sufficient time to multiply (i.e. to prevent algal washout).

The cumulative filtered BOD removal in the anaerobic pond and facultative pond is 90%. So the facultative pond effluent have a filtered BOD of (0.1*300) i.e., 30mg/l that is suitable for river discharge.

Information related to facultative pond is summarized below.

No. of Ponds	2 Nos
Design flow consider for each pond	5 MLD
Type	Rectangular
Minimum Detention Time	4.5 Days
Dimensions	At Top: 204 m x 62.5 m x 2.0 m ht + 0.5 m Free Board; At Bottom: 52.5m x 194m

Baffles are provided for approaching plug flow condition in the Facultative lagoon/pond for better efficiency in winter as well as better settling performance. The facultative lagoons are provided in the form of simple earthen basins with inlet at one end and out let at the other to enable the waste water to flow through to stabilize the organic matter.

The flow will be equally distributed to two facultative ponds by providing weirs in the distribution chamber. The flow will be conveyed to facultative ponds through inlet chamber and RCC NP3 pipe. Baffles are provided in the facultative pond to avoid stagnation near the inlet and reduce the fetch of water surface. Overflow weirs are provided on the downstream side of ponds for uniform withdrawal of treated sewage. Finally treated sewage will be conveyed to MD-1 to Sirsiya River through Pipes/channel.

Pond Lining:

Though the Pond area soil at Chhapkaiya, Birgunj is low permeable, Lining is recommended for pond base and inside of embankment to increase impermeability. The inside slope of embankment of anaerobic and facultative ponds and the base of anaerobic pond will be provided with Clay lining with proper compaction instead of brick /stone pitching which is not durable.

Outside slope of embankment for both type of ponds will be provided with grass turfing by transplantation of grass on outside slopes of embankment etc. in rows 15cm centre to centre in each direction including ploughing, levelling, breaking of clods, and removal of stones etc. if required including maintenance for 1 year.

Precast cement concrete M 25 Kerb stone of 150x150x450 mm and fixing in cc 1:3:6 including necessary excavation, painting etc. complete at spacing of 1m centre to centre is to be provided.

To access to Facultative ponds, 40 mm thick stones steps (riser 150 mm and tread 300 mm) in CM 1:6 with width of steps 1500 mm etc is to be fixed.

Clay Soil for Pond Lining: Clay soil suitable as lining is to be tested in the laboratory before use in pond base as well as inside of embankments as impervious material. Clay shall be free from excessive sand and silt and no foreign material in clay will be accepted. Clay soil for lining will be provided carefully either manually or mechanical means as appropriate during construction following prudent engineering practice or as per direction of Engineer.

Pond Embankment:

For Anaerobic Pond, 3 m carriage way on either side will be provided on top of embankments for operation and maintenance purpose. But for facultative Pond common embankment width will be 3.0 m and side embankment will be 2.0 m width. For WWTP site will be initially stripped upto 0.15 m depth to remove all shrubs and bushes. Excavation will be done upto desired level with required side slopes for the embankment. The embankments will be formed layer by layer by watering and compaction to 95% proctor density.

A side slope of 1 in 2 shall be provided for inner and outer side of embankment for both type of the ponds. For embankment wave protection near water level, 100 mm thick stone pitching or 600 mm width x 50 mm thick M25 concrete (insitu or precast) slab shall be used for Anaerobic and Facultative Ponds.

Site grading will be done for remaining area of WWTP to required level. Trees will be planted all around anaerobic ponds and along the boundary of WWTP.

11.2.10 Inlet and Outlet Structure for the Ponds

The inlet to anaerobic pond should discharge well below the liquid level so as to minimize short-circuiting (especially in deep anaerobic ponds) and thus reduce the quantity of scum (which is important in facultative ponds). Inlets to facultative ponds should also discharge below the liquid level, preferably at mid-depth in order to reduce the possibility of short-circuiting.

The outlet of all ponds should be protected against the discharge of scum by the provision of a scum guard. The take-off level for the effluent, which is controlled by the scum guard depth, is important as it has a significant influence on effluent quality. In facultative ponds, the scum guard should extend just below the maximum depth of the algal band when the pond is stratified so as to minimize the daily quantity of algae, and hence BOD, leaving the pond. In anaerobic ponds, where algal banding is irrelevant, the take-off should be nearer the surface: in anaerobic ponds it should be well above the maximum depth of sludge but below any surface crust. The following effluent take-off levels are recommended:

Anaerobic ponds: 300 mm

Facultative ponds: 600 mm

The installation of a variable height scum guard is recommended, since it permits the optimal take-off level to be set once the pond is operating.

The outlet from the final pond in a series should discharge into a simple flow-measuring device such as a triangular or rectangular notch. Since the flow into the first pond is also measured, this permits the rate of evaporation and seepage to be calculated or, if evaporation is measured separately, the rate of seepage.

11.2.11 **Sludge Drying Bed**

Anaerobic ponds require desludging when they are one third full of sludge (by volume). The stabilized sludge (no raw sludge) is discharged into Sludge Drying Bed (SDB) through Raft Mounted Sludge Pumps or mobile sludge pumps to feed the digested sludge to SDB through Sludge Channel. After the recycle time, the moisture has been drained away or evaporated during its detention time in the SDB, the dried sludge as sludge cake from SDB will be used as manure. Although pond sludge has a better microbiological quality than that from conventional treatment works, its disposal must be carried out in accordance with local regulations governing sludge disposal.

The Filter media shall consist of the following:

First Layer from Top: 150 mm thick clean coarse sand

Second Layer from Top: 200 mm thick of 25-50 mm size broken stone material

Bottom Layer from Top: 100 mm thick 50-75 mm stone soling.

The under drainage system shall consist of pipe drain laterals laid to suitable slope preferable 2%. The Under-drains shall be placed at suitable distance apart. The filtrate collected from the beds shall be carried through these drains via 110 mm dia uPVC perforated pipes laid and jointed by connected filtrate sump and shall be taken to sump of pump house. No separate Filtrate pumps are required as quantity is small. The pipe line leading to sump of pump house shall be 160 mm dia HDPE pipe laid at required slope about 0.5 % slope. Necessary brick masonry chambers shall be provided in front of each Sludge Drying Bed in which the filtrate from the under drainage system shall be collected. All such chambers will be connected by means of suitable diameter not less than 160 mm HDPE pipe with proper joints and at suitable slope about 0.5%. All the brick chambers in front of each Drying bed shall be made with class brick 75 mm thick and cement mortar 1:4 and provided with precast RCC removal covers with lifting hooks. The brick masonry chambers on the filtrate pipe line shall be placed at every 11.0 m interval for inspection and cleaning. The top of chambers shall be at least 700 mm above Finished ground level. The brick walls of drying bed shall be 230 mm thick and jointed in cement mortar 1:4. The walls shall be made with 150 mm thick 1:4:8 cement concrete foundations. The Top of the brick masonry wall shall be provided with 45 mm thick 1:2:4 cement concrete coping. The Top external wall shall be minimum 0.60 m above formation level. The sludge feed pipe line shall be of 100 mm diameter DI pipe and shall run over the brick pillars along the one side of Bed in longer direction. Necessary Tees with valves shall be provided for feeding sludge in each drying bed. Provision should be made for walkway to operate the sluice valves. The sludge shall be discharged at half length of Bed over a 125 mm thick precast concrete splash tray of size of 1 m x 1 m.

No. of Sludge Drying Bed	8 Nos.
Design thickness for sludge layer	300mm
Feed Sludge Concentration	8%-10%
Moisture in dewatered sludge	Approx. 40%
Size –Type	Rectangular
Detention Time	2 – 3 weeks
Dimensions	20 m x 11 m x 0.30 m sludge depth + 0.5 m Free Board

11.2.12 **Sludge Pumps for Pond Sludge Withdrawal**

The accumulated sludge in anaerobic pond and facultative pond will be withdrawn by manually controlled pumps from the bottom of ponds to the sludge drying beds. The capacity of each of the sludge pumps shall be 120 m^3/h with 10 m head and they shall pump alternating through sludge pipe line from both types of ponds to sludge drying beds.

The proper distribution of sludge at the sludge drying beds shall be made by manually operated sluice gates in the sludge distribution channels.

11.2.13 **Effluent Channel/Pipe**

Treated sewage shall be taken to the MD-1 Drain towards Sirsiya River through RCC channel or RCC NP3 Pipe. Ultrasonic flow meter shall be provided in the RCC channel to measure the flow. The length of the channel shall be as per site condition. Capacity of the channel should be such that it can carry peak flow. The channel shall be constructed in M 25 grade concrete (Sulphate Resistant Cement) as per IS 3370. RCC platform 1000mm wide with railing as per specifications shall be provided.

11.2.14 **Office cum Laboratory Building**

The administration building shall be Single Storied structure. The floor shall be of 130 m^2 (17.2 m x 7.5 m) of area. The admin block shall accommodate office, conference room, wash room, workshop cum Store/Tool room, administrative block and laboratory, for the easy and smooth operation of plant. The structure will be for the sole use of the Employers representative, his staff and consultants that shall be provided by the contractor at site. The contractor shall provide, erect, furnish, clean, maintain and subsequently hand over the office and associated furniture/items to the employer after the completion of the works.

The walls shall be 230 thick brick masonry, plastered and painted with oil bound distemper on the inner face and snowcem on the outer face. RC slab roofing with roof height of 3 meters from the floor painted with all bound distemper shall be provided. The doors shall be of first quality wood and aluminium sliding windows of approved quality shall be provided.

Before commencing the construction of the office, the contractor shall submit to the Employers Representative for his approval a drawing of the proposed building with all the architectural and finishing details fully shown. The location of the office building shall be finalized after taking approval of the Employer's representative. The office shall be maintained throughout the contract period with office boy, power, water and housekeeping. Power and water supply shall be arranged by the contractor either with the available resources or from independent sources (DG sets, bore well, etc.)

A. Office

The office building shall be provided with adequate forced ventilation and exhaust fans. Flooring for the office shall be of vitrified tiles.

Toilets shall be provided on the each floor. Adequate number of toilets and washbasins shall be provided separately for men & women. A covered service water tank shall be suitable provided to cater to the water requirements laboratory and office building. Space for keeping plant records shall be provided in the administration building. Following furniture shall be provided in the office.

- One wooden conference table 3m x 1.5 m with twelve chairs
- Six nos. 1.5m x 0.9m tables with both side drawers
- Four nos. 1.2 m x 0.75 m table with drawers on both sides

- nos. 0.9 m x 0.6 m tables with single side three drawers
- Twelve nos. chairs
- Chairs for computers
- Four nos. steel cupboards (store well or any other approved make)
- Two nos. filing cabinet with 4 drawers
- Vertical blinds to all windows
- Water supply, plumbing electrical complete
- Telephone with STD facility

The fittings shall include:

- 4'-0' long tube lights in each room except in conference room and toilet (11 per 3 sq.m. floor area)
- 6 rube lights 4'-0" long in conference room
- Nos. of 48" ceiling fan in conference room
- All rooms with 4 plug point each
- Passage 4" long tube light at every 20" distance

The administration block shall comprise of following:

S. No.	Item of work	Work
1.	Personal Computer	01 No: P IV or latest Version & Configuration, with latest microprocessors, 60 GB HD 02 nos., 512 R DVD CD ROM, CD writer ROM additional, 17 " Screen monitor, 1500 w speaker system etc.
2.	Printer	01 No: HP or equivalent- All in one- A3 size X0 Scanner, Fax, Printer and Laser Mode
3.	Telecommunicati on Facility	Min 1 no. Telephone line, with a Broad Band connection Chargers will be beard by the contractor up to the O & M period.
4.	Plant Model	1 no: On Wall Mounted process model: Electronic Plant Display model, with flow diagram and working. (Minimum size 3 m x 1.5 m)

B. Workshop cum Store Room

In addition, to the above, workshop and tool room of 5m x 4m each shall be accommodated within Office cum Lab building. Both workshop and tool rooms shall be provides with working platforms and cabinets to store spares and accessories. The tool room shall also be provided with lockers (minimum 6 nos.).

The Contractor shall provide the following tools and equipment for routine operation and maintenance works, as well as for emergency breakdowns and limited specials repairs, which can be made locally. Replacement of parts of various machines, equipment (mechanical and electrical) shall be carried out by specialists or at the manufacturer's workshop.

Standard tool kits for following trades shall be supplied (1 set in a suitable toolbox each) for:

a. Machine mechanic
b. Electrician
c. Plumber

Following special tools/equipments are to be provided (1 set of each item)

i. Set of 3 large spanners,

ii. 2 large pliers
iii. 2 Buckets 20 l drum 100
iv. Cutters, hacksaws
v. Pipe threading equipment
vi. Super sieve pipe cutters
vii. Grease gun
viii. Large scissors, tongs
ix. Lubrication cans with long necks
x. Pipe wrench
xi. Sheer legs and tripods
xii. Set of 4 large screw drivers
xiii. Chain pulley blocks with hooks, portable, 1000 kg
xiv. 2 shovels
xv. Man winch
xvi. Set of 4 chisels
xvii. Ladders, telescopic aluminum, max. height 5 m
xviii. Set of 3 hammers

The following consumables shall be supplied:

i. Cotton waste
ii. Oils of different grades
iii. Greases of different grades
iv. Kerosene, Diesel, petrol, spirit as per the requirements for the plant machinery operation
v. Nuts, bolts, washers, nipples etc. shall be as per the compilation on the basis of manufacturer's recommendations for various equipments.
vi. Rubber hose 1", L =50 m with coupling
vii. Neoprene rubber pads

Various consumable for different trades –

d. Electrician Wires, fuses, insulation tapes, switches etc.
e. Plumber Pipes, fittings, specials
f. Painter Brushes, paints, varnishes

The workshop shall have at least the following equipment:

i. 1 work benches
ii. 6 running meters of shelves, 2 m high
iii. 1 steel almirah, 1 m wide, 2 m high, with shelves
iv. 2 vices
v. 1 grinder
vi. Drilling machine for metals and concrete (hammer) (1 kW)
vii. Various type of bits for drilling of steel and concrete
viii. Small universal milling machine
ix. Single phase welding transformer
x. The tools shall not be used for the erection of the equipment being supplied and must be handed over to Engineer in a completely new and unused condition during the commissioning period. The tools provided shall include wrenches, grease guns and any other special tools, gauges, test rings, jigs, which may be required during the life of the plant.

C. Laboratory

The bidder shall also include the cost for the following laboratory equipment of IS or DIN or reputed make into the lump sum price of WWTP. The equipment's are required for the following tests which shall have to be conducted.

i. pH
ii. Turbidity
iii. Suspended Solids – Total , Fixed, Volatile
iv. Dissolved Oxygen
v. Oil & Grease
vi. COD by Chromate Reflux Method
vii. BOD at 27^0C and 20^0 C
viii. Coli form Measurement using both MPN and Millipore Filter/Plate count technique

The minimum suggested equipment's required for conducting the tests are

i. Analytical Balance electronic type with an accuracy of 1 mg and accuracy of +/-3%
ii. Autoclave for sterilization of 100 litres capacity.
iii. Laboratory Centrifuge
iv. Chlorine Comparator Apparatus
v. Distilled Water Apparatus
vi. Dissolved Oxygen Meter
vii. Drying Oven Hot Air (105^0C)
viii. Hot Plates
ix. Incubator settable for both 27^0C and 20^0 C for BOD
x. Magnetic Stirrers
xi. COD Apparatus
xii. Muffle Furnace 600^0 C of 20 litres capacity
xiii. pH Meter
xiv. Refrigerator 230 liters with 2 separate compartment – i.e. separate freezer (65 liters) and lower compartment maintaining a temperature of 8^0 C+/-2^0 C of 165 liters capacity
xv. Soxhlet Extraction Unit – for Oil/Grease
xvi. Spectrophotometer for above tests
xvii. Hydro Extractor
xviii. Water Bath – Thermostat Control
xix. Laboratory Furniture comprising of Laboratory bench, 1.0 m wide x 4.0 long, treated with anticorrosive paint, comprising of almirah underneath for storage of glass wares, side racks for storage of reagents bottles, two laboratory sinks with taps, valves and drain pipe etc.
xx. Glass Ware comprising of beakers, conical flask, burette, pipette, volumetric flask titration and gravimetric analysis, sampling bottles etc.
xxi. Chemicals for six months testing.

The bidder can review the above list and add/delete any laboratory equipment's with proper justification.

11.2.15 **Generator Room**

A generator room (5.5m x 4.5m x 3.5m height) should be provided as specified in the drawing.

11.2.16 **Transformer Yard**

A Transformer Yard will be (3.0m x 3.0m) should be provided as specified in the drawing.

11.2.17 **Security Cabin and Workers' Toilet Block**

A security cabin shall be provided as per the tender specifications at each entry gate to plant. Minimum size of security cabin shall be 3m x 3m. A separate toilet block shall be provided for the labourers comprising of following facilities:

- Bathrooms, 1 no.

- WC, 2 nos.

11.2.18 **Watchman Quarter**

A watchman quarter should be provided (7.5m x 4.5m x 3.0m height) as specified in the drawings.

11.2.19 **Inter Connecting Piping**

All piping including valves, specials and other appurtenances, auxiliaries and accessories required as per process design and scope of work. All the piping, valves, specials shall be designed for peak flow. In case of buried pipes warning tapes shall be provided of the appropriate colours.

The sizes and material for major interconnecting piping shall be as follows:

S.No.	From	To	Material and class
1.	Inlet cum Diversion Chamber with Bypass to MD-1	Screen Chamber	RCC M25 Channel
2.	Screen Chamber	Sump Well/Wet Pump Well	RCC M25 Channel
3.	PUMP WELL	Receiving Chamber	500 mm dia. Pumping Main (DI –K9)
4.	Receiving Chamber	Grit Chamber	RCC M25 Channel
5.	Grit Chamber	Parshall Flume	RCC M25 Channel
6.	Parshall Flume	Distribution Chamber	RCC M25 Channel
7.	Distribution Chamber	Anaerobic Ponds	500 mm dia. RCC NP3 Pipe
8.	Distribution Chamber	Facultative Pond Bypass with Gate to By Pass Anaerobic Pond	500 mm dia RCC NP3 Pipe
9.	Anaerobic Pond	Facultative Pond	350mm dia. RCC NP3 Pipe
10.	Facultative pond	Outlet Collection Chamber1 & 2	350 mm RCC NP3 Pipe
11.	Outlet Collection Chamber -1	Outlet Collection Chamber-2	350 mm dia RCC NP3 Pipe

12.	Outlet Collection Chamber-2	Main Drain MD-1	500 mm RCC NP3 Pipe/RCC M25 Channel (0.80m W x 0.4 m D)

11.2.20 **Plant Utilities**

A. Compound Fencing and Entrance Gate

Contractor shall construct the compound fencing along the perimeter of the premises as per approved layout during execution of the work. The construction of the compound barbed wire fencing wall shall be based on the drawing issued by engineer-in-charge. 1.6 m high barbed wire fencing with MS angle post shall be provided.

The entrance provided in the compound for access into the WWTP premises shall be complete with double openable MS gate with MS arch as per design and drawing approved by engineer-in-charge.

B. Storm Water Drainage

Storm water drains adjacent to the proposed approach road shall be sized for rainfall intensity of 50 mm/hr, allowing for 100% runoff. Drains shall be in Brick Masonry with Cement Mortar as per typical cross sectional details shown in the drawing. These drains shall be covered with precast RCC (1:2:4) 75 mm thick cover slab.

C. Approach Road, Walkway/Pathways

An access road through the site along with a network of pathway will be provided separately under road component to link the existing approach road and permit access to the WWTP site for necessary maintenance, delivery of consumables and personnel access. All internal roads of width 4.0 m wide shall be of Bituminous road with 20 mm premix carpet with seal coat over 150 mm Aggregate Base Course (ABC) and 150 mm Granular Sub Base (GSB) on well compacted Sub-Grade. Vehicular access shall be provided for such plant units that may require frequent access. All roads shall be provided with drainage and constructed to prevent standing water. The walkway /pathways shall be 2 m wide concrete tiles 65 mm thick on over 150 mm thick sand gravel on well compacted Sub-Grade as given in the drawing. Damage to any existing roads, on account of their use by the Contractor shall be made good to the satisfaction of the Employer.

The road system is to be designed such that vehicles involved in the delivery of consumables can continuous route through the works and out again. The work of approach road and storm water drainage shall be carried approved layout during execution of the contract.

D. Fire Extinguishers

The portable fire extinguishers with ISI/International mark of approved make shall be provided at the Office room.

Each building shall be provided with following portable fire extinguishers

1. Dry chemical powder type fire extinguishers of 3.2 kg capacity – 6 cylinders

2. Buckets filled with dry clean sand – 6 Nos.

All buildings shall be provided with manual fire alarm system connected main control panel. The alarm system shall be with pillboxes and hoc layout of the fire alarm system shall be in accordance with the relevant ISI or International standards.

E. Yard Lighting

Effective yard and building lighting systems shall be incorporated within the treatment plant site in order to provide sufficient illumination for operation and maintenance schedules to be carried out during day and night periods. In addition, the entire treatment plant site shall have sufficient street lights and perimeter lights for various operations, safety and security reasons as given in the drawing.

F. Plantation, Horticulture, Landscaping and Gardening

Landscaping involves beautification of Wastewater Treatment Plant site by cultivating Lands, Plants and shrubs of environmental value and suitably modifying the appearance of WWTP site. It shall add scenic value to the WWTP site to obtain maximum visual impact. Contractor has to develop proper landscaping in the WWTP site from professional landscaper approved by PIU. Area for future expansion shall also be considered for landscaping.

G. Water Supply Arrangement

Provision has been made for water supply for the WWTP by providing water supply connection to Under Ground Tank of 15000 litre capacity with a small pump house to accommodate 2 pump sets (1w + 1s) each 5 m^3/hour capacity for pumping water to overhead tank on Administration building and for cleaning of screens grit removal equipment. A sump will be provided for treated sewage and will be pumped in distribution system through uPVC pipe grid for maintenance of various units of treatment plant and watering of plants and grass turfing.

B. Submissions

B-1. Drawings / Documents

Following documents and drawings are to be submitted by the successful bidder after execution of contract.

1) Mechanical general arrangement drawing of all equipment with its weight, load, fixing details etc. in the tender drawing foundation detail has been given in general but it may vary from manufacturer to manufacturer. In that case he is to revise the drawing and resubmit the same.

2) All design calculations to justify the correct selection of equipment.

3) Characteristics curve, cross section drawing for pump and blower.

4) Cross sectional drawing of all rotating equipment giving part list, so that, in future the spare parts can be procured properly.

5) Technical literatures from manufacturer for all equipment, machines specified herein or as required by engineer.

6) 6 copies of catalogues for all supplied mechanical and electrical equipment.

7) 8 copies of operation and maintenance manual of all equipment. All these manuals should be bound in one or two volumes for easy handling and presenting.

B.2 As Built Drawing

The as built drawings shall be submitted by contractor after completion of trial run. The contractor shall record all changes of drawing during execution and prepare final "as built drawing" duly approved by owner/engineer. These drawing shall be used by owner for maintenance/dismantling/reassembling. These drawings shall be submitted to owner in 4 sets and reproducible print within 90 days after provisional acceptance.

The acceptance certificate will not be issued until the complete set of as built drawings & transparency etc. received to the satisfaction of owner/engineer.

C. Commissioning

After completion of preliminary test (after mechanical completion) contractor shall notify in writing to owner/engineer. The contractor shall coordinate with owner's personnel for commissioning/operation of plant & machinery.

Only after uninterrupted operation and reliability test continuously for 3 days equipment shall be considered in order for acceptance. Any maintenance/replacement of parts & spare shall be on contractor's account.

Only after satisfactory completion of uninterrupted operation and reliability test (the duration of test will be as per agreement with owner & contractor) of the provisional taking over of plant/equipment may be issued as per terms of contract.

During the test period contractor is responsible for training to owner's personnel, on maintenance, operation and documentation of records etc.

D. Functional Guarantee and Process Guarantee

The Contractor will provide the functional guarantee and process guarantee for the sewage pumping station and sewage treatment plant as per Nepalese norms.

E. Defect Liability Period

The Contractor will provide defect liability period for at least one year period.

F. Operation and Maintenance Guarantee

The Contractor will take the responsibility of at least one year of operation and maintenance.

12 QUANTITY AND COST ESTIMATES:

10 MLD Capacity Wastewater Treatment Plant (Based on Waste Stabilisation Ponds process)

Summary Sheet

Sn.	Description of the work	Amount (Nrs.)	Remarks
1	Inlet Chamber/Bar Screen/Sump Well/Micro Piles	11673347.77	
2	Receiving Chamber/Grit Chamber/Parshall Flume/Distribution Chamber	2967000.28	
3	Facultative Pond	25634967.14	
4	Anaerobic Pond	10140174.08	
5	Sludge Drying Bed	6103871.82	
6	Road And Drain	14852892.25	
7	Administrative building	5808316.36	
8	Under Ground Water Tank And Pump House	828539.84	
9	Generator Room	852255.69	
10	Watchman's Cabin	405427.39	
11	Watchman's Quarter	1012615.21	
12	Watchman's Changing Room	746301.01	
13	Barbed Wire Fencing	2414106.46	
14	Green Parks	148029.58	
15	Electromechanical Equipment	20870895.46	
i	**Total**	**104458740.33**	

1. Inlet Chamber/Bar Screen/Sumpwell

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	14.94	10		**149.397**	**Sqm**	3.45	515.42
2	**E/W in Excavation In Foundation Ordinary Soil**								
	Inlet Chamber	1	5.10	4.5	6.8	156.060			
	Bar Screen	1	5.10	3.3	7.05	118.652			
	Sump Well	1	72.41		10.1	731.355			
	Outlet Chamber	1	1.60	3.6	1.35	7.776			
		TOTAL				**1013.843**	**Cum**	248.75	252188.36
3	**Backfilling**								
	Backfilling in Inlet chamber & Bar Screen	1	22.90	0.60	6.00	82.440			
	Backfilling in Sump Well	1	24.29	0.65	9.30	146.807			
		TOTAL				**229.247**	**Cum**	177.68	40731.49
4	**Boulder Soiling In foundation**								
	Inlet Chamber	1	5.10	4.5	0.25	5.738			
	Bar Screen	1	5.10	3.3	0.25	4.208			
	Sump Well	1	72.41		0.25	18.103			
	Outlet Chamber	1	1.60	3.6	0.25	1.440			
		TOTAL				**29.488**	**Cum**	2449.50	72230.51
5	**PCC M15 In Foundation**								
	Inlet Chamber	1	5.10	4.5	0.1	2.295			
	Bar Screen	1	5.10	3.3	0.1	1.683			
	Sump Well	1	72.41		0.1	7.241			
	Outlet Chamber	1	1.60	3.6	0.1	0.576			
		TOTAL				**11.795**	**Cum**	8550.84	100858.41
6	**RCC M25**								
	Inlet Chamber								
	in foundation Base	1	4.90	4.4	0.45	9.702			
	in Wall	1	13.40	0.325	6.2	27.001			
	Bar Screen								
	in foundation Base	1	2.60	3.6	0.45	4.212			
	in Wall	1	4.90	3.3	6.2	100.254			
	Center Wall	1	4.20	0.3	1.048	1.320			
	Top Slab(Plat Form)	1	4.00	3.1	0.2	2.480			
	Sump Well								
	in foundation Base	1	67.96		0.45	30.580			
	in Wall	1	24.83	0.4	9.85	97.825			
	Slab	1	58.79		0.175	10.288			
	Outlet Chamber								
	in foundation Base	1	2.25	3.5	0.25	1.969			
	in Wall	1	7.50	0.25	1.1	2.063			

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	For Micro Piles	15	0.02		2.7	0.716			
		TOTAL				288.410			
	Deduction								
	Inlet Chamber								
	800mm dia RCC pipe	1	0.50	0.325		0.163			
	Sluice Gate	2	0.60	0.325	0.6	0.234			
	Outlet of bar screen/Inlet of sump well	2	0.90	0.4	0.9	0.648			
	Outlet of Sump well	5	0.04	0.4		0.080			
		TOTAL				1.125			
		GRAND TOTAL				**287.285**	**Cum**	13373.32	3841951.76
7	**40 mm Medium class handrail GI Pipe**								
	Inlet Chamber & Bar screen two horizontal & vertical post 1.2m C/C	1	35.90			**35.900**	**Rm**	2318.55	83235.88
8	**Brick masonry 1:4 cement mortar joint**	1	26.87	0.25	3.325	22.337			
	Deduction								
	Door D1 (1.2X2.1)	1	1.20	0.25	2.1	0.630			
	Window W(1.2X1.2)	3	1.20	0.25	1.2	1.080			
		TOTAL				1.710			
		GRAND TOTAL				**20.627**	**Cum**	8444.40	174181.67
9	**RCC M20**								
	Lintel								
	Door and Window	4	1.50	0.25	0.15	0.225			
	Chajja	4	1.50	0.45	0.0875	0.236			
	Ring Beam	1	26.87	0.25	0.25	1.679			
	Slab	1	69.43		0.175	12.150			
		GRAND TOTAL				**14.290**	**Cum**	10615.62	151699.50
10	**Formwork**								
	RCC M25								
	Inlet Chamber								
	in foundation Base	1	16.00		0.45	7.2			
	in Wall	2	13.40		6.2	166.16			
	Bar Screen								
	in foundation Base	1	9.80		0.45	4.41			
	in Wall	2	11.10		6.2	137.64			
	Center Wall	2	4.20		1.048	8.8032			
	Top Slab(Plat Form)	1	4.00	3.1		12.4			
	Sump Well								
	in foundation Base	1	29.23		0.45	13.153			
	in Wall	2	24.83		9.85	489.123			

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Slab	1	58.79			58.789			
	Outlet Chamber								
	in foundation Base	1	8.00		0.25	2.000			
	in Wall	2	7.50		1.1	16.500			
	RCC M20								
	Lintel								
	Door and Window	4	1.50	0.55		3.300			
	Chajja	4	1.50	0.55		3.300			
	Ring Beam	1	26.87	0.75		20.154			
	Slab	1	69.43			69.426			
		TOTAL				**1012.357**	**Sqm**	600.90	608321.20
11	**Reinforcement Bar 1.5% of Total Quantity Of M25 + M20**	1				35510.457			
	Steel Plate(10mmX60mm @ 40mm C/C)	152	3.30	0.01	0.06	2362.536			
	For Micro Piles	15			2.7	154.346			
	400mmX400mm Steel Plates for Micro piles	15	0.40	0.40	0.008	150.720			
		TOTAL				**38178.058**	**kg**	100.96	3854399.47
12	**20mm thick External Cement Plaster 1:4**								
	In Wall	1	54.13		3.325	179.975			
	Chajja	4	1.70	1		6.800			
	Slab Top	1	69.43			69.426			
	Deduction	TOTAL				256.201			
	Door D1 (1.2X2.1)	1	1.20		2.1	2.520			
	Window W(1.2X1.2)	3	1.20		1.2	4.320			
		TOTAL				6.840			
		GRAND TOTAL				**249.361**	**Sqm**	320.33	79876.66
13	**12.5mm Thick Internal Cement Plaster 1:4**								
	In Wall	1	47.80		3.325	158.945			
	Ceiling & Floor	2	47.80			95.606			
		TOTAL				**254.550**	**Sqm**	250.59	63787.69
14	**Cement Punning 1:1**								
	Floor & Slab Top	2	47.80			**95.606**	**Sqm**	156.61	14972.52
15	**Chequred Plate For Outlet Chamber(2.15X3.3)**	1				**1.000**	**Sets**	10000.00	10000.00
16	**C.I Cover (Medium Duty)**	5				**5.000**	**Sets**	26220.00	131100.00
17	**Stainless Steel Foot Steps**	50				**50.000**	**Nos.**	1500.00	75000.00
18	**Aluminum Door & Windows**								
	Door D1 (1.2X2.1)	1	1.20		2.1	2.520			

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Window W(1.2X1.2)	3	1.20		1.2	4.320			
		TOTAL				**6.840**	**Sqm**	8467.15	57915.31
19	**Pipe Works**								
	800mm Dia Inlet pipe NP3	1	2.50			**2.500**	**m**	10203.42	25508.55
	700mm Dia Overflow pipe	1	2.50			**2.500**	**m**	9179.76	22949.39
	DI Pipe 250mm	3	30.00			**90.000**	**m**	6451.20	580608.00
	DI Pipe 200mm	2	30.00			**60.000**	**m**	4838.40	290304.00
	DI Pipe 500mm	2	24.00			**48.000**	**m**	23031.59	1105516.32
20	**Two Coat Cement painting**								
	Exterior								
	In Wall	1	54.13		3.325	179.975			
	Chajja	4	1.70	1		6.800			
		TOTAL				**186.775**	**Sqm**	95.74	17881.38
21	**Two Coat Distemper painting**								
	Interior								
	In Wall	1	24.51		3.325	81.510			
	Ceiling	1	47.80			47.803			
	Deduction	TOTAL				129.313			
	Door D1 (1.2X2.1)	1	1.20		2.1	2.520			
	Window W(1.2X1.2)	3	1.20		1.2	4.320			
		TOTAL				6.840			
		GRAND TOTAL				**122.473**	**Sqm**	128.51	15739.29
22	**Electrification**	1				1	**job**		
23	**25mm Dia Steel Nut bolts For Micro piles(300mm Length**	15				15	**Nos**	125.00	1875.00
		TOTAL AMOUNT(Nrs.)							**11673347.77**

2. Receiving Chamber/Grit Chamber/Parshal Flume/Distribution Chamber

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1.00	30.00	10.00		**300.00**	**Sqm**	3.45	1035.00
2	**E/W in excavation in Foundation In Ordinary Soil**								
	In Column C1/ F1	11.00	1.30	1.30	1.48	27.42			
	In Column F2	2.00	1.52	1.52	1.48	6.82			
	In Column CF1	2.00	2.95	1.45	1.48	12.62			
		TOTAL				**46.85**	**Cum**	248.75	11654.84
3	**Backfilling**								
	In Column C1/ F1	11.00	1.60		1.10	19.36			
	In Column F2	2.00	2.22		1.07	4.73			
	In Column CF1	2.00	4.03		1.03	8.26			
		TOTAL				**32.35**	**Cum**	177.68	5747.04
4	**Flat Brick Soling**								
	In Column C1/ F1	11.00	1.30	1.30		18.59			
	In Column F2	2.00	1.52	1.52		4.62			
	In Column CF1	2.00	2.95	1.45		8.56			
		TOTAL				**31.77**	**Sqm**	480.93	15277.02
5	**PCC M10 In Foundation**								
	In Column C1/ F1	11.00	1.30	1.30	0.08	1.39			
	In Column F2	2.00	1.52	1.52	0.08	0.35			
	In Column CF1	2.00	2.95	1.45	0.08	0.64			
		TOTAL				**2.38**	**Cum**	8550.84	20371.83
6	**RCC M20**								
	Foundation base								
	In Column C1/ F1	11.00	1.30	1.30	0.20	3.72			
	In Column F2	2.00	1.52	1.52	0.24	1.10			
	In Column CF1	2.00	2.95	1.45	0.28	2.35			
	Column								
	Column C1 (Inlet chamber)	4.00	0.30	0.30	2.55	0.92			
	Column C1 (Staircase)	1.00	0.30	0.30	3.15	0.28			
	Column CF1(Grit Chamber)	3.00	0.30	0.30	2.25	0.61			
	Column C3,C4 & C5(Grit Chamber)	4.00	0.40	0.40	2.00	1.28			
	Column C2(Distribution Chamber)	4.00	0.30	0.30	1.75	0.63			
	Beam								
	Beam B1	1.00	40.67	0.25	0.35	3.56			
	Beam B2	1.00	4.95	0.25	0.35	0.43			
	Beam B3	1.00	13.20	0.30	0.50	1.98			
	Beam B4	1.00	9.00	0.30	0.50	1.35			
	Slab								
	Inlet Chamber								
	Top Slab	1.00	3.75	2.10	0.15	1.18			

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Base Slab	1.00	3.40	2.10	0.20	1.43			
	Wall	1.00	10.20	0.20	1.30	2.65			
	Grit Chamber(Inlet)								
	Base Slab	1.00	2.00	2.10	0.20	0.84			
	Top Slab(Foot Track)	1.00	2.00	1.00	0.20	0.40			
	Grit Chamber								
	Inlet Triangular Portion	1.00	0.50	2.60	0.20	0.26			
	Grit Chamber	1.00	9.00	3.10	0.20	5.58			
	Top Slab(Foot Track)	1.00	9.00	1.00	0.15	1.35			
	Outlet Triangular Portion	1.00	1.10	2.10	0.20	0.46			
	Wall	1.00	34.80	0.20	1.45	10.09			
	Parshall Flume								
	Base Slab	1.00	4.80	2.10	0.20	2.02			
	Top Slab(Foot Track)	1.00	4.80	1.00	0.15	0.72			
	Wall	1.00	10.00	0.20	1.38	2.75			
	Distribution Chamber								
	Base Slab	1.00	5.10	3.40	0.20	3.47			
	Top Slab	1.00	5.10	4.40	0.15	3.37			
	Wall	1.00	19.60	0.20	1.85	7.25			
	Grit Collection chamber								
	Base Slab	2.00	3.40	2.40	0.20	3.26			
	Wall	2.00	10.80	0.20	0.30	1.30			
	Staircase								
	Beam	1.00	6.00	0.25	0.35	0.53			
	Slab	1.00	6.50	1.00	0.15	0.98			
	Riser	18.00	0.13	1.00	0.16	0.36			
		Total				68.45			
	Deduction								
	250mm Inlet pipe	5.00	0.05		0.20	0.01			
	500mm Outlet Pipe	3.00	0.20		0.20	0.04			
	CI Man hole Cover 600mm dia	2.00	0.28		0.20	0.06			
		Total				0.11			
		Grand Total				**68.34**	**Cum**	10615.62	725475.66
7	**Reinforcement Bar 1.5% of Total Quantity of M20**	1.00				**8047.08**	**Kg**	100.96	812421.18
8	**Formwork**								
	Column								
	Column C1 (Inlet chamber)	4.00	1.20		2.55	12.24			
	Column C1 (Staircase)	1.00	1.20		3.15	3.78			
	Column CF1(Grit Chamber)	3.00	1.20		2.25	8.10			
	Column C3,C4 & C5(Grit Chamber)	4.00	1.60		2.00	12.80			
	Column C2(Distribution Chamber)	4.00	1.20		1.75	8.40			
	Beam								

Sn.	Description of the work	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Beam B1	1.00	40.67	0.95		38.64			
	Beam B2	1.00	4.95	0.95		4.70			
	Beam B3	1.00	13.20	1.30		17.16			
	Beam B4	1.00	9.00	1.30		11.70			
	Slab								
	Inlet Chamber								
	Top Slab	1.00	3.75	2.10		7.88			
	Base Slab	1.00	3.40	2.10		7.14			
	Wall	2.00	10.20		1.30	26.52			
	Grit Chamber(Inlet)								
	Base Slab	1.00	2.00	2.10		4.20			
	Top Slab(Foot Track)	1.00	2.00	1.00		2.00			
	Grit Chamber								
	Inlet Triangular Portion	1.00	0.50	2.60		1.30			
	Grit Chamber	1.00	9.00	3.10		27.90			
	Top Slab(Foot Track)	1.00	9.00	1.00		9.00			
	Outlet Triangular Portion	1.00	1.10	2.10		2.31			
	Wall	2.00	34.80		1.45	100.92			
	Parshall Flume								
	Base Slab	1.00	4.80	2.10		10.08			
	Top Slab(Foot Track)	1.00	4.80	1.00		4.80			
	Wall	2.00	10.00		1.38	27.50			
	Distribution Chamber								
	Base Slab	1.00	5.10	3.40		17.34			
	Top Slab	1.00	5.10	4.40		22.44			
	Wall	2.00	19.60		1.85	72.52			
	Grit Collection chamber								
	Base Slab	2.00	3.40	2.40		16.32			
	Wall	4.00	10.80		0.30	12.96			
	Staircase								
	Beam	1.00	6.00	0.95		5.70			
	Slab	1.00	6.50	1.00		6.50			
	Riser	18.00	1.50		0.16	4.32			
		Total				**507.16**	**Sqm**	600.90	304752.69
9	**DI Pipe works**								
	500mm Outlet & Overflow Pipe	4.00	6.00			**24.00**	**M**	23031.59	552758.16
	250mm dia DI Pipe	5.00	3.00			**15.00**	**M**	6451.20	96768.00
	500mm dia DI Elbow	4.00				**4.00**	**No.**	22579.20	90316.80
10	**40mm dia GI-M Pipe Railing**	1.00	95.00			**95.00**	**M**	2318.55	220262.07
11	**CI Man hole Cover 600mm dia**	3.00				**3.00**	**Nos.**	26220.00	78660.00
12	**Stainless Steel footsteps**	21.00				**21.00**	**Nos.**	1500.00	31500.00
		TOTAL AMOUNT(Nrs.)							**2967000.28**

3. Facultative Pond

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	230.00	160.00		**34136.160**	**Sqm**	3.45	117769.75
2	**Earthwork In Ordinary Soil**								
	in Facultative Pond	2	191.70	50.20	1.15	22133.682			
	Valve chamber for interconnection	1	2.05	1.55	1.31	4.163			
	Inlet & Outlet chamber	4	6.36	5.36	3.25	443.165			
	Brick column for supporting pipe @3m C/C	6	1.67	1.67	0.85	14.140			
		TOTAL				**22595.149**	**Cum**	248.75	5620430.43
3	**Embankment filling**								
	Facultative Pond	1	876.00	4.70	1.35	5558.220			
	Around The STP Site	1	23809.86		0.8	19047.888			
		TOTAL				**24606.108**	**Cum**	287.49	7073973.08
4	**Selected material filling(Clay lining)**								
	In Bed	2	194.00	52.50	0.2	4074.000			
	In Slope	2	455.50	6.71	0.2	1222.235			
		TOTAL				**5296.235**	**Cum**	1013.15	5365880.24
5	**100 mm thick stone pitching in 1:4 cement mortar**	2	463.50	0.60	0.1	**55.620**	**Cum**	6854.75	381261.06
6	**Flat Brick soling**								
	Brick column for supporting pipe @3m C/C	6	1.67	1.67		**16.635**	**Sqm**	480.93	8000.38
7	**RCC M20**								
	For splash pad	3	1.20	1.20	0.1	0.432			
	Inlet and Outlet Chamber								
	Foundation Base	4	6.16	5.16	0.45	57.214			
	Wall	4	19.72	0.43	2.7	91.580			
	Slab Cover	4	5.86	4.86	0.15	17.088			
	Internal Bed slope	4	5.00	4.00	0.175	14.000			
	Valve Chamber for Inter connection								
	Foundation Base	1	1.90	1.40	0.2	0.532			
	Wall	1	5.80	0.20	1.91	2.216			
	Slab Cover	1	1.90	1.40	0.2	0.532			
		Total				183.161			
	Deduction								
	1500 mm Dia. NP3 RCC Outlet pipe	2	2.55		0.45	2.291			
	500 mm Dia. DI Inlet Pipe	2	0.44		0.2	0.177			
	500 mm Dia. DI Inter connection Pipe	2	0.44		0.2	0.177			
	Manhole Cover	4	0.28		0.15	0.170			
	Manhole Cover	1	0.28		0.2	0.057			
		Total				2.871			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
		Grand Total				**180.290**	**Cum**	10615.62	1913891.63
8	**Reinforcement Bar**	1.5% steel Total volume of RCC M20				**21229.162**	**Kg**	100.96	2143264.31
9	**Form Work**								
	For splash pad	3	4.80		0.1	1.440			
	Inlet and Outlet Chamber								
	Foundation Base	4	22.64		0.45	40.752			
	Wall	8	19.72		2.85	449.616			
	Slab Cover	4	5.86	4.86		113.918			
	Valve Chamber for Inter connection								
	Foundation Base	1	6.60		0.2	1.320			
	Wall	2	5.80		2.11	24.476			
	Slab Cover	1	1.90	1.40		2.660			
		Total				**632.742**	**Sqm**	600.90	380212.21
10	**CI Manhole Cover Medium Duty**	5				**5.000**	**No**	26220.00	131100.00
11	**Stainless Steel steps(SS304)**								
	Inlet and Outlet Chamber	28				**28.000**	**No**	1500.00	42000.00
12	**PCC M15**								
	Brick column for supporting pipe @3m C/C in base	6	1.47	1.47	0.45	5.796			
	Brick column for supporting pipe @3m C/C in capping	6	0.15	1.16		1.035			
	Inlet and Outlet Chamber	4	6.36	5.36	0.1	13.636			
					Total	**20.467**	**Cum**	8550.84	175007.85
13	**PCC M10**								
	Valve Chamber for inter connection	1	2.10	1.55	0.1	**0.326**	**Sqm**	7318.24	2382.09
14	**Boulder soling With Sand**								
	Valve Chamber for inter connection	1	2.10	1.55	0.25	**0.814**	**Cum**	2449.50	1993.28
15	**Brick Masonry 1:4 C/M**								
	Brick column for supporting pipe @3m C/C in base	6	1.16	1.16	1.45	**8.074**	**Cum**	8444.40	68176.74
16	**Pipe works**								
	1500 mm Dia. NP3 RCC Outlet pipe	8	2.50			20.000	**M**	17000.00	340000.00
	500 mm Dia. DI Inlet Pipe	20	2.50			50.000			
	500 mm Dia. DI Inter connection Pipe	12	2.50			30.000			
		Total				**80.000**	**M**	23031.59	1842527.20
17	**Grass turfing**	1	602.93	8.00		**4823.440**	**Sqm**	5.62	27096.88
		TOTAL AMOUNT(Nrs.)							**25634967.14**

4. Anaerobic Pond

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	72.450	79.400		**5752.530**	**Sqm**	3.45	19846.23
2	**Earthwork In Ordinary Soil**								
	In Anaerobic Pond	2	45.300	21.300	3.150	6078.807			
	Valve chamber for interconnection	1	2.050	1.550	1.310	4.163			
	Inlet & Outlet chamber	2	6.360	5.360	3.250	221.582			
	Brick column for supporting pipe @3m C/C	6	1.665	1.665	0.850	14.140			
		TOTAL				**6318.692**	**Cum**	248.75	1571743.03
3	**Embankment filling**	1	331.000	6.000	2.250	**4468.500**	**Cum**	287.49	1284642.36
4	**Selected material filling(Clay lining)**								
	In Slope	2	348.000	11.200	0.200	1559.040			
	In Bed	2	39.000	15.000	0.200	234.000			
		TOTAL				**1793.040**	**Cum**	1013.15	1816618.48
5	**100 mm thick stone pitching in 1:4 cement mortar**	2	463.500	0.600	0.100	**55.620**	**Cum**	6854.75	381261.06
6	**Flat Brick soling**								
	Brick column for supporting pipe @3m C/C	6	1.665	1.665		**16.635**	**Sqm**	480.93	8000.38
7	**RCC M20**								
	For splash pad	3	1.200	1.200	0.100	0.432			
	Inlet and Outlet Chamber								
	Foundation Base	2	6.160	5.160	0.450	28.607			
	Wall	2	19.720	0.430	2.700	45.790			
	Slab Cover	2	5.860	4.860	0.150	8.544			
	Internal Bed slope	2	5.000	4.000	0.175	7.000			
	Valve Chamber for Inter connection								
	Foundation Base	1	1.900	1.400	0.200	0.532			
	Wall	1	5.800	0.200	1.910	2.216			
	Slab Cover	1	1.900	1.400	0.200	0.532			
		Total				93.220			
	Deduction								
	1500 mm Dia. MP3 RCC Outlet pipe	2	2.546		0.450	2.291			
	500 mm Dia. DI Inlet Pipe	2	0.442		0.200	0.177			
	500 mm Dia. DI Inter connection Pipe	2	0.442		0.200	0.177			
	Manhole Cover	2	0.283		0.150	0.085			
	Manhole Cover	1	0.283		0.200	0.057			
		Total				**2.786**			
		Grand Total				**90.434**	**Cum**	10615.62	960015.40
8	**Reinforcement Bar**	**1.5%**				**10648.629**	**Kg**	100.96	1075069.62

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
		steel Total volume of RCC M20							
9	**Form Work**								
	For splash pad	3	4.800		0.100	1.440			
	Inlet and Outlet Chamber								
	Foundation Base	2	22.640		0.450	20.376			
	Wall	8	19.720		2.850	449.616			
	Slab Cover	2	5.860	4.860		56.959			
	Valve Chamber for Inter connection								
	Foundation Base	1	6.600		0.200	1.320			
	Wall	2	5.800		2.110	24.476			
	Slab Cover	1	1.900	1.400		2.660			
		Total				**555.407**	**Sqm**	600.90	333741.82
10	**CI Manhole Cover Medium Duty**	3				**3.000**	**No**	26220.00	78660.00
11	**Stainless Steel steps(SS304)**								
	Inlet and Outlet Chamber	18				**18.000**	**No**	1500.00	27000.00
12	**PCC M15**								
	Brick column for supporting pipe @3m C/C in base	6	1.465	1.465	0.450	5.796			
	Brick column for supporting pipe @3m C/C in capping	6	0.149	1.160		1.035			
	Inlet and Outlet Chamber	2	6.360	5.360		68.179			
		Total				**75.010**	**Cum**	8550.84	641399.52
13	**PCC M10**								
	Valve Chamber for inter connection	1	2.100	1.550	0.100	**0.326**	**Cum**	7318.24	2382.09
14	**Boulder soling With Sand**								
	Valve Chamber for inter connection	1	2.100	1.550	0.250	**0.814**	**Cum**	2449.50	1993.28
15	**Brick Masonry 1:4 C/M**								
	Brick column for supporting pipe @3m C/C in base	6	1.160	1.160	1.450	**8.074**	**Cum**	8444.40	68176.74
16	**Pipe works**								
	500 mm Dia. DI Inlet Pipe	20	2.500			50.000			
	500 mm Dia. DI Inter connection Pipe	12	2.500			30.000			
		Total				**80.000**	**Rm**	23031.59	1842527.20
17	**Grass turfing**	1	602.930	8.000		**4823.440**	**Sq.m**	5.62	27096.88
		TOTAL AMOUNT(Nrs.)							**10140174.08**

5. Sludge Drying Bed

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	100.000	25.000		**2500.000**	**Sq.m**	3.45	8625.00
2	**Earthwork in Ordinary Soil**								
	in Sludge Drying main Wall	1	231.450	1.030	1.475	351.630			
	Inside of Drying chamber	1	88.860	19.250	0.650	1111.861			
	Sludge Canal Support pillar	18	1.250	1.250	0.400	11.250			
	Outlet Chamber	6	0.980	2.160	1.475	18.734			
	Pipe lining	1	190.070	0.600	1.000	114.042			
	For under Drainage	6	20.230	0.500	0.375	22.759			
		TOTAL				**1630.276**	**Cu.m**	248.75	405522.90
3	**Back filling**								
	Main wall	1	231.450	0.400	1.000	92.580			
	Outlet Chamber	1	2.960	0.350	1.000	1.036			
	Pipe lining	1	190.070	0.600	1.000	114.042			
		TOTAL				**207.658**	**Cu.m**	177.68	36895.64
4	**RCC M20**								
	Inlet Channel	6	9.950	0.550	0.100	3.284			
	Precast Slab For Outlet Chamber	6	1.250	0.870	0.075	0.489			
	Splash Tray	6	1.000	1.000	0.125	0.750			
		TOTAL				**4.523**	**Cu.m**	10615.62	48013.13
5	**Reinforcement Bar**	**1% steel Total volume of RCC M20**				**355.046**	**Kg**	100.96	35844.88
6	**Form Work**								
	Inlet Channel	6	9.950	0.750		44.775			
	Precast Slab For Outlet Chamber	6	1.400	1.020		8.568			
	Splash Tray	6	4.000		0.125	3.000			
		TOTAL				**56.343**	**Sq.m**	600.90	33856.27
7	**PCC M10 In Foundation Base**								
	in Sludge Drying main Wall	1	231.450	1.030	0.075	17.880			
	Sludge Canal Support pillar	18	1.250	1.250	0.075	2.109			
	Outlet Chamber	6	0.980	2.160	0.075	0.953			
	Inside of Sludge Drying Area	1	88.460	20.000	0.100	176.920			
		TOTAL				**197.861**	**Cu.m**	7318.24	1447998.25
8	**Brick Masonry 1:4 C/M**								
	in Sludge Drying main Wall								
	1st Footing	1	231.450	1.030	0.400	95.357			
	2nd Footing	1	231.450	0.230	1.813	96.486			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Sludge Channel Support pillar								
	1st Footing	18	1.250	1.250	0.400	11.250			
	2nd Footing	18	0.550	0.550	0.925	5.037			
	inlet Channel	12	9.950	0.125	0.350	5.224			
	Outlet Chamber								
	1st Footing	6	0.980	2.160	0.400	5.080			
	2nd Footing	6	2.210	0.230	1.700	5.185			
	Brick Masonry Pillar for DI Pipe Supports	6	0.230	0.230	1.300	0.413			
	For under Drainage	6	20.230	1.250	0.250	37.931			
		TOTAL				**261.962**	**Cu.m**	8444.40	2212115.86
9	**150mm thick compacted Selected material(Soil)**	1	88.460	20.000	0.150	**265.380**	**Cu.m**	287.49	76293.70
10	**River Gravel Filling (50-75mm thick)**	1	88.460	20.000	0.100	**176.920**	**Cu.m**	2335.49	413194.71
11	**River Gravel Filling (20-35mm thick)**	1	88.460	20.000	0.200	**353.840**	**Cu.m**	2335.49	826389.43
12	**Coarse Sand Filling**	1	88.460	20.000	0.150	**265.380**	**Cu.m**	1414.16	375288.45
13	**Pipe works**								
	160mm Dia. PVC Pipe	1	105.070			**105.070**	**Rm**	1237.35	130008.21
	100 mm Dia. DI Pipe	1	88.500			**88.500**	**Rm**	608.20	53825.38
		TOTAL AMOUNT(Nrs.)							**6103871.82**

6. Road and Drain

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Proposed Road At Ground Level 4.0m Wide Asphalt Pavement & 25m Approach Road**								
	Sub Grade Preparation	1	470.00	4.70		**2209**	**Sqm**	113.16	249967.90
	Sub Base Lining	1	470.00	4.20	0.20	**394.800**	**Cum**	2570.43	1014807.34
	Base Laying	1	470.00	4.15	0.15	**292.575**	**Cum**	2570.43	752044.73
	Prime Coat	1	470.00	4.15		**1950.500**	**Sqm**	129.52	252626.32
	Asphalt Concrete	1	470.00	4.00	0.05	**94.000**	**Cum**	19444.88	1827818.58
2	**Gravel Road**								
	Walkways on Embankment 3m wide	1	274.00	3.00	0.10	82.200			
	Walkways on Embankment 2m wide	1	927.00	2.00	0.10	185.400			
	Walkways 2m wide	1	700.00	2.00	0.10	140.000			
		Total				**407.600**	**Cum**	287.49	117180.31
3	**Strom Drain Type I(B=0.6,h=0.5)**								
i	Earthwork in Excavation In Ordinary Soil	1	465.00	1.10	0.80	**409.200**	**Cum**	248.75	101786.45
ii	Granular Material Filling	1	465.00	1.10	0.10	**51.150**	**Cum**	1749.61	89492.55
ii	RCC M20 Base And Slab	2	465.00	1.10	0.10	**102.300**	**Cum**	10615.62	1085978.05
iv	Brick Masonry (1:4)	2	465.00	0.25	0.50	**116.250**	**Cum**	8444.40	981661.97
v	**Plaster**								
	Base	1	465.00	0.60		279.000			
	Inside Wall	2	465.00		0.50	465.000			
		Total				**744.000**	**Sqm**	320.33	238322.25
vi	**Neat Cement Punning**	Same as Item No.3-e				**744.000**	**Sqm**	156.61	116515.61
4	**Strom Drain Type I(B=0.8,h=0.6)**								
i	Earthwork in Excavation In Ordinary Soil	1	1490.00	1.30	0.90	**1743.300**	**Cum**	248.75	433637.16
ii	Granular Material Filling	1	1490.00	1.30	0.10	**193.700**	**Cum**	1749.61	338899.46
ii	RCC M20 Base And Slab	1	1490.00	1.30	0.10	**193.700**	**Cum**	10615.62	2056245.84
iv	Brick Masonry (1:4)	2	1490.00	0.25	0.60	**447.000**	**Cum**	8444.40	3774648.59
v	**Plaster**								
	Base	1	1490.00	0.80		1192.000			
	Inside Wall	2	1490.00		0.60	1788.000			
						2980.000	**Sqm**	320.33	954570.29
vi	**Neat Cement Punning**	Same as Item No.4-e				**2980.000**	**Sqm**	156.61	466688.86
		Total Amount of Road And Drainage (Nrs.)							**14852892.25**

7. Administrative Building

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	20.00	10.00		200.000	**Sqm**	3.45	690.00
2	**E/W in foundation In Ordinary Soil**								
	Along Grid 1-1 & 4-4	2	18.18	1.05	1.45	55.343			
	Along Grid 2	1	3.05	1.05	1.45	4.644			
	Grid3	1	5.85	1.05	1.45	8.907			
	Along Grid A-A, B-B & D-D	3	6.68	1.05	1.45	30.488			
	Grid c	1	4.85	1.05	1.45	7.384			
	Steps	1	2.70	1.00	0.30	0.810			
		TOTAL				**107.575**	**Cum**	248.75	26758.82
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	Sn.(2-4-5)				26.726			
	Earth filling in flooring	1	16.75	6.98	0.25	29.208			
	Deduction								
	Wall	-1	21.93	0.38	0.25	-2.055			
		TOTAL				**53.878**	**Cum**	177.68	9572.75
4	**PCC M10 in foundation**								
	Along Grid 1-1 & 4-4	2	18.18	1.05	0.15	5.725			
	Along Grid 2	1	3.05	1.05	0.15	0.480			
	Grid3	1	5.85	1.05	0.15	0.921			
	Along Grid A-A, B-B & D-D	3	6.68	1.05	0.15	3.154			
	Grid c	1	4.85	1.05	0.15	0.764			
	Steps	1	2.70	1.00	0.10	0.270			
		TOTAL				**11.315**	**Sqm**	7318.24	82803.64
5	**Brick Masonry work in 1:4 C/M**								
A	**Up to Formation Ground Level(FGL)**								
	Along Grid 1-1 & 4-4	2	17.88	0.75	1.30	34.856			
	Along Grid 2	1	3.20	0.75	1.30	3.120			
	Grid3	1	6.00	0.75	1.30	5.850			
	Along Grid A-A, B-B & D-D	3	6.98	0.75	1.30	20.402			
	Grid c	1	5.00	0.75	1.30	4.875			
	Steps	1	2.70	0.80	0.20	0.432			
		TOTAL				69.535			
B	**In Superstructure(FGL To Slab)**								
	Along Grid 1-1 & 4-4	2	17.50	0.38	3.60	47.250			
	Along Grid 2	1	3.39	0.38	3.60	4.573			
	Grid3	1	6.19	0.38	3.60	8.353			
	Along Grid A-A, B-B & D-D	3	7.35	0.38	3.60	29.768			
	Grid c	1	5.19	0.38	3.60	7.003			
	Steps	1	2.70	2.50	0.15	1.013			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Parapet Wall	1	48.95	0.25	0.30	3.671			
	Toilet Partition Wall	2	0.52	0.13	1.80	0.234			
		TOTAL				101.865			
		TOTAL(A)				171.400			
	DEDUCTION								
	Opening								
	windows W1(1.2x1.2)	10	1.20	0.38	1.20	5.400			
	Door opening D1 (1.5x2.1)	1	1.50	0.38	2.10	1.181			
	Door opening D2(1.2x2.1)	3	1.20	0.38	2.10	2.835			
	Door opening D3(0.9x2.1)	1	0.90	0.38	2.10	0.709			
	Door opening D4(0.6x2.1)	1	0.60	0.38	2.10	0.473			
	Ventilation V1 (0.45x0.9)	4	0.45	0.38	0.90	0.608			
	Lintels								
	windows W1(1.2x1.2)	10	1.50	0.38	0.15	0.844			
	Door opening D1 (1.5x2.1)	1	1.80	0.38	0.15	0.101			
	Door opening D2(1.2x2.1)	3	1.50	0.38	0.15	0.253			
	Door opening D3(0.9x2.1)	1	1.20	0.38	0.15	0.068			
	Door opening D4(0.6x2.1)	1	0.90	0.38	0.15	0.051			
	Ventilation V1 (0.45x0.9)	4	0.75	0.38	0.15	0.169			
		TOTAL				12.690			
		Grand Total				**158.710**	**Cum**	8444.40	1340209.25
6	**RCC M20**								
	Lintels								
	windows W1(1.2x1.2)	10	1.50	0.38	0.15	0.844			
	Door opening D1 (1.5x2.1)	1	1.80	0.38	0.15	0.101			
	Door opening D2(1.2x2.1)	3	1.50	0.38	0.15	0.253			
	Door opening D3(0.9x2.1)	1	1.20	0.38	0.15	0.068			
	Door opening D4(0.6x2.1)	1	0.90	0.38	0.15	0.051			
	Ventilation V1 (0.45x0.9)	4	0.75	0.38	0.15	0.169			
	Chajja								
	windows W1(1.2x1.2)	10	1.50	0.60	0.10	0.900			
	Door opening D1 (1.5x2.1)	1	1.80	0.60	0.10	0.108			
	Door opening D2(1.2x2.1)	3	1.50	0.60	0.10	0.270			
	Door opening D3(0.9x2.1)	1	1.20	0.60	0.10	0.072			
	Door opening D4(0.6x2.1)	1	0.90	0.60	0.10	0.054			
	Ventilation V1 (0.45x0.9)	4	0.75	0.60	0.10	0.180			
	Slab	1	19	9.225	0.12	21.033			
		TOTAL				**24.102**	**Cum**	10615.62	255857.70
7	**Reinforcement**	**1% steel Total volume of RCC M20**				**1892.007**	**Kg**	600.90	1136898.95
8	**Formwork**								
	Lintels								

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	windows W1(1.2x1.2)	10	1.50	0.68		10.200			
	Door opening D1 (1.5x2.1)	1	1.80	0.68		1.224			
	Door opening D2(1.2x2.1)	3	1.50	0.68		3.060			
	Door opening D3(0.9x2.1)	1	1.20	0.68		0.816			
	Door opening D4(0.6x2.1)	1	0.90	0.68		0.612			
	Ventilation V1 (0.45x0.9)	4	0.75	0.68		2.040			
	Chajja								
	windows W1(1.2x1.2)	10	1.70	0.70		11.900			
	Door opening D1 (1.5x2.1)	1	2.00	0.60		1.200			
	Door opening D2(1.2x2.1)	3	1.70	0.70		3.570			
	Door opening D3(0.9x2.1)	1	1.40	0.70		0.980			
	Door opening D4(0.6x2.1)	1	1.10	0.70		0.770			
	Ventilation V1 (0.45x0.9)	4	0.95	0.70		2.660			
	Slab	1	19.24	9.465		182.107			
		TOTAL				**221.139**	**Sqm**	600.90	132881.24
9	**Boulder Soiling in flooring**	1	16.75	6.98	0.15	17.525			
	Deduction								
	Wall	1	21.93	0.38	0.15	1.233			
		TOTAL				**16.291**	**Cum**	2449.50	39905.80
10	**PCC M15 in flooring**	1	16.75	6.98	0.08	8.762			
	Deduction								
	Wall	1	21.93	0.38	0.08	0.617			
		TOTAL				**8.146**	**Cum**	8550.84	69652.62
11	**20 mm thick cement Plaster (1:4)**								
	In floor & Ceiling	2	16.75	6.98		233.663			
	Inside wall	1	88.25		3	264.75			
	Deduction								
	Wall	-2	21.93	0.38		-16.444			
		TOTAL				**481.969**	**Sqm**	320.33	154386.93
12	**12 mm thick cement Plaster (1:4)**								
	Outside Wall up to Parapet								
	Inside Parapet Wall & Top	1	50.45		4.05	204.323			
	Chajja	1	48.95		0.55	26.923			
	windows W1(1.2x1.2)	10	1.70	1.30		22.100			
	Door opening D1 (1.5x2.1)	1	2.00	1.30		2.600			
	Door opening D2(1.2x2.1)	3	1.70	1.30		6.630			
	Door opening D3(0.9x2.1)	1	1.40	1.30		1.820			
	Door opening D4(0.6x2.1)	1	1.10	1.30		1.430			
	Ventilation V1 (0.45x0.9)	4	0.95	1.30		4.940			
	Slab	1	20.75	10.975		227.731			
	Steps								
	Front Face	1	2.70		1.60	4.320			
	Side Face	4	1.00		0.75	3.000			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Toilet Partition Wall	4	0.96		1.80	6.912			
	Opening								
	windows W1(1.2x1.2)	-10	1.20		1.20	-14.400			
	Door opening D1 (1.5x2.1)	-1	1.50		2.10	-3.150			
	Door opening D2(1.2x2.1)	-3	1.20		2.10	-7.560			
	Door opening D3(0.9x2.1)	-1	0.90		2.10	-1.890			
	Door opening D4(0.6x2.1)	-1	0.60		2.10	-1.260			
	Ventilation V1 (0.45x0.9)	-4	0.45		0.90	-1.620			
		TOTAL				**482.848**	**Sqm**	250.59	120996.86
13	**1:1 Cement Punning(Plaster Area of Slab Top + Flooring + Staircase)**					**351.883**	**Sqm**	156.61	55107.26
14	**Aluminum Door and windows works**								
	windows W1(1.2x1.2)	10	1.20		1.20	14.400			
	Door opening D1 (1.5x2.1)	1	1.50		2.10	3.150			
	Door opening D2(1.2x2.1)	3	1.20		2.10	7.560			
	Door opening D3(0.9x2.1)	1	0.90		2.10	1.890			
	Door opening D4(0.6x2.1)	1	0.60		2.10	1.260			
	Ventilation V1 (0.45x0.9)	4	0.45		0.90	1.620			
		TOTAL				**29.880**	**Sqm**	8467.15	252998.44
15	**Two Coat Distemper Painting (Internal)**								
	In Ceiling	1	16.75	6.98		116.831			
	Inside wall	1	88.25		3	264.75			
	Toilet Partition Wall	4	0.96		1.80	6.912			
	Deduction								
	Wall	-2	21.93	0.38		-16.444			
		TOTAL				**372.050**	**Sqm**	128.51	47813.01
16	**Two Coat Cement Painting(External)**								
	Outside Wall up to Parapet								
	Inside Parapet Wall & Top	1	50.45		4.05	204.323			
	Chajja	1	1.50		0.55	0.825			
	windows W1(1.2x1.2)	10	1.50	1.30		19.500			
	Door opening D1 (1.5x2.1)	1	1.80	1.30		2.340			
	Door opening D2(1.2x2.1)	3	1.50	1.30		5.850			
	Door opening D3(0.9x2.1)	1	1.20	1.30		1.560			
	Door opening D4(0.6x2.1)	1	0.90	1.30		1.170			
	Ventilation V1 (0.45x0.9)	4	0.75	1.30		3.900			
	Opening								
	windows W1(1.2x1.2)	-10	1.20		1.20	-14.400			
	Door opening D1 (1.5x2.1)	-1	1.50		2.10	-3.150			
	Door opening D2(1.2x2.1)	-3	1.20		2.10	-7.560			
	Door opening D3(0.9x2.1)	-1	0.90		2.10	-1.890			
	Door opening D4(0.6x2.1)	-1	0.60		2.10	-1.260			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Ventilation V1 (0.45x0.9)	-4	0.45		0.90	-1.620			
		TOTAL				**209.588**	**Sqm**	95.74	20065.38
		(A) TOTAL AMOUNT(Nrs.)							3746598.66
17	**Office Furniture**	3% Of (A)							112397.96
18	**Sanitation**	5% Of (A)							187329.93
19	**Electrification**	15% Of (A)							561989.80
20	**Laboratory Appliances**	LS							1200000.00
		Total Amount of Under Ground Water Tank & Pump House(Nrs.)							**5808316.36**

8. Underground Water Tank And Pump House

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	10.00	10.00		**100.000**	**Sqm**	3.45	345.00
2	**E/W in foundation In Ordinary Soil**								
	Water Tank	1	6.40	4.40	1.76	49.421			
	For Staircase	1	1.20	1.50	0.48	0.855			
		TOTAL				**50.276**	**Cum**	248.75	12505.85
3	**E/W in Backfilling**								
	Earth filling in flooring	1	20.12	0.40	1.13	9.094			
		TOTAL				**9.094**	**Cum**	177.68	1615.82
4	**Sand Filling**	1	6.40	4.40	0.10	**2.816**	**Cum**	1414.16	3982.26
5	**Flat Brick Soling**								
	water Tank Base	1	6.40	4.40		28.160			
	Steps	1	1.80	1.50		2.700			
		TOTAL				**30.860**	**Sqm**	480.93	14841.39
6	**PCC M10 in foundation**								
	In Water Tank	1	6.40	4.40	0.10	2.816			
	In Steps	1	0.90	2.40	0.10	0.216			
		TOTAL				**3.032**	**Cum**	7318.24	22188.91
7	**RCC M20**								
	Lintels								
	windows W2(0.6x1.2)	1	0.90	0.25	0.15	0.034			
	Door D2(1.2x2.1)	1	1.50	0.25	0.15	0.056			
	In Water Tank								
	In Bed	1	6.20	4.20	0.35	9.114			
	In Slope	1	5.00	3.00	0.10	1.500			
	Shear Wall	1	17.2	0.3	2	10.320			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Beam	1	3.6	0.25	0.3	0.270			
	Water Tank Slab	1	5.6	3.6	0.15	3.024			
	Pump House Slab	1	4.2	2.6	0.12	1.310			
		TOTAL				**25.628**	**Cum**	10615.62	272061.39
8	**Reinforcement**	**1.5% steel Total volume of RCC M20**				**3017.744**	**Kg**	100.96	304666.92
9	**Formwork**								
	Lintels								
	windows W2(0.6x1.2)	1	0.90	0.55		0.495			
	Door D2(1.2x2.1)	1	1.50	0.55		0.825			
	In Water Tank								
	In Bed	1	20.80		0.35	7.280			
	Shear Wall	2	17.2		2.3	79.120			
	Beam	1	4.2	0.85		3.570			
	Water Tank Slab	1	5.85	3.85		22.523			
	Pump House Slab	1	4.45	2.85		12.683			
		TOTAL				**126.495**	**Sqm**	600.90	76010.31
10	**Brick Masonry works (1:4 Cement Mortar Joint)**								
	Pump House Wall	1	11.2	0.25	2.5	0.625			
	In Steps	1	1.8	1.5	0.81	1.215			
	Deduction								
	windows W2(0.6x1.2)	-1	0.60	0.25	1.20	-0.150			
	Door D2(1.2x2.1)	-1	1.20	0.25	2.10	-0.300			
		TOTAL				**1.390**	**Cum**	8444.40	11737.72
11	**20 mm thick cement Plaster (1:4)**								
	In Water Tank								
	In Bed	1	5.00	3.00		15.000			
	Shear Wall	1	16		2	32.000			
	Beam	1	3.6	0.85		3.060			
	Water Tank Slab	1	5.6	3.6		20.160			
	Pump House Slab(Ceiling + Top)	2	4.2	2.6		21.840			
	Pump House Wall	2	10.46		2.5	52.300			
	In Steps								
	Front Face	1	1.5		2.82	4.230			
	Side Face	2	1.8		0.51	1.836			
	Deduction								
	windows W2(0.6x1.2)	-1	0.60		1.20	-0.720			
	Door D2(1.2x2.1)	-1	1.20		2.10	-2.520			
		TOTAL				**147.186**	**Sqm**	250.59	36883.31

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
12	**1:1 Cement Punning(Plaster Area of Slab Top + Flooring + Steps + inside of Water Tank)**					**84.146**	**Sqm**	156.61	13177.85
13	**Aluminum Door and windows works**								
	windows W2(0.6x1.2)	1	0.60		1.20	0.720			
	Door D2(1.2x2.1)	1	1.20		2.10	2.520			
		TOTAL				**3.240**	**Sqm**	8467.15	27433.57
14	**Two Coat Distemper Painting (Internal)**								
	Pump House Ceiling	1	4.2	2.6		10.920			
	Pump House Wall	1	10.46		2.5	26.150			
		TOTAL				**37.070**	**Sqm**	128.51	4763.96
15	**Two Coat Cement Painting(External)**								
	Pump House Wall	1	10.46		2.5	26.150			
	Deduction								
	windows W2(0.6x1.2)	-1	0.60		1.20	-0.720			
	Door D2(1.2x2.1)	-1	1.20		2.10	-2.520			
		TOTAL				**22.910**	**Sqm**	95.74	2193.35
		(A) TOTAL AMOUNT(Nrs.)							804407.61
16	**Electrification**	3% Of (A)							24132.23
		Total Amount of Under Ground Water tank & Pump House(Nrs.)							**828539.84**

9. Generator's Room

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	7.00	6.00		**42.000**	**Sqm**	3.45	144.90
2	**E/W in foundation In Ordinary Soil**								
	Long Wall	2	6.10	1.00	1.33	16.165			
	Short Wall	2	3.15	1.00	1.33	8.348			
	Ramp RS1	1	8.30	1.00	1.18	9.769			
	Steps	1	1.20	0.90	0.40	0.432			
		TOTAL				**34.714**	**Cum**	248.75	8634.83
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	Sn.(2-4-5-6A)				8.605			
	Earth filling in flooring	1	3.00	3.00	0.20	1.800			
4	**PCC M10 in foundation**	**TOTAL**				**10.405**	**Cum**	177.68	1848.64

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Long Wall	2	6.10	1.00	0.15	1.830			
	Short Wall	2	3.15	1.00	0.15	0.945			
	Ramp Wall	1	8.30	1.00	0.15	1.245			
	Ramp Base	1	1.30	2.40	0.10	0.312			
	Steps	1	1.20	0.90	0.10	0.108			
		TOTAL				**4.440**	**Cum**	7318.24	32493.00
5	**Flat Brick Soiling**								
	Long Wall	2	6.10	1.00		12.200			
	Short Wall	2	3.15	1.00		6.300			
	Ramp Wall	1	8.30	1.00		8.300			
	Ramp Base	1	1.30	2.40		3.120			
	Floor	1	4.70	3.75		17.625			
	Generator Room	1	3.00	2.30		6.900			
	Steps	1	1.20	0.90		1.080			
		TOTAL				**55.525**	**Sqm**	480.93	26703.45
6	**Brick Masonry work in 1:4 C/M**								
A	**Up to Formation Ground Level(FGL)**								
	Long Wall								
	1st Footing	2	5.85	0.75	0.45	3.949			
	2nd Footing	2	5.68	0.58	0.45	2.965			
	3rd Footing	2	5.55	0.45	0.20	0.999			
	Short Wall								
	1st Footing	2	3.40	0.75	0.45	2.295			
	2nd Footing	2	3.57	0.58	0.45	1.864			
	3rd Footing	2	3.70	0.45	0.20	0.666			
	Ramp Rs1								
	1st Footing	1	8.30	0.75	0.58	3.579			
	2nd Footing	1	8.30	0.58	0.63	3.018			
	Steps	1	1.20	0.90	0.30	0.324			
		TOTAL				19.659			
B	**B/W in Superstructure(FGL To Slab)**								
	Long Wall								
	Up to Plinth	2	5.55	0.45	0.30	1.508			
	Superstructure	2	5.48	0.38	3.33	13.674			
	Short Wall								
	Up to Plinth	2	3.70	0.45	0.30	0.999			
	Superstructure	2	3.78	0.38	3.33	9.428			
	Steps	1	1.20	0.90	0.34	0.367			
	Deduction								
	Opening								
	windows W1(1.2x1.2)	-5	1.20	0.38	1.20	-2.700			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Door opening D2(1.2x2.1)	-1	1.20	0.38	2.10	-0.945			
	Rolling Shutters Rs1(2.0X2.1)	-1	2.00	0.38	2.10	-1.575			
	Lintels								
	windows W1(1.2x1.2)	-5	1.50	0.38	0.15	-0.422			
	Door opening D2(1.2x2.1)	-1	1.50	0.38	0.15	-0.084			
	Rolling Shutters Rs1(2.0X2.1)	-1	2.30	0.38	0.15	-0.129			
		TOTAL				20.250			
		Grand Total				**39.909**	**Cum**	8444.40	337010.40
7	**PCC M15**								
	In DPC	1	18.5	0.375	0.1	0.694			
	Generator Base	1	3	2	0.5	3.000			
	In Floor	1	4.7	3.375	0.1	1.586			
		TOTAL				**5.280**	**Cum**	8550.84	45148.45
8	**RCC M20**								
	Lintels								
	windows W1(1.2x1.2)	5	1.50	0.38	0.15	0.422			
	Door opening D2(1.2x2.1)	1	1.50	0.38	0.15	0.084			
	Rolling Shutters Rs1(2.0X2.1)	1	2.30	0.38	0.15	0.129			
	Chajja								
	windows W1(1.2x1.2)	5	1.50	0.45	0.10	0.338			
	Door opening D2(1.2x2.1)	1	1.50	0.45	0.10	0.068			
	Rolling Shutters Rs1(2.0X2.1)	1	2.30	0.45	0.10	0.104			
	Slab	1	6.05	5.1	0.1	3.086			
	Tie Beam	1	18.4	0.375	0.2	1.380			
	Ramp	1	3	2.3	0.15	1.035			
		TOTAL				**6.645**	**Cum**	10615.62	70536.82
9	**Reinforcement**	**1.25% steel Total volume of RCC M20**				**652.004**	**Kg**	100.96	65825.33
10	**Formwork**								
	Lintels								
	windows W1(1.2x1.2)	5	1.80	0.68		6.075			
	Door opening D2(1.2x2.1)	1	1.80	0.68		1.215			
	Rolling Shutters Rs1(2.0X2.1)	1	2.60	0.68		1.755			
	Chajja								
	windows W1(1.2x1.2)	5	1.70	0.65		5.525			
	Door opening D2(1.2x2.1)	1	1.70	0.65		1.105			
	Rolling Shutters Rs1(2.0X2.1)	1	2.60	0.65		1.690			
	Ramp	1	10.60		0.15	1.590			
	Slab	1	6.25	5.3		33.125			
	Tie Beam	1	18.4	0.775		14.260			
		TOTAL				**66.340**	**Sqm**	600.90	39863.42

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
11	**20 mm thick Internal cement Plaster (1:4)**								
	In floor & Ceiling	2	4.70	3.75		35.250			
	Inside wall	1	16.9		3.53	59.657			
				TOTAL		**94.907**	**Sqm**	320.33	30401.14
12	**12 mm thick External cement Plaster (1:4)**								
	Outside Wall	1	19.9		4.03	80.197			
	Chajja								
	windows W1(1.2x1.2)	5	1.70	1.10		9.350			
	Door opening D2(1.2x2.1)	1	1.70	1.10		1.870			
	Rolling Shutters Rs1(2.0X2.1)	1	2.60	1.10		2.860			
	Slab Top	1	6.25	5.3		33.125			
	Cantilever	1	21.5	0.4		8.600			
	Steps								
	Front Face	1	1.20		1.40	1.680			
	Side Face	2	0.90		0.35	0.630			
	Deduction								
	Opening								
	windows W1(1.2x1.2)	-5	1.20		1.20	-7.200			
	Door opening D2(1.2x2.1)	-1	1.20		2.10	-2.520			
	Rolling Shutters Rs1(2.0X2.1)	-1	2.00		2.10	-4.200			
				TOTAL		**124.392**	**Sqm**	250.59	31171.37
13	**1:1 Cement Punning(Plaster Area of Slab Top + Flooring +Steps)**					**53.060**	**Sqm**	156.61	8309.57
14	**Aluminum Door and windows works**								
	windows W1(1.2x1.2)	5	1.20		1.20	7.200			
	Door opening D2(1.2x2.1)	1	1.20		2.10	2.520			
				TOTAL		**9.720**	**Sqm**	8467.15	82300.70
15	**Rolling Shutters Rs1(2.0X2.1)**	1	2		2.1	**4.200**	**Sqm**	6000.00	25200.00
16	**Two Coat Distemper Painting (Internal)**								
	In Ceiling	1	4.70	3.75		17.625			
	Inside wall	1	16.9		3.53	59.657			
				TOTAL		**77.282**	**Sqm**	128.51	9931.70
17	**Two Coat Cement Painting(External)**			**Same as item No.12**		**124.392**	**Sqm**	95.74	11908.98
				(A) TOTAL AMOUNT(Nrs.)					827432.70
18	**Electrification**			3% Of (A)					24822.98
				Total Amount of Generator Room (Nrs.)					**852255.69**

10. Watchman's Cabin

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	6.00	6.00		**36.000**	**Sqm**	3.45	124.20
2	**E/W in foundation In Ordinary Soil**								
	Long Wall	2	4.13	0.88	1.40	10.106			
	Short Wall	2	2.38	0.88	1.40	5.819			
	Steps	1	1.20	0.90	0.40	0.432			
		TOTAL				**16.357**	**Cum**	248.75	4068.72
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	Sn.(2-4-5-6A)				4.103			
	Earth filling in flooring	1	3.00	3.00	0.20	1.800			
		TOTAL				**5.903**	**Cum**	177.68	1048.88
4	**PCC M10 in foundation**								
	Long Wall	2	4.13	0.88	0.10	0.722			
	Short Wall	2	2.38	0.88	0.10	0.416			
	Steps	1	1.20	0.90	0.10	0.108			
		TOTAL				**1.246**	**Cum**	7318.24	9114.87
5	**Flat Brick Soiling**								
	Long Wall	2	4.13	0.88		7.219			
	Short Wall	2	2.38	0.88		4.156			
	Steps	1	1.20	0.90		1.080			
		TOTAL				**12.455**	**Sqm**	480.93	5989.94
6	**Brick Masonry work in 1:4 C/M**								
A	**Up to Formation Ground Level(FGL)**								
	Long Wall								
	1st Footing	2	4.00	0.75	0.40	2.400			
	2nd Footing	2	3.88	0.63	0.35	1.695			
	3rd Footing	2	3.75	0.50	0.35	1.313			
	4th Footing	2	3.63	0.38	0.15	0.408			
	Short Wall								
	1st Footing	2	2.50	0.75	0.40	1.500			
	2nd Footing	2	2.63	0.63	0.35	1.148			
	3rd Footing	2	2.75	0.50	0.35	0.963			
	4th Footing	2	2.88	0.38	0.15	0.323			
	Steps	1	1.20	0.90	0.30	0.324			
		TOTAL				10.074			
B	**B/W in Superstructure(FGL To Slab)**								
	Long Wall								
	Up to Plinth	2	3.63	0.38	0.45	1.223			
	Superstructure	2	3.50	0.25	2.77	4.848			
	Short Wall								

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Up to Plinth	2	2.88	0.38	0.45	0.970			
	Superstructure	2	3.00	0.25	2.77	4.155			
	Steps	1	1.20	0.90	0.34	0.367			
	Deduction								
	Opening								
	windows W1(1.2x1.2)	-2	1.20	0.25	1.20	-0.720			
	Door opening D2(1.2x2.1)	-1	1.20	0.25	2.10	-0.630			
	Lintels								
	windows W1(1.2x1.2)	-2	1.50	0.25	0.15	-0.113			
	Door opening D2(1.2x2.1)	-1	1.50	0.25	0.15	-0.056			
		TOTAL				10.045			
		Grand Total				**20.119**	**Cum**	8444.40	169890.43
7	**PCC M15**								
	In DPC	1	13	0.375	0.1	0.488			
	In Floor	1	3	3	0.1	0.900			
		TOTAL				**1.388**	**Cum**	8550.84	11864.29
8	**RCC M20**								
	Lintels								
	windows W1(1.2x1.2)	2	1.50	0.25	0.15	0.113			
	Door opening D2(1.2x2.1)	1	1.50	0.25	0.15	0.056			
	Chajja								
	windows W1(1.2x1.2)	2	1.50	0.60	0.10	0.180			
	Door opening D2(1.2x2.1)	1	1.50	0.90	0.10	0.135			
	Slab	1	4.4	4.4	0.1	1.936			
	Tie Beam	1	13	0.25	0.25	0.813			
		TOTAL				**3.232**	**Cum**	10615.62	34312.34
9	**Reinforcement**	1.25% steel Total volume of RCC M20				**317.165**	**Kg**	100.96	32020.46
10	**Formwork**								
	Lintels								
	windows W1(1.2x1.2)	2	1.50	0.55		1.650			
	Door opening D2(1.2x2.1)	1	1.50	0.55		0.825			
	Chajja								
	windows W1(1.2x1.2)	2	1.70	0.80		2.720			
	Door opening D2(1.2x2.1)	1	1.70	1.10		1.870			
	Slab	1	4.6	4.6		21.160			
	Tie Beam	1	13	0.75		9.750			
		TOTAL				**37.975**	**Sqm**	600.90	22819.02
11	**Boulder Soiling in flooring**	1	3.00	3.00	0.15	1.350			
		TOTAL				**1.350**	**Cum**	2449.50	3306.83
12	**20 mm thick Internal cement Plaster (1:4)**								
	In floor & Ceiling	2	3.00	3.00		18.000			
	Inside wall	1	12		3.02	36.24			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
		TOTAL				54.240	Sqm	320.33	17374.46
13	12 mm thick External cement Plaster (1:4)								
	Outside Wall	1	13		3.17	41.21			
	Chajja								
	windows W1(1.2x1.2)	2	1.70	1.30		4.420			
	Door opening D2(1.2x2.1)	1	1.70	1.90		3.230			
	Slab Top	1	4.4	4.4		19.360			
	Cantilever	1	15.8	0.55		8.690			
	Steps								
	Front Face	1	1.20		1.40	1.680			
	Side Face	2	0.90		0.35	0.630			
	Deduction								
	Opening								
	windows W1(1.2x1.2)	-2	1.20		1.20	-2.880			
	Door opening D2(1.2x2.1)	-1	1.20		2.10	-2.520			
		TOTAL				73.820	Sqm	250.59	18498.54
14	1:1 Cement Punning(Plaster Arera of Slab Top+Flooring+Steps)					30.670	Sqm	156.61	4803.14
15	Aluminum Door and windows works								
	windows W1(1.2x1.2)	2	1.20		1.20	2.880			
	Door opening D2(1.2x2.1)	1	1.20		2.10	2.520			
		TOTAL				5.400	Sqm	8467.15	45722.61
16	Two Coat Distemper Painting (Internal)								
	In Ceiling	1	3.00	3.00		9.000			
	Inside wall	1	12		3.02	36.24			
		TOTAL				45.240	Sqm	128.51	5813.91
17	Two Coat Cement Painting(External)								
	Outside Wall	1	13		3.17	41.21			
	Chajja								
	windows W1(1.2x1.2)	2	1.70	1.30		4.420			
	Door opening D2(1.2x2.1)	1	1.70	1.90		3.230			
	Slab Top	1	4.4	4.4		19.360			
	Cantilever	1	15.8	0.55		8.690			
	Deduction								
	Opening								
	windows W1(1.2x1.2)	-2	1.20		1.20	-2.880			
	Door opening D2(1.2x2.1)	-1	1.20		2.10	-2.520			
		TOTAL				71.510	Sqm	95.74	6846.19
		(A) TOTAL AMOUNT(Nrs.)							393618.82
18	Electrification	3% Of (A)							11808.56

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
		Total Amount of Watchman's Cabin (Nrs.)							**405427.39**

11. Watchman's Quarter

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	10.00	6.00		**60.000**	**Sqm**	3.45	207.00
2	**E/W in foundation In Ordinary Soil**								
	Long Wall	2	8.90	1.20	1.18	25.098			
	Short Wall 1	2	3.15	1.20	1.40	10.584			
	Short Wall 2	1	3.15	1.20	1.40	5.292			
	Steps	1	1.20	0.90	0.40	0.432			
		TOTAL				**41.406**	**Cum**	248.75	10299.54
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	Sn.(2-4-5-6A)				3.601			
	Earth filling in flooring	1	3.00	3.00	0.30	2.700			
		TOTAL				**6.301**	**Cum**	177.68	1119.44
4	**PCC M10 in foundation**								
	Long Wall	2	8.90	1.20	0.10	2.136			
	Short Wall 1	2	3.15	1.20	0.10	0.756			
	Short Wall 2	1	3.15	1.20	0.10	0.378			
	Steps	1	1.20	0.90	0.10	0.108			
		TOTAL				**3.378**	**Cum**	7318.24	24721.03
5	**Flat Brick Soiling**								
	Long Wall	2	8.90	1.20		21.360			
	Short Wall 1	2	3.15	1.20		7.560			
	Short Wall 2	1	3.15	1.20		3.780			
	Steps	1	1.20	0.90		1.080			
	In Floor	1	7.35	4		29.400			
	Deduction								
	Inside Wall	-1	8	0.35		-2.800			
		TOTAL				**60.380**	**Sqm**	480.93	29038.35
6	**Brick Masonry work in 1:4 C/M**								
A	**Up to Formation Ground Level(FGL)**								
	Long Wall								
	1st Footing	2	8.70	1.00	0.50	8.700			
	2nd Footing	2	8.35	0.65	0.50	5.428			
	3rd Footing	2	8.20	0.50	0.40	3.280			
	Short Wall								

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	1st Footing	2	6.70	1.00	0.50	6.700			
	2nd Footing	2	7.05	0.65	0.50	4.583			
	3rd Footing	2	7.20	0.50	0.40	2.880			
	Steps	1	1.20	0.90	0.30	0.324			
		TOTAL				31.894			
B	**B/W in Superstructure(FGL To Slab)**								
	Long Wall								
	Super Structure	2	8.05	0.35	2.52	14.200			
	Short Wall								
	Super Structure	2	7.35	0.35	2.52	12.965			
	Toilet Partition Wall	1	2.91	0.13	2.52	0.915			
	Steps	1	1.20	0.90	0.30	0.324			
	Deduction								
	Opening								
	windows W1(1.5x1.2)	-4	1.50	0.35	1.20	-2.520			
	windows W2(1.2x1.2)	-2	1.2	0.35	1.2	-1.008			
	Door opening D1(1.0x2.1)	-2	1.00	0.35	2.10	-1.470			
	Door opening D2(0.75x1.8)	-1	1.20	0.35	1.80	-0.756			
	Door opening D3(0.9x1.8)	-1	0.90	0.35	1.80	-0.567			
	Ventilation V1(1.0X0.5)	-1	1.00	0.35	0.50	-0.175			
	Lintels								
	windows W1(1.5x1.2)	-4	1.80	0.35	0.15	-0.378			
	windows W2(1.2x1.2)	-2	1.5	0.35	0.15	-0.158			
	Door opening D1(1.0x2.1)	-2	0.31	0.35	0.15	-0.033			
	Door opening D2(0.75x1.8)	-1	1.50	0.35	0.15	-0.079			
	Door opening D3(0.9x1.8)	-1	1.20	0.35	0.15	-0.063			
	Ventilation V1(1.0X0.5)	-1	1.30	0.35	0.15	-0.068			
	Verandha	-1	5.30	0.35	2.52	-4.675			
		TOTAL				16.456			
		Grand Total				**48.350**	**Cum**	8444.40	408287.14
7	**PCC M15**								
	In DPC								
	Long Wall								
	Super Structure	2	8.20	0.50	0.10	0.820			
	Short Wall								
	Super Structure	2	7.20	0.50	0.10	0.720			
	In Floor	1	7.35	4	0.1	2.940			
	Deduction								
	Inside Wall	-1	8	0.35	0.1	-0.280			
		TOTAL				**4.200**	**Cum**	8550.84	35913.54
8	**RCC M20**								
	Lintels								

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	windows W1(1.5x1.2)	4	1.80	0.35	0.15	0.378			
	windows W2(1.2x1.2)	2	1.5	0.35	0.15	0.158			
	Door opening D1(1.0x2.1)	2	0.31	0.35	0.15	0.033			
	Door opening D2(0.75x1.8)	1	1.50	0.35	0.15	0.079			
	Door opening D3(0.9x1.8)	1	1.20	0.35	0.15	0.063			
	Ventilation V1(1.0X0.5)	1	1.30	0.35	0.15	0.068			
	Slab	1	8.85	5.5	0.1	4.868			
	Tie Beam								
	Long Wall								
	Super Structure	2	8.05	0.35	0.23	1.296			
	Short Wall								
	Super Structure	2	7.35	0.35	0.23	1.183			
	Toilet Partition Wall	1	2.91	0.13	0.23	0.084			
		TOTAL				**8.208**	**Cum**	10615.62	87138.00
9	**Reinforcement**	1.25% steel Total volume of RCC M20				**805.456**	**Kg**	100.96	81317.63
10	**Formwork**								
	Lintels								
	windows W1(1.5x1.2)	4	1.80	0.65		4.680			
	windows W2(1.2x1.2)	2	1.5	0.65		1.950			
	Door opening D1(1.0x2.1)	2	0.31	0.65		0.403			
	Door opening D2(0.75x1.8)	1	1.50	0.65		0.975			
	Door opening D3(0.9x1.8)	1	1.20	0.65		0.780			
	Ventilation V1(1.0X0.5)	1	1.30	0.65		0.845			
	Slab	1	9.05	5.7		51.585			
	Tie Beam								
	Long Wall								
	Super Structure	2	8.05	0.81		13.041			
	Short Wall								
	Super Structure	2	7.35	0.81		11.907			
	Toilet Partition Wall	1	2.91	0.59		1.699			
		TOTAL				**87.865**	**Sqm**	600.90	52797.96
11	**20 mm thick Internal cement Plaster (1:4)**								
	Wall	1	39.62		2.52	99.842			
	Ceiling + Floor	2	7.35	4		58.800			
	Deduction								
	Inside Wall	-1	8	0.35		-2.800			
	Steps								
	Front Face	1	1.20		1.40	1.680			
	Side Face	2	0.90		0.35	0.630			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
		TOTAL				**158.152**	**Sqm**	320.33	50660.26
12	**12 mm thick External cement Plaster (1:4)**								
	Outside Wall	1	25.5		3.36	85.68			
	Slab Top	1	11.55	4.6		53.130			
	Cantilever Ceiling	1	28.7	0.55		15.785			
	Deduction								
	Opening								
	windows W1(1.5x1.2)	-4	1.50		1.20	-7.200			
	windows W2(1.2x1.2)	-2	1.2		1.2	-2.880			
	Door opening D1(1.0x2.1)	-2	1.00		2.10	-4.200			
	Door opening D2(0.75x1.8)	-1	1.20		1.80	-2.160			
	Door opening D3(0.9x1.8)	-1	0.90		1.80	-1.620			
	Ventilation V1(1.0X0.5)	-1	1.00		0.50	-0.500			
		TOTAL				**136.035**	**Sqm**	250.59	34088.99
13	**1:1 Cement Punning(Plaster Area of Slab Top + Flooring + Steps)**					**84.840**	**Sqm**	156.61	13286.54
14	**Aluminum Door and windows works**								
	windows W1(1.5x1.2)	4	1.50		1.20	7.200			
	windows W2(1.2x1.2)	2	1.2		1.2	2.880			
	Door opening D1(1.0x2.1)	2	1.00		2.10	4.200			
	Door opening D2(0.75x1.8)	1	1.20		1.80	2.160			
	Door opening D3(0.9x1.8)	1	0.90		1.80	1.620			
	Ventilation V1(1.0X0.5)	1	1.00		0.50	0.500			
		TOTAL				**18.560**	**Sqm**	8467.15	
15	**Two Coat Distemper Painting (Internal)**								
	Wall	1	39.62		2.52	99.842			
	Ceiling	1	7.35	4		29.400			
	Deduction								
	Inside Wall	-1	8	0.35		-2.800			
		TOTAL				**126.442**	**Sqm**	128.51	16249.43
16	**Two Coat Cement Painting(External)**	Same as Item No. 12				**136.035**	**Sqm**	95.74	13023.65
		(A) TOTAL AMOUNT(Nrs.)							858148.48
17	**Electrification**	3% Of (A)							25744.45
18	**Sanitation**	15% Of (A)							128722.27
		Total Amount of Watchman's Quarter (Nrs.)							**1012615.21**

12. Watchman's Changing Room

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	10.000	5.000		**50.000**	**Sqm**	3.45	172.50
2	**E/W in foundation In Ordinary Soil**								
	Long Wall	2	9.000	0.900	1.075	17.415			
	Short Wall 1	2	2.390	0.900	1.075	4.625			
	Short Wall 2	1	0.870	0.900	1.075	0.842			
	Steps	1	4.380	0.900	0.475	1.872			
		TOTAL				**24.754**	**Cum**	248.75	6157.39
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	S.No.(2-4-5-6A)				7.456			
	Earth filling in flooring	1	3.000	3.000	0.300	2.700			
		TOTAL				**10.156**	**Cum**	177.68	1804.39
4	**PCC M10 in foundation**								
	Long Wall	2	9.000	0.900	0.100	1.620			
	Short Wall 1	2	2.390	0.900	0.100	0.430			
	Short Wall 2	1	0.870	0.900	0.100	0.078			
	Steps	1	4.380	0.900	0.100	0.394			
		TOTAL				**2.523**	**Cum**	7318.24	18461.73
5	**Flat Brick Soiling**								
	Long Wall	2	9.000	0.900		16.200			
	Short Wall 1	2	2.390	0.900		4.302			
	Short Wall 2	1	0.870	0.900		0.783			
	Steps	1	4.380	0.900		3.942			
	In Floor								
	Bath Room +Washing Room	1	3.040	3.495		10.625			
	Toilet	2	1.500	2.000		6.000			
		TOTAL				**41.852**	**Sqm**	480.93	20127.64
6	**Brick Masonry work in 1:4 C/M**								
A	**Up to Formation Ground Level(FGL)**								
	Long Wall								
	1st Footing	2	8.725	0.625	0.300	3.272			
	2nd Footing	2	8.600	0.500	0.600	5.160			
	Short Wall 1								
	1st Footing	2	2.665	0.625	0.300	0.999			
	2nd Footing	2	2.790	0.500	0.600	1.674			
	Short Wall 2								
	1st Footing	1	1.145	0.625	0.300	0.215			
	2nd Footing	1	1.270	0.500	0.600	0.381			
	Steps	1	4.380	0.900	0.300	1.183			
		TOTAL				12.884			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	B/W in Superstructure(FGL To Slab)								
	Long Wall								
	GL To Plinth	2	8.475	0.375	0.375	2.384			
	Super Structure	2	8.350	0.250	2.170	9.060			
	Short Wall 1								
	GL To Plinth	2	2.915	0.375	0.375	0.820			
	Super Structure	2	3.040	0.250	2.170	3.298			
	Short Wall 2								
	GL To Plinth	1	1.395	0.375	0.375	0.196			
	Super Structure	1	1.520	0.250	2.170	0.825			
	Toilet Partition Wall	1	3.540	0.125	2.170	0.960			
	Steps	1	4.380	0.900	0.300	1.183			
	Deduction								
	Opening								
	Door opening D1(1.0x2.1)	-1	1.000	0.250	2.100	-0.525			
	Door opening D2(0.75x1.8)	-3	0.750	0.250	1.800	-1.013			
	Ventilation V1(1.0X0.7)	-5	1.000	0.250	0.700	-0.875			
	Opening(1.0X2.1)	-1	1.000	0.250	2.100	-0.525			
	Lintels								
	Door opening D1(1.0x2.1)	-1	1.300	0.250	0.150	-0.049			
	Door opening D2(0.75x1.8)	-3	1.050	0.250	0.150	-0.118			
	Ventilation V1(1.0X0.7)	-5	1.300	0.250	0.150	-0.244			
	Opening(1.0X2.1)	-1	1.000	0.250	0.150	-0.038			
		TOTAL				15.340			
		Grand Total				**28.223**	**Cum**	8444.40	238327.23
7	**PCC M15**								
	In DPC								
	Long Wall								
	Super Structure	2	8.475	0.375	0.075	0.477			
	Short Wall 1								
	Super Structure	2	2.915	0.375	0.075	0.164			
	Short Wall 2								
	Super Structure	1	1.395	0.375	0.075	0.039			
	In Floor								
	Bath Room +Washing Room	1	3.040	3.495	0.075	0.797			
	Toilet	2	1.500	2.000	0.075	0.450			
		TOTAL				**1.927**	**Cum**	8550.84	16475.61
8	**RCC M20**								
	Lintels								
	Door opening D1(1.0x2.1)	1	1.300	0.250	0.150	0.049			
	Door opening D2(0.75x1.8)	3	1.050	0.250	0.150	0.118			
	Ventilation V1(1.0X0.7)	5	1.300	0.250	0.150	0.244			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Opening(1.0X2.1)	1	1.000	0.250	0.150	0.038			
	Slab	1	9.250	4.440	0.100	4.107			
	Deduction slab opening	-1	4.830	1.000	0.100	-0.483			
	Tie Beam								
	Long Wall								
	Super Structure	2	8.350	0.250	0.230	0.960			
	Short Wall 1								
	Super Structure	2	3.040	0.250	0.230	0.350			
	Short Wall 2								
	Super Structure	1	1.495	0.250	0.230	0.086			
		TOTAL				**5.468**	**Cum**	10615.62	58045.55
9	**Reinforcement**	1.25% steel Total volume of RCC M20				**536.541**	**Kg**	100.96	54168.41
10	**Formwork**								
	Lintels								
	Door opening D1(1.0x2.1)	1	1.300	0.550		0.715			
	Door opening D2(0.75x1.8)	3	1.050	0.550		1.733			
	Ventilation V1(1.0X0.7)	5	1.300	0.550		3.575			
	Opening(1.0X2.1)	1	1.000	0.550		0.550			
	Slab	1	9.450	4.640		43.848			
	Tie Beam								
	Long Wall								
	Super Structure	2	8.350	0.710		11.857			
	Short Wall 1								
	Super Structure	2	3.040	0.710		4.317			
	Short Wall 2								
	Super Structure	1	1.495	0.710		1.061			
		TOTAL				**67.656**	**Sqm**	600.90	40654.05
11	**20 mm thick Internal cement Plaster (1:4)**								
	Wall	1	32.390		2.170	70.286			
	In Floor & Ceiling								
	Bath Room +Washing Room	2	3.040	3.495		21.250			
	Toilet	4	1.500	2.000		12.000			
	Steps								
	Front Face	1	4.380		1.400	6.132			
	Side Face	2	0.900		0.350	0.630			
		TOTAL				**110.298**	**Sqm**	320.33	35331.24
12	**12 mm thick External cement Plaster (1:4)**								
	Outside Wall	1	23.780		2.950	70.151			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	Slab	1	9.450	4.640		43.848			
	Deduction slab opening	-1	4.830	1.000		-4.830			
	Cantilever Ceiling	1	28.180	0.650		18.317			
	Deduction								
	Opening								
	Door opening D1(1.0x2.1)	-1	1.000		2.100	-2.100			
	Door opening D2(0.75x1.8)	-3	0.750		1.800	-4.050			
	Ventilation V1(1.0X0.7)	-5	1.000		0.700	-3.500			
	Opening(1.0X2.1)	-1	1.000		2.100	-2.100			
		TOTAL				**115.736**	**Sqm**	250.59	29002.26
13	**1:1 Cement Punning(Plaster Area of Slab Top + Flooring +Steps)**					**62.405**	**Sqm**	156.61	9773.03
14	**Aluminum Door and windows works**								
	Door opening D1(1.0x2.1)	1	1.000		2.100	2.100			
	Door opening D2(0.75x1.8)	3	0.750		1.800	4.050			
	Ventilation V1(1.0X0.7)	5	1.000		0.700	3.500			
		TOTAL				**9.650**	**Sqm**	8467.15	81708.00
15	**Two Coat Distemper Painting (Internal)**								
	Wall	1	32.390		2.170	70.286			
	In Ceiling								
	Bath Room +Washing Room	1	3.040	3.495		10.625			
	Toilet	2	1.500	2.000		6.000			
		TOTAL				**86.911**	**Sqm**	128.51	11169.16
16	**Two Coat Cement Painting(External)**	Same as Item No. 12				**115.736**	**Sqm**	95.74	11080.28
		(A) TOTAL AMOUNT(Nrs.)							632458.48
17	**Electrification**	3% Of (A)							18973.75
18	**Sanitation**	15% Of (A)							94868.77
		Total Amount of Worker's Changing Room (Nrs.)							**746301.01**

13.Barbed Wire Fencing And Gate

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	1300.000	2.000		**2600.000**	**Sqm**	3.45	8970.00
2	**E/W in foundation in ordinary Soil**								
	Barbed Wire Pillar	521	0.350	0.350	0.600	38.294			
	Main Gate Column	2	1.000	1.000	1.050	2.100			
		TOTAL				**40.394**	**Cum**	248.75	10047.68
3	**E/W in Backfilling**								
	Backfilling in Foundation trench	Sn.(2-4-5)				3.546			
		TOTAL				**3.546**	**Cum**	177.68	629.96
4	**PCC M10 in foundation**								
	Barbed Wire Pillar	521	0.350	0.350	0.500	31.911			
		TOTAL				**31.911**	**Cum**	7318.24	233534.30
5	**Flat Brick Soiling**								
	Barbed Wire Pillar	521	0.350	0.350		63.823			
	Main Gate Column	2	1.000	1.000		2.000			
		TOTAL				**65.823**	**Sqm**	480.93	31655.79
6	**B/W in Pillar**								
	Barbed Wire Pillar	521	0.350	0.350	0.500	31.911			
	Main Gate Column	2	0.450	0.450	3.200	1.296			
	Main Gate Capping	2	0.650	0.650	0.200	0.169			
	Deduction								
	RCC Column	-2	0.300	0.300	3.200	-0.576			
		TOTAL				**32.800**	**Cum**	8444.40	276978.56
7	**Barbed Wire**								
	7 Horizontal	7	1365.000			9555.000			
	2 Diagonal	1042	3.023			3150.220			
		TOTAL				**12705.220**	**Rm**	93.99	1194186.45
8	**RCC M15**								
	RCC Column								
	Base	2	1.000	1.000	0.175	0.350			
	Column	2	0.300	0.300	3.000	0.540			
		TOTAL				**0.890**	**Cum**	8550.84	7610.25
9	**Reinforcement**								
	For RCC	1.5% steel Total volume of RCC M20				104.798			
	MS Angle For Barbed Wire Fencing(40X40X6mm)	521	2.250	0.080	0.006	4417.038			
		TOTAL				**4521.836**	**Kg**	100.96	456517.73
10	**Formwork**								

	RCC Column								
	Column	2	1.200		3.000	**7.200**	**Sqm**	600.90	4326.45
11	**20 mm thick Cement Plaster (1:4)**								
	Barbed Wire Pillar	521	1.400		0.500	364.700			
	Main Gate Column	2	1.800		2.500	9.000			
	Main Gate Capping	2	2.600		0.200	1.040			
		TOTAL				**374.740**	**Sqm**	320.33	120038.82
12	**Steel Gate including Enamel Painting**								
	Steel Gate	1	6.000		1.600	9.600			
		TOTAL				9.600	Sqm	6000.00	57600.00
		(A) TOTAL AMOUNT(Nrs.)							2402095.98
13	**Electrification**	0.5% Of (A)							12010.48
		Total Amount of Barbed Wire Fencing For Compound Wall (Nrs.)							**2414106.46**

14. Green Parks

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	Planting containerized tree and shrub seedling, including pitting, transplanting, composting and mulching, on slopes <30 degree, Pit size 30 cm dia. X 30 cm depth. Mix compost with soil and back fill into pit to 1/4 of the pit volume.	200				**200.00**	**Nos.**	665.01	133002.10
2	Broadcasting grass seeds on slopes <40 degree seeding rate 25 gm per sqm.	1	2675.00			**2675.00**	**Sqm**	5.62	15027.48
		Total Amount of Green Parks (Nrs.)							**148029.58**

15. Electromechanical Components

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
1	**Supply , Installation , testing and commissioning of following**				
	Mechanical Equipments				
1.1	Mechanical Vertical coarse Bar Screen : Width : 600 mm ,				
	depth : 900 mm made with 20 mm thick (bar :13 no) SS 304 flat				
	mechanical screen vertical / inclined rake type of 30 mm opening together				
	with conveyor belt and chute arrangement to take screenings to				

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
	drop automatically in a wheel barrow placed at 8 m above the top				
	of the screen including necessary accessories all complete	2	Unit	1560000.00	3120000.00
1. 2	Single stage submersible sewage transfer pump set for solid				
	handling capacity up to 100 mm together with double auto-rail coupling all				
	complete confirming to attached specification for a duty of :				
	a) 380 cu.m per hour at 12 m water column				
	Motor type : Star/Delta Started ,Oil filled with class F insulation				
	Nominal rating 22 kW at 3 phase 400±10% V .	3	Unit	. 1500000.00	4500000.00
	50±3% Hz , speed 1450 rpm .				
	Pump delivery size : DN 200 mm				
	b) 190 cu.m per hour at 12 m water column				
	Motor type : Star/Delta Started ,Oil filled with class F insulation				
	Nominal rating 11 kW at 3 phase 400±10% V .				
	50±3% Hz, speed 1450 rpm.	2	Unit	900000.00	1800000.00
	Pump delivery size : DN 150 mm				
	Each pump set shall be provided with following built-in motor				
	controls:				
	• Thermistor protection against winding overheating				
	• Seal wear out sensor				
	• Reverse rotation protection				
	• Bearing temperature sensor				
	• Moisture sensor for leakage in stator housing				
	Material of pump components : Ductile Iron				
1.3	Traveling trolley with 2 Ton capacity chain pulley block with Hoisting- comprising of I-Girder	1	Unit	400000.00	400000.00
	.all complete required to be removed for maintenance of all pumps with horizontal travel on the I-beam				
1.4	Self supported suitable size metallic Motor control panel for above motors consisting of :				
	• suitable capacity MCCB				

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
	• Voltmeter with S/S for three phases				
	• Fully automatic air break type Star-Delta motor starter with				
	electronic timer ,all magnetic contactors selected for line current.				
	• Motor protection against over current , dry run , phase fail,				
	opposite phase				
	• Automatic Level switches for high and low water levels with provision of buzzer				
	• Fault indication lamps				
	Nominal Motor Ratings :				
	a) 22 KW	3	Unit	150000.00	450000.00
	b) 11 KW	2	Unit	100000.00	200000.00
1.5	3 core 10 mm2 PVC insulated flat submersible copper cable	200	m	850.00	170000.00
1.6	Double Flanged DI Taper				
	a) 150 mm x 250 mm	2	No.	9434.88	18869.76
	b) 200 mm x 250 mm	3	No.	13386.24	40158.72
	c) 250 mm x 300 mm	5	No.	15386.24	76931.20
1.7	Double Flanged 300 mm dia DI 90 bend	6	No.	22579.20	135475.20
1.8	Double flanged. CI dismantling joint (suitable for sluice valves etc.) as per IS specification				
	a) 300 mm dia.	10	No.	70000.00	700000.00
	b) 500 mm dia	2	No.	210000.00	420000.00
1.9	300 mm dia. Manually operated CI D/F Sluice valves of approved make	5	No.	200000.00	1000000.00
	(IS: 14846 Amended up to date) PN 1.0 class				
1.1	Dual plate check valve as per API:594 and API :598 of PN 1.0 rating	5	No.	200000.00	1000000.00
1.11	Double flanged DI Tee				
	a) 300 mm x 300 mm x 500 mm	1	No.	45480.96	45480.96
	b) 500 mm x 300 mm x 500 mm	4	No.	45480.96	181923.84
1.12	Suitable size Stainless Steel nut, bolt and washer , Rubber Gasket for		LS	50000.00	50000.00
	above pipes and valves quantity as per requirement				
	Subtotal of 1				
2	**Supply ,Installation , testing and commissioning of electricity power line and accessories all complete**				
	11 KV Power line				

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
2.1	11 m long PSC pole erecting including pit excavation , fixing of necessary cross-arms with brackets, installation of hardware and insulators (pin , disc all complete)	4	No.	25000.00	100000.00
2.2	3 W 11 KV line using 30 sq. mm ACSR conductor on above 11 m high PSC pole with dead ended H-pole structure including jumper & binding works of the conductors all complete	135	m	325.00	43875.00
2.3	Stay set comprising of earth plate , rod, turnbuckle , insulator , eye-bolt, 7/12 SWG stay wire all complete	3	No.	850.00	2550.00
2.4	8x50x100x2000 MS channel cross arm on H-pole structure with necessary clamps , nut-bolts all complete	2	No.	1100.00	2200.00
2.5	GOAB on H-pole structure including operating handle and fixing	1	Set	40000.00	40000.00
2.6	L.A. on H-pole structure with earthing connection complete	1	Set	30000.00	30000.00
2.7	Drop out cut set on H-pole structure with fuses all complete	1	Set	10000.00	10000.00
2.8	Copper winded 11/0.415 KV, 3 phase, 50 HZ 160 KVA distribution transformer including necessary hardware.				
		1	No.	600000.00	600000.00
2.9	Plate Earthing as per IS:3043 with Copper Earth plate of size 600mm x 600mmx 6.0mm by embodying 3 to 4 mtr. below the ground level with 20 mm dia. G.I. 'B' class watering Pipe including all accessories like nut, bolts, reducer, nipple , wire meshed funnel, and C.C. finished chamber covered with hinged type with locking arrangement C.I. Cover, C.I. Frame of size300mm x 300mm complete with alternate layers of salt and coke/charcoal, testing of	4	Set	25000.00	100000.00
	earth resistance as required. Copper wire size : 2 SWG				

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
2.1	Construction of transformer platform 2M x 2M x 2M height from ground including excavation with 300 mm. thick dry stone soling in bottom & 150mm. thick PCC 1:2:4 on stone soling. Platform will be constructed from R. R. stone / Brick masonry in cement mortar 1:4 with cement plaster 20 mm thick onsides and 100 mm PCC of grade M 15 on top of platform size				
	2000mmX2000mm complete in all respect.	1	Set	85930.78	85930.78
3	**Supply ,Installation , testing and commissioning of L/T electricity power line and accessories all complete**				
3.1	350 A MCCB in rainwater proof pole box	1	Set	17500.00	17500.00
3.2	XLPE insulated armored cable with copper cable (AS-IS:7098 (1))				
	a) 3.5 core 150 mm2	200	m	6500.00	1300000.00
	b) 4 core 16 mm2	200	m	850.00	170000.00
3.3	TPN L/T TOD meter in a suitable cabinet	1	Unit	50000.00	50000.00
3.4	Power Distribution Box with 1 no. 350 A TPN Panel type Changeover Switch , 1 no 250 A MCCB , 4 nos. 50 A MCCB , 60 A DP MCB , copper bus bar in suitable self standing metallic cabinet	1	Unit	100000.00	100000.00
3.5	Equipment Earthing Plate/or Pipe as per instruction	6	Set	15000.00	90000.00
3.6	Cable shoes, cable socket, screw, nut, bolt, PVC tape , Waterproof cable jointing materials etc.				
		1	Lot	5000.00	5000.00
4	**Supply ,Installation , testing and commissioning with all necessary accessories all complete**				
4.1	Silent (Noise free) Generator set ; 3 phase , 400/0.23 V ,50 HZ with water cooled four stroke diesel engine and all necessary accessories including control panel and diesel storage tank all complete :				
	a) 150 KVA				
	b) 63 KVA				

S.No.	Item	Quantity	Unit	Rate (Rs)	Amount (Rs)
		1	Set	1200000.00	1200000.00
		1	Set	600000.00	600000.00
4.2	350 A TPN Changeover Switch in a suitable metallic cabinet	1	No.	15000.00	15000.00
5	**Supply ,Installation , testing and commissioning with all necessary accessories all complete**				
5.1	9 m long steel tubular pole with D-iron and shackle insulator	50	Set	15000.00	750000.00
5.2	1.25 m long outdoor type street light fixture inclusive of 36 watt tube lamp with 400 mounting bracket with cable connection box , switch etc complete				
		50	Set	5000.00	250000.00
5.3	4 C 10 sq. mm XLPE insulated armored cable with aluminum conductor including embedding at 1 meter depth below ground and raising through 50 mm med. Class GI pipe including all necessary accessories complete				
		1000	m	1000.00	1000000.00
Total Cost of Electromechanical Components (Nrs)					**20870895.46**

15.1 Transformer Platform

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	**Site Clearance**	1	3.00	3.00		**9.000**	**Sqm**	3.45	31.05
2	**E/W in foundation in Ordinary Soil**								
	Platform	1	2.00	2.00	0.45	1.800			
		TOTAL				**1.800**	**Cum**	248.75	447.74
3	**Stone Soiling**								
	Foundation Base	1	2.00	2.00	0.30	1.200			
		TOTAL				**1.200**	**Sqm**	2449.50	2939.40
4	**Brick Masonry work in 1:4 C/M**								
	Transformer Base	1	2	2	2	8.000			
		Total				**8.000**	**Cum**	8444.40	67555.23
5	**PCC M15**								
	In Top	1	2.00	2.00	0.10	0.400			
	In Foundation Base	1	2	2	0.15	0.600			
		TOTAL				**1.000**	**Cum**	8550.84	8550.84
6	**20 mm thick Internal cement Plaster (1:4)**								
	In Wall	1	8.00		2.00	16.000			

S.No.	Description of works	No	Length	Breadth	Height	Quantity	Unit	Rate	Amount
	In Wall Top	1	2	2		4			
		TOTAL				**20.000**	**Sqm**	320.33	6406.51
		Total Amount of Transformer Platform (Nrs.)							**85930.78**

Annexure – 1

Approved Population and Urban Density Projection

(Population Projection Report -March 2013)

Annexure – 1

Population and Urban Density Projection

Information on Population was collected from the previous reports of Birgunj Sub-municipality like IAP, Periodic Plan and Structure Plan. Population projections were carried out in all these reports in different ways.

Total Population and growth rate of Birgunj Sub-Metropolitan City of years: 1971, 1981, 1991, 2001 and 2011

Table No 1

S.No.	Year	Population	Growth Rate %
1.	1971	12,999	
2.	1981	43,642	
3.	1991	68,764	4.65
4.	2001	1,12,284	5.04
5.	2007	1,45,478	4.89
6	2011	135904	1.91

Source: Census and BSMC town profile

Population Projection

Central Bureau of Statistics has released the result of the National Population Census 2011 on November 27, 2011. According to the National Population Census 2011, population of Nepal as of the census day (June 22, 2011) stands at 26,494,504. The increment of population during the last decade is recorded as 3,343,081 with an annual average growth rate of 1.35 percent.

Tarai constitutes 50.27 percent (13,318,705) of the total population while Hill and Mountain constitutes 43 percent (11,394,007) and 6.73 percent (1,781,792) respectively. Among the five development regions, Central development region has the highest population (36.45 percent) and far western region records the lowest (9.63 percent).

According to the National Population Census 2001, the population growth rate of Nepal was 2.25 percent per annum. Likewise, the result shows that there are 5,659,984 households living in 4,767,196 dwellings/houses throughout the country which shows the ratio of houses to households 1:1.19.

Furthermore, the result also revealed that the size of the household in Nepal has decreased from 5.44 in 2001 to 4.88 in 2011. The household size is recorded highest (6.44) in Rautahat district and lowest (3.92) in Kaski.

The result shows that the absentee population in Nepal increased to 1,921,494 which are more than double the absentee population in 2001. Apparently, the population of male absentee

dominates in the total absentee population. The male absentee population comprises about 87.6 percent.

The percentage of male and female absentee population in the year 2001 was 89 and 11 percent respectively.

The result reveals that the population of male and female in Nepal is 12,849,051 and 13,645,433 respectively.

Accordingly, sex ratio (number of males per 100 females) at the national level has decreased from 99.8 in 2001 to 94.2 in 2011. In abstract number, there are 796,422 more females than males in the country. Sex ratio is highest (127) in Manang district and lowest (76) in Gulmi district

Also, the result reveals the massive increase in the urban population. The urban population (population residing in 58 municipalities) constitutes 17% (4,523,820) of the total population compared to 13.94% (3,227,879).

Population density (average number of population per square kilometer) at the national level is 180 compared to 157 in 2001. The highest population density is found in Kathmandu district (4,416 persons per square km) and lowest (3 person per square km) in Manang district.

The fastest decadal population growth rate is to be found in Kathmandu district (61.23 percent) and least in Manang (-31.80 percent). Altogether 27 districts including Manang, Khotang, Mustang, Terhathum, Bhojpur etc. recorded negative population growth rate during the last decade.

Likewise the rural population of Nepal decreased from 86 percent in 2001 to 83 percent in 2011. The sex ratio in the rural areas, as in the census 2001 is higher (104) than in the urban areas (92).

Among the urban areas, the Kathmandu Metropolitan City constitutes the largest population of 1,006,656 followed by Pokhara and Biratnagar Municipality. Dhulikhel Municipality has the lowest population, 16,406 among the urban areas followed by Dasharathchand, Bhadrapur and Ilam Municipalities.

The result also reveals that Kathmandu district has the largest population of 1,740,977 followed by Morang, Rupandehi, Jhapa and Kailali which has the population of 964,709; 886,706; 810,636 and 770,279 respectively. Manang constitutes the lowest population of 6,527 followed by Mustang, Dolpa, Rasuwa and Humla that has population of 13,799; 36,701; 43798 and 51008 respectively.

Population Projection Method

The population projection depends upon number of factors such as socio-economic activities, political development and availability of infrastructures.

Population projections are based on the assumptions that the past trends will continue in future. In general population projections are treated predetermines and never to termed as final projections. They should be reviewed frequently in order to determine the degree to which it agree with recent demographic change

There are various methods of projecting population (mathematical, economic and component methods). Some are very sophisticated and rigorous while others are simple and less sophisticated.

In case of Birgunj, the projection of the population has been done ***by the geometric growth method i.e.*** $P_n = P_0 (1+r)^n$

The annual ward wise growth rates have been calculated based on the census data of 2001 and 2011 and projected the population in wards with the base year 2015.

Numbers of meetings were held with PCO and PMSC to discuss the other alternatives identified by DSC for the population projection. The main issue discussed in the meetings is to decide the annual growth rate in negative growth rate wards such as 4, 5, 6, 7, 8, 11, and 12. The meeting decided to take the growth rate for the ward wise population projection as follows:

Project the population with natural growth rates for positive growth rate wards like ward no. 1, 2, 3, 9, 10, 13, 14, 15, 16, 17, 18 and 19.

Project the population with zero growth rate in case of negative rate wards like ward no. 4, 5, 6, 7, 8,11 and 12 but increase 10% of the total population of the year 2035 in commercially actives wards such as 4, 5, 7, 8, 9 ,11 and 12.

The projected population in different wards reveals the following facts:

Out of the total population of 269,154, population of 113,180 (42.05%) is expected to live in big ward no 17, 18 and 19; population of 85,594 (31.80%) in medium ward no 1, 2, 13 and 16; population of 48,817 (18.16%) in small ward no. 3, 10, 14 and 15 and population of 21,563 (8.01%) in very small ward 4, 5, 6, 7, 8, 9, 11 and 12 which are core wards. Due care should be given in planning of ward no 17, 18 and 19, so that there shall not be problem in providing infrastructure services.

Ward 17, 18 and 19 have still medium urban density, less than 150 pph even in 2035 and enough land for urbanization. Thus these three wards could accommodate more that the projected population even after 2035.

Medium ward 16 and 13 are expected to reach high urban density of 258.8 pph and 180.7 pph where as ward 1 and 2 are expected to reach medium density of 93.00pph and 123.00pph. These two wards can accommodate more people even after 2035 as more lands are still available in these two wards.

Small ward 3,10,14,15 will reach fairly good urban density in 2035 but these wards do not have enough land.

Very small ward 4, 5, 6, 7, 8, 9, 11 and 12 ranging 133.6 pph in ward no 4 to 362.5 pph in ward no 9. Since these wards are very small, increase in density is possible due to more commercial activities, high rise building and property separation among family members.

Conclusions & Recommendations

Birgunj Sub-metropolitan City has experience rapid urban growth in the last two decades in ward no 13, 14 in the western sector and ward no. 15, 16, 18 and 19, in the eastern sector, especially in between main road and By-pass road. The building permit data show the present development trend is still continuing in this direction. If one looks at the development trend of the city, one could notice haphazard development of road network system with narrow road width, the effect of which will be in providing the infrastructure services.

The pattern of new residential development is a function of access; distance from established urban areas. Extension of infrastructure services such as water, electricity, drainage and sewerage are dependent on access since these services are provided along road access.

There is opportunity to guide the urban development by predetermining primary infrastructure networks. Public awareness of road networks would automatically influence private sectors decisions about where to invest in land for future urban development.

Current development pattern

In case of Birgunj, the present scenario of urban development and possibility of future urban expansion can be looked upon as follows:

The central part of Birgunj, ward no. 4, 5, 6, 7, 8, 9, 11 and 12 are fully developed and concentrated settlement. Only natural growth is possible in these wards.

Ward 3 in south, ward 13, 14, 16 in the west are well developed with some vacant lands still available for development and there is limited opportunity for further new development.

Ward 1, 2 in south and ward 17 in north and ward 18, 19 in east are the only wards where there are enough opportunity for further urban expansion. The urban densities are also very low in these wards in compared to the other wards.

Planning Intervention in ward no. 17, 18 and 19

The current development pattern shows that the area bounded by Padma road in the north, Chhapkaiya in the south, Sirsiya river in the west and second by-pass road in the east is almost fully developed. Planning intervention is required beyond the By-pass road in the east and north south sectors. Immediate planning intervention is suggested for the area between the By-pass road and canal road as sprawl development is already taking place in this area.

Population Projection

Ward	Population	Population	Actual Growth Rate	Assumed Growth Rate	Population	Population	Population	Population	Population	Population	
	(2001)	(2011)	(2001-2011)	(2001-2011)	(2012)	(2015)	(2020)	(2025)	(2030)	(2035)	
1	6337	8,005	2.36%	2.36%	8194	8788	9875	11097	12470	14013	
2	6694	9,012	3.02%	3.02%	9284	10151	11779	13668	15860	18404	
3	5510	7,083	2.54%	2.54%	7263	7831	8877	10063	11408	12932	
4	2537	2,297	-0.99%	**0.00%**	2297	2297	2297	2297	2297	**2527**	Increased 2035 Pop by 10%
5	1940	1,807	-0.71%	**0.00%**	1807	1807	1807	1807	1807	**1988**	Increased 2035 Pop by 10%
6	5453	3,685	-3.56%	0.00%	3685	3685	3685	3685	3685	3685	
7	2367	1,648	-3.49%	**0.00%**	1648	1648	1648	1648	1648	**1813**	Increased 2035 Pop by 10%
8	1721	1,115	-4.25%	**0.00%**	1115	1115	1115	1115	1115	**1227**	Increased 2035 Pop by 10%
9	4486	4,597	0.24%	0.24%	4608	4641	4697	4754	4811	4869	
10	6133	6,535	0.59%	0.59%	6574	6691	6891	7097	7309	7527	
11	1913	1,656	-1.43%	**0.00%**	1656	1656	1656	1656	1656	**1822**	Increased 2035 Pop by 10%
12	3357	3,302	-0.17%	**0.00%**	3302	3302	3302	3302	3302	**3632**	Increased 2035 Pop by 10%
13	13030	14,720	1.23%	1.23%	14901	15458	16432	17468	18569	19739	
14	10647	12,372	1.51%	1.51%	12559	13136	14158	15260	16447	17727	
15	7732	8,493	0.94%	0.94%	8573	8817	9239	9681	10145	10631	
16	6833	10,903	4.78%	4.78%	11424	13142	16598	20963	26476	33438	
17	7684	8,550	1.07%	1.07%	8641	8922	9410	9924	10466	11038	
18	5832	9,540	5.04%	**5.04%**	10021	11614	14851	18990	24283	31051	
19	12278	20,584	5.30%	5.30%	21675	25307	32763	42416	54913	71091	
Aggre-gate	**112484**	135904	**1.91%**								
				Total of wards	**139227**	**150008**	**171080**	**196891**	**228667**	**269154**	

POPULATION DENSITY & PROJECTED POPULATION

Actual and Projected Population and Urban Density of Birgunj Municipality by Wards

A Time Series Data for the Year 2001 Through 2035

Ward	Area	Year 2001 (A)		Year 2011 (A)		Year 2015 (P)		Year 2020 (P)		Year 2025 (P)		Year 2030 (P)		Year 2035 (P)	
No.	Ha	Popn.	Density	Popn.	Density	Popn.	Density	Popn.	Density	Popn.	Density	Popn.	Density	Popn.	Density
1	146.46	6337	43.3	8,005	54.7	8788	60.0	9875	67.4	11097	75.8	12470	85.1	14013	95.7
2	149.3	6694	44.8	9,012	60.4	10151	68.0	11779	78.9	13668	91.5	15860	106.2	18404	123.3
3	57.15	5510	96.4	7,083	123.9	7831	137.0	8877	155.3	10063	176.1	11408	199.6	12932	226.3
4	18.92	2537	134.1	2,297	121.4	2297	121.4	2297	121.4	2297	121.4	2297	121.4	2527	133.6
5	9.48	1940	204.6	1,807	190.6	1807	190.6	1807	190.6	1807	190.6	1807	190.6	1988	209.7
6	15.63	5453	348.9	3,685	235.8	3685	235.8	3685	235.8	3685	235.8	3685	235.8	3685	235.8
7	9.92	2367	238.6	1,648	166.1	1648	166.1	1648	166.1	1648	166.1	1648	166.1	1813	182.8
8	5.61	1721	306.8	1,115	198.8	1115	198.8	1115	198.8	1115	198.8	1115	198.8	1227	218.7
9	13.43	4486	334.0	4,597	342.3	4641	345.6	4697	349.7	4754	354.0	4811	358.2	4869	362.5
10	42.91	6133	142.9	6,535	152.3	6691	155.9	6891	160.6	7097	165.4	7309	170.3	7527	175.4

11	6.63	1913	288.5	1,656	249.8	1656	249.8	1656	249.8	1656	249.8	1656	249.8	1822	274.8
12	26.41	3357	127.1	3,302	125.0	3302	125.0	3302	125.0	3302	125.0	3302	125.0	3632	137.5
13	109.26	13030	119.3	14,720	134.7	15458	141.5	16432	150.4	17468	159.9	18569	170.0	19739	180.7
14	95.6	10647	111.4	12,372	129.4	13136	137.4	14158	148.1	15260	159.6	16447	172.0	17727	185.4
15	56.77	7732	136.2	8,493	149.6	8817	155.3	9239	162.7	9681	170.5	10145	178.7	10631	187.3
16	129.22	6833	52.9	10,903	84.4	13142	101.7	16598	128.4	20963	162.2	26476	204.9	33438	258.8
17	454.33	7684	16.9	8,550	18.8	8922	19.6	9410	20.7	9924	21.8	10466	23.0	11038	24.3
18	482.2	5832	12.1	9,540	19.8	11614	24.1	14851	30.8	18990	39.4	24283	50.4	31051	64.4
19	507.79	12278	24.2	20,584	40.5	25307	49.8	32763	64.5	42416	83.5	54913	108.1	71091	140.0
Total	**2337.02**	**112484**	**48.1**	135904	**59.0**	**150008**	**64.2**	**171080**	**73.2**	**196891**	**84.2**	**228667**	**97.8**	**269154**	**115.2**

Note: (P) =Projected Population and Density (Year 2012-2035).

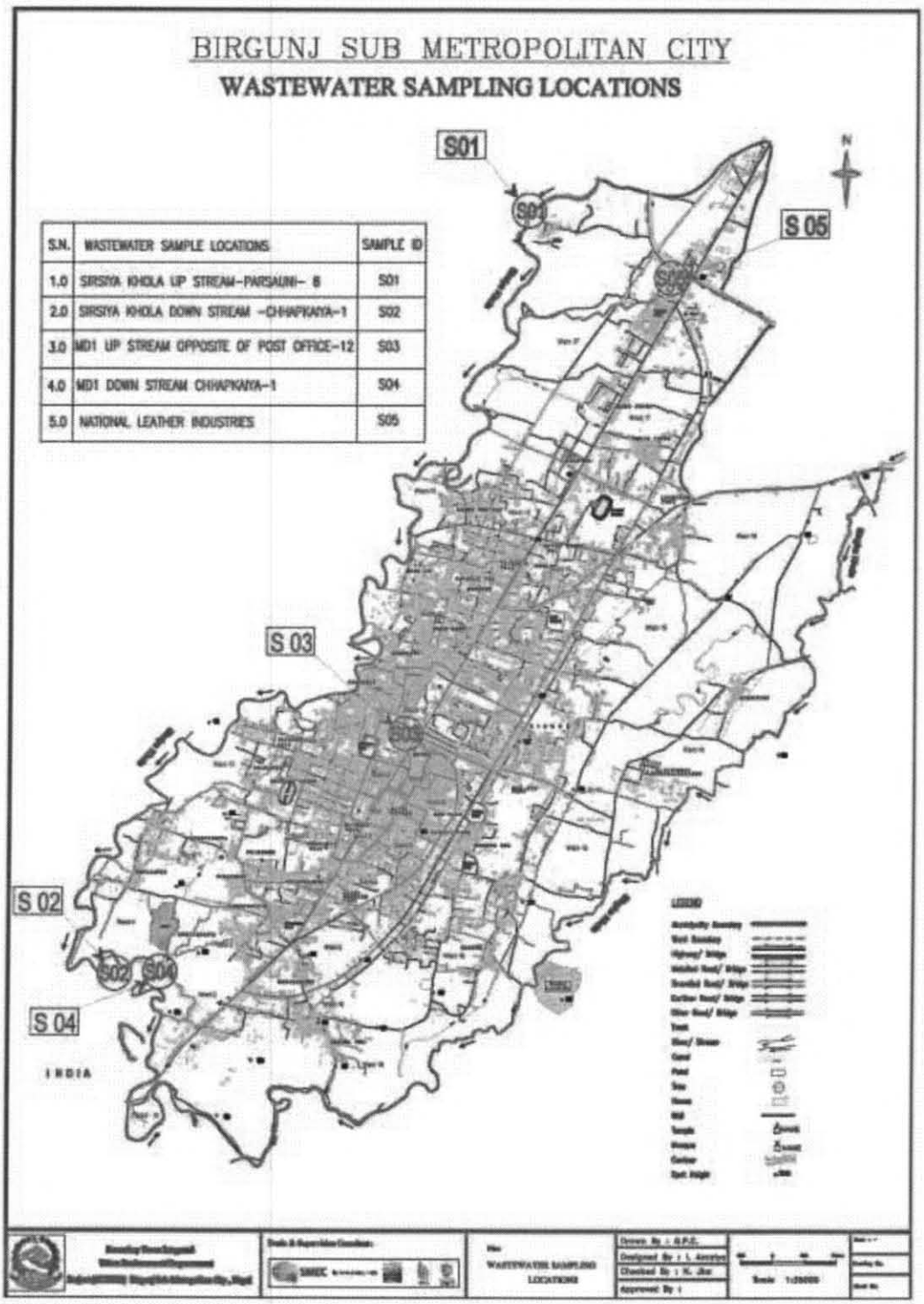
Annex – 2

Birgunj Wastewater Samples-Location & Test Results

Annex – 2

BIGUNJ-STIUEIP: WASTEWATER SAMPLING AT BIRGUNJ

Sr. No.	Location of surface water and Wastewater Sample with description	Sample ID
1	Parsauni-8, Sirsiya Khola Up Stream	Sample-1 (S-01)
2	Chhapkaiya-1, Sirsiya Khola Down Stream	Sample-2 (S-02)
3	Opposite of Post Office, MD-1 Up Stream	Sample-3 (S-03)
4	Chhapkaiya-1, MD-1 Down Stream	Sample-4 (S-04)
5.	National Leather Industries	Sample-5 (S-05)


BIRGUNJ SUB METROPOLITAN CITY
WASTEWATER SAMPLING LOCATIONS
S01
S 05
S 03
S 02
S 04
INDIA
N
S.N. | WASTEWATER SAMPLE LOCATIONS | SAMPLE ID
1.0 | SIRSIYA KHOLA UP STREAM-PARSAUNI- 8 | S01
2.0 | SIRSIYA KHOLA DOWN STREAM -CHHAPKAIYA-1 | S02
3.0 | MD1 UP STREAM OPPOSITE OF POST OFFICE-12 | S03
4.0 | MD1 DOWN STREAM CHHAPKAIYA-1 | S04
5.0 | NATIONAL LEATHER INDUSTRIES | S05

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Kathmandu, Nepal

WASTEWATER ANALYSIS REPORT

Sender :- CEMAT Consultancy P. Ltd	Sample No. :- 1	Lab No. :- 519 A/12
Collector :- CEMAT Water Lab. P. Ltd	Location :- Parsauni-8, Birgunj	District :-
Source :- Sirsiya Khola S.01 Upstream	Collection Date :-	Time : 4: 15 pm
Receipt Date :- 13 Dec , 2012	Analysis Date :- 13 Dec, 2012	

Parameters	Unit	Result	Method
PHYSICAL			
pH	-	7.2	*Electrometric*
Total Suspended Solids	*mg/L*	886	*Filtration*
Lab.Temperature	^0C	14.5	*Thermometer*
CHEMICAL			
Ammonia	*mg/L as* NH_3	6.7	*Spectrophotometric (Nessler's)*
C.O.D.	*mg/L*	90	$K_2Cr_2O_7$, *Digestion*
B.O.D.	*mg/L*	35	*5 days incubation*
Total Nitrogen	*mg/L as N*	15	*Kjeldahl Method*
Oil & Grease	*mg/L*	< 1	*Partition Gravimetric method*
BACTERIOLOGICAL			
Total Coliform	*MPN Index/100ml*	4.6×10^5	*Multiple Tube Test*
Faecal Coliform	*MPN Index/100ml*	2.4×10^5	*Multiple Tube Test*

Analyzed by: Ramu
Date: 31 Dec. '12

Checked by: Raghunandan
Date:

Authorized sign: KBaj
Date: 2 Jan '13

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Pawanmarg-33, Maitidevi
Kathmandu, Nepal

WASTEWATER ANALYSIS REPORT

Sender :- CEMAT Consultancy P. Ltd	Sample No. :- 3	Lab No. :- 519 C/12
Collector :- CEMAT Water Lab. P. Ltd	Location :- Opposite of Post office-12	District :-
Source :- MD1 upstream S.03	Collection Date :-	Time : 4:46 pm
Receipt Date :- 13 Dec , 2012	Analysis Date :- 13 Dec, 2012	

Parameters	Unit	Result	Method
PHYSICAL			
pH	-	7.4	*Electrometric*
Total Suspended Solids	*mg/L*	294.9	*Filtration*
Lab.Temperature	^0C	14.5	*Thermometer*
CHEMICAL			
Ammonia	*mg/L as NH ,*	40.5	*Spectrophotometric (Nessler's)*
C.O.D.	*mg/L*	153	$K_2 Cr_2O_7$, *Digestion*
B.O.D.	*mg/L*	61	*5 days incubation*
Total Nitrogen	*mg/L as N*	44	*Kjeldahl Method*
Oil & Grease	*mg/L*	< 1	*Partition Gravimetric method*
BACTERIOLOGICAL			
Total Coliform	*MPN Index/100ml*	32.6×10^3	*Multiple Tube Test*
Faecal Coliform	*MPN Index/100ml*	20.0×10^3	*Multiple Tube Test*

Analyzed by: Renu
Date: 31 Dec, '12

Checked by: Raj Bhandari
Date:

Authorized sign: KBaj
Date: 2 Jan, '13

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Kathmandu, Nepal

WASTEWATER ANALYSIS REPORT

Sender :- CEMAT Consultancy P. Ltd	Sample No. :- 4	Lab No. :- 519 D/12
Collector :- CEMAT Water Lab. P. Ltd	Location :- Chapkaya-1	District :-
Source :- MD1 Downstream S.07	Collection Date :-	Time : 3:15 pm
Receipt Date :- 13 Dec , 2012	Analysis Date :- 13 Dec, 2012	

Parameters	Unit	Result	Method
PHYSICAL			
pH	-	7.4	*Electrometric*
Total Suspended Solids	*mg/L*	9864	*Filtration*
Lab.Temperature	^0C	14.5	*Thermometer*
CHEMICAL			
Ammonia	*mg/L as* NH_3	38.7	*Spectrophotometric (Nessler's)*
C.O.D.	*mg/L*	612	$K_2Cr_2O_7$, *Digestion*
B.O.D.	*mg/L*	294	*5 days incubation*
Total Nitrogen	*mg/L as N*	48	*Kjeldahl Method*
Oil & Grease	*mg/L*	< 1	*Partition Gravimetric method*
BACTERIOLOGICAL			
Total Coliform	*MPN Index/100ml*	11×10^5	*Multiple Tube Test*
Faecal Coliform	*MPN Index/100ml*	46×10^5	*Multiple Tube Test*

Analyzed by: Rama
Date: 31 Dec. '12

Checked by: Raj Bandar
Date:

Authorized sign: KB
Date: 2 Jan, 13

Note: - The results refer only to the parameters tested of the samples provided/collected for analysis. Endorsement of products is neither inferred nor implied.
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CEMAT
WATER LAB P. LTD.
(Water Analysis, Treatment Consultancy & Environment Research)

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Kathmandu, Nepal

WATER ANALYSIS REPORT

Sender :- Cemat Consultant P. Ltd	Sample No. :- 5	Lab No. :- 435 C/12
Collector :- CEMAT Water Lab P. Ltd	Location :- Birgunj	District :-
Source :- National Leather Industries	Collection Date :-	
Receipt Date :- 18 Nov, 2012	Analysis Date :- 18 Nov, 2012	

Parameters	Unit	Result	Method
PHYSICAL			
pH	-	6.9	*Electrometric*
Total dissolved solids	*mg/L*	1913	*Evaporation*
Lab.Temperature	^{o}C	15.0	*Thermometer*
CHEMICAL			
Chloride	*mg/L as Cl*	409	*Titration, Mohr's method*
T. Phosphate	*mg/L as P*	2.4	*Spectrophotometric (Ant.tar-Ammo molybdate)*
Sulphate	*mg/L as* SO_4	38	*Spectrophotometric* ($BaCl_2$)
C.O.D.	*mg/L*	93	$K_2Cr_2O_7$, *Digestion*
B.O.D.	*mg/L*	42	*5 days incubation*

Analyzed by: Semee
Date: 9 Dec. '12

Checked by: Jagchandar
Date:

Authorized sign:
Date: 9 Dec; 12

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Annexure – 3

Geotechnical Information at WWTP site at Chhapkaiya, Birgunj

(Draft Geotechnical Investigation Report- May 2013)

BIRGUNJ: SUMMARY RESULTS OF SOIL SAMPLE AT STP SITE (CHHAPKAIYA) FOR WASTE STABILIZATION POND CONSTRUCTION

Borehole BH- 4 For WWTP

Started : 25th March, 2013

Terminated : 25th March, 2013

Total Drill Depth : 12.00m

In-Situ Test : 2 SPT tests, 2 Permeability Tests and 3 UD sampling

Water Table : 3.50m from ground level.

Description of Soil Strata:

The upper layer between 0.00 to 1.00m from ground level consists of medium to fine sand with silt and fines which changes to silty clay up to 6.00m which gradually changes of fine to medium grained sand up to 12.00m.

In-situ permeability test revealed the strata to be low permeable with value ranging from $5.37E^{-3}$ to $1.07E^{-2}$ cm/sec and the SPT data suggest the strata to be very loose.

Conclusion:

- The boreholes show that almost all of them consist of silt and clay fines with dominancy of silt with silty fine sand layer sandwiched between two clayey silty layers.
- There are fine sand layers between depths 6.00m to 15.00m with thin silty clay layer in between.
- In-situ permeability test in borehole reveals strata to be of low permeable with permeability value varying between $1.07E^{-2}$ to $5.37E^{-3}$ cm/sec.
- Soil strata, in general, is loose to medium dense at top and medium dense to dense at bottom with some exception with borehole BH-2.
- The soil revealed medium to loose dense in nature.
- The dugout pit reveals, the soil layer dips gently ($<5^0$) towards south west.
- Water table is located at shallow depth (<4m).

- The soil is low to intermediate in plasticity (LL<45) and Plasticity index value (PI<13). It shows the soil is slightly to moderately plastic, which indicate the dominancy of silt in comparison to clay

Annexure-4

Nepal-National Standards For

Tolerance Limits for Different Industrial Effluents Discharged into Inland Surface Water

Annexure-4: Nepal-National Standards

Tolerance Limits for Different Industrial Effluents Discharged into Inland Surface Water

Characteristics	Land Surface Water	Public Sewerage	Inland Surface Water
Total Suspended solids, mg/l, Max	30-200	600	50
Particle size of total suspended particles	Shall pass 850-micron sieve		Shall pass 850-micron Sieve
pH value	5.5-9.0	5.5-9.0	5.5-9.0
Temperature, ^{0}C, Max	Shall not exceed 40 degree C in any section of the stream within 15 meters downstream from the effluent outlet	45	Shall not exceed 40 degree C in any section of the stream within 15 meters downstream from the effluent outlet
Total Chromium, mg/l, Max	-	2	
Sulphates (SO4), mg/l, Max		500	
Total Dissolved Solids, mg/l, Max	-	2100	
Biochemical oxygen demand (BOD) for 5 days at 20 degree C, mg/l, Max	50	400	50
Oils and grease, mg/l, Max	10	50	10
Phenolic compounds, mg/l, Max	1	10	1
Cyanides (as CN), mg/, Max	0.2	2	0.2
Sulphides (as S), mg/l, Max	2	2	2
Radioactive materials			
Alpha emitters, c/ml, max	10-7	-	10-7
Beta emitters, c/ml, max	10-8	-	10-8
Insecticides	Absent	Absent	Absent
Total residual chlorine, mg/l	1		1
Fluorides (as F), mg/l, Max	2	10	2
Arsenic (as AS), mg/l, Max	0.2	1	0.2
Cadmium (as Cd), mg/l, Max	2	2	2
Hexavalent chromium (as Cr,) mg/l, Max	0.1		0.1
Copper (as Cu), mg/l, Max	3	3	3

Characteristics	Land Surface Water	Public Sewerage	Inland Surface Water
Lead (as pb), mg/l, max	0.1	0.1	0.1
Nickel (as Ni), mg/l, Max	3	3	3
Selenium (as Se), mg/l, Max	0.05	0.05	0.05
Zinc (as Zn), mg/l, Max	5	5	5
TDS, mg/l, max			
Chloride (Cl), Mg/l, max			
Sulphate (SO4), mg/l, max			
Mercury (as Hg), mg/l, max	0.01	0.01	0.01
Mineral oils, mg/l, max		10	
Inhibition of nitrification test at 2000 ml/l		<50%	
Sodium, % max			
Ammonical nitrogen, mg/l, max	50	50	50
Chemical Oxygen Demand, mg/l, max	250	1000	250
Silver, mg/l, max	0.1	0.1	0.1

Source PPTA: Nepal Gazette, 2058/01/17 (30 April 2001) and 2060/03/09 (23 June 2003).

Clarifications on Comments on Draft Final Report- Sewage Treatment Plant of DSC Birgunj

	Comments	Reply/Clarifications	Remarks
	Main Report		
1	It is advised to provide the cost of an individual WWTP component in Salient Feature and suggested to remove free board from the list (Page No. 2-3).	Suggestions have been incorporated in Final Report.	
2	Population density method is quiet appropriate in such rapid growing town (core areas, developing and to be developed in the near future, ha) rather than Geometrical Progression or Incremental Increase Method for population forecasting (Tab.5.4, 5.5and 5.6, Page 17).	The figures on population projection have been taken from the Final Report on "Birgunj Sub Metropolitan City and Urbanization". The same figures have been used for all sub project components. But for the calculation of household discharge for the design purpose population density method has been used.	
3	Any Technological Process or Waste Water Treatment Processes should be basically socially acceptable, economic viable, environmental friendly and sustainable except provided 9 criteria (Chapter 6, Page 19).	The comment is not clear what it meant by "except provided 9 criteria". All criteria listed on the report intends to create socially acceptable, economically viable, sustainable and environmentally friendly waste water management system.	
4	The DSC should clearly mention in the report about the management of pre-treated industrial effluent in such Industrial Town, Birgunj. In practice pretreated industrial effluent will be disposed either directly or indirectly sewerage (illegally) to the Sewerage System or Drainage System or open field which may create the problem in Waste Water Management.	Scope of the proposed work is to provide a safe conveyance and treatment to the sanitary sewerage generated within Birgunj Sub-Metropolitan City. Any industrial waste water generated within the service area must be pretreated before discharged in to the proposed sewerage system. In addition 10% of flow has been added as an industrial flow to be in safe side. Government regulation has to be strictly followed. In case of violation design criteria would not hold and treatment plant will not function as designed.	
5	90% treatment efficiency and 95% pathogenic bacteria removal is questionable without maturation ponds. If so give the citation and justification (page 20). BOD removal from facultative pond is 70-80% (Page 29).	For a design temperature of 20°C, efficiency of anaerobic pond is 60%. Facultative pond in general removes 50% of BOD. When anaerobic and facultative ponds are combined their combined removal rate will be around 80%. Seventy to ninety percent of BOD in the effluent from the facultative pond is due to the	

		algae. Therefore, if effluent quality is expressed in terms of filtered BOD, removal rate of the proposed system is higher than 90% (Duncan Mara, 1995. Low-Cost Urban Sanitation and Duncan Mara Manual page no. 3 30 and 40). Maximum allowable coliform numbers depends on the reuse purpose of the treated wastewater. Most of the reuses require coliform count less than 1000/100 ml, which is not possible without maturation ponds. Ninety five percent removal efficiency sounds like a big number but it leaves thousands of coliforms in the effluent. Waste Stabilization Pond Design Manual by Power and Water Corporation Australia suggests that 94.9% removal efficiency can be achieved through facultative pond.	
6	Less numbers of electro-mechanical equipments/ devices will be used in WSP but not nil (6.3, No.5, Page No.20).	In process (AP and FP) there is no electromechanical equipment required. However, some E and M equipments will be used in overall treatment system. Compared to conventional treatment system WSP requirements are lower. "Nil" has been replaced by "minimum".	
7	The second sentence is not clear 'They are designed.....'(page 22). If this is taken from the technical literature and Diagram, Fig 6.1 has to provide the citation.	"They" means Facultative Ponds. Better it will be written as "these". Also it is continuation under the subheading "Facultative Ponds". Sentence means that low BOD loading is provided to allow the growth of healthy algal population. Since algal photosynthesis is the major source of oxygen consumed during organic matter oxidation, healthy algal population is important to the efficient pond treatment. Fig. 6.1 Citation already is given. PMSC has overlooked it.	
8	Adopted Design Criteria is missing in the Report.	Adopted design criteria are shown in sections 7.7 and 7.8.	
9	It is not an appropriate solution to add chlorine instead of maturation ponds which have been suggested earlier in the comments (Page 26).	Sizing of the maturation ponds have been calculated and shown in the report. But execution of these ponds is not possible at present due to the land availability. Disinfection with chlorine has not been recommended in the report.	
10	pH is unit less significant water and wastewater parameter indicating acidic and basic nature as well as equilibrium	Corrected.	

	condition of above mentioned substances (7.3.1, page 27).		
11	Provision of Sludge Lagoon should not be made which is unnecessary 7.3.3, Page No.28.	Correction to the wording on page 27 has been made. No sludge lagoons have been proposed for anaerobic treatment of sludge as written in the quoted sentence. Eight sludge drying beds have been proposed against 24 beds that are required because of the limited land availability. Therefore their purpose has been reduced to dewater the sludge produced in anaerobic and facultative ponds.	
12	Security Cabin, two Bar Screens not Racks are seem unnecessary and 20mm opening between the bars are recommendable (Page 28).	As suggested by PMSC Security Cabin has been removed. We still feel that it is essential. There are two bar racks (screens) in the design. One is mechanically cleaned and the next is manually cleaned. Manually cleaned bar screen is a stand by unit, which operates during the shutdown and maintenance of the mechanically cleaned bar screen. It is a standard practice to provide a back-up unit.	
13	It is advised to give the depth of Anaerobic and Facultative Ponds which is being the significant design parameter (7.4 a, b, Page 28-29).	Anaerobic and facultative ponds are designed based on the loading rates and they have been shown in section 7.7 (Design summary). Pond depths have been calculated and checked against the standard practice in section 9.1 (Hydraulic design of process units).	
14	Re-editing the Draft Final Report is needed before submission.	It is not clear to DSC as PMSC should indicate particular Chapter. But All errors and minor mistakes pointed out by PMSC are re-edited.	
15	It is advised to provide equation number (Page 29-31).	Equation numbers are assigned.	
16	The provision of Oil and Grease Separator is prerequisite and scum guard is not solution (Page 32-33)(see Comment No.6 under Drawings).	Stabilization pond system is a decentralized treatment system especially designed to serve the population with minimum capital and operational cost. It is not a standard practice to provide separate oil and grease separator in a low cost treatment options such as stabilization ponds until and unless the concentration warrants it. Therefore, it is neither required nor a part of the standard engineering practice. We do not believe that this unit is a prerequisite and has not been proposed. No Manual recommends Oil & Grease	

		Chamber for WSP. Also it can be noted that oil & grease test results are less than 1.0 mg/l (allowable 10.0 mg/l) which has been pointed out in clarification note on Interim Report. Also in PPTA, there is no provision made. It is unnecessary to increase the cost.	
17	Cascade type effluent out fall structure is recommendable (7.5.5, Page 32)	Out fall structure has been redesigned based on the advice.	
18	It is advised to clearly mention about water detention period for maximum and minimum water level maintaining (Page 33).	The hydraulic design of Wet well is given in page 41-42. At peak flow, maximum water level corresponds to 3.82 minutes and at average flow it is 9.55 minutes (page 33-7.7.3). For minimum flow/lean flow, detention time is about 19 minutes. Minimum water level is a dead storage, which depends on the pump specifications such as pumps size, pumps suction and support of pumps. Minimum water level is provided to protect submersible pumps as they should always be under submerged condition.	
19	It is advised to clearly describe about the mechanism of screenings and grit removal and safe disposal (Page 33-34).	Suggestions taken into account. These items have been clearly described in Final Report.	
	Cost Estimates		
1	Any changes, modification of an individual WWTP component, its sizes in Site Development Plan, Flow Diagram etc. leading to change the cost accordingly. The Watchman Cabin is not justifiable and Watchman Quarter is enough.	Suggestions are incorporated with required modifications in the final submission.	
2	It is suggested to recheck the cost of Screen Channel/Bar Screen, Inlet and Outlet Chambers, Facultative Ponds and it seems in higher side.	Appropriate costs assigned.	
3	Cost of Asphalt Road, Gravel Road, Foot Trail and Surface Drainage should be provided separately.	It has been done accordingly.	
4	DSC should provide the cost Collection Chamber, Grit Chamber, Parshall Flume and Distribution Chamber separately.	Cost of these units are kept together in the final Report.	

	Drawings		
1.	Refer to Drawing NO: BIRG/PLM/1-1, a) It is suggested to highlight the coverage area using different colour for waste water collection, conveyance to the WWTP (Drawing NO: BIR/TS-OS/01-3), b) It is advised to mention all the details of the Drawings in the Legend, c) It is suggested to increase the letter font to make it readable in all Drawings (Drawing NO: BIRG/ PLM/ 1-1 to onwards) and maintain the same format, same scale if possible,	Comments are followed and incorporated in the Final Report.	
2.	It is recommended to give the provision for waste water treatment generated from uncovered areas (Drawing NO: BIRG/CA/1-2).	WWTP design has considered all population from whole (one catchment area out of two for which WWTP has been designed) area.	
3.	It is desirable to indicate the secondary sewers and trunk sewer with flow direction with different color to make it distinct (Drawing NO: BIRG/CA/1-2 and BIR/TS-OS/01-3).	Comment is followed and incorporated in the Final Report.	
4.	It is recommended to use black colour instead of red one in Contour Map (DRG No: BIRG/CM/01-4)	It is followed and incorporated in the Final Report.	
5.	Refer to Drawing No: BIRG/SD/01-5, a) Collection cum Diversion Chamber, Bar Screen and Sump Well with pump station are missing in Schematic Diagram, b) It is strongly recommended to divert the flow from the collection cum diversion chamber at the beginning during rapid flow fluctuation, emergency and maintenance and it is not recommended to have a provision of over flow from Receiving/Collection Chamber and the Distribution Chamber immediately after the Parshall Flume. c) It is recommended to design only single feeder channel or pipe for Grit Chamber and single Grit Chamber with two cells,	a. Schematic Diagram is presented for WWTP. b. It is shown in Sewage Pumping Station- drawing no. BIRG/GAPS/01-9. Overflow pipe from Receiving/Collection Chamber has been removed. Bypass from Distribution Chamber to Facultative Pond are kept to secure partial treatment during the maintenance of anaerobic ponds. c. Design is already as per comment. There are two chambers with single channel.	

	d) It is recommended to provide single Collection Chamber after Facultative Ponds. e) It is advised to rewrite Components of WWTP-WSP instead of Schedule of Structures/ Buildings.	d. It has been done e.Comment has been implemented.	
6.	Oil and Grease Separator is missing which is needed for oily and greasy material separation, ease surface aeration and sun light penetration.	Comment has been already answered above (Main Report comment number 16).	
7.	It is prerequisite to provide plan, profile, cross-sections and details of all WWTP-WSP individual components such as collection cum diversion chamber, screen chamber, sump well and pumping station, greet chamber, oil and grease separator, parshall flume, anaerobic pond, facultative pond and sludge drying beds after Site Development Plan considering complex joints for making it more informatory.	DSC has presented drawings accordingly. Improvements have been made on sectional details and detailing to make them better.	
8.	Refer to Drawing No: BIRG/ SDP/ 01-6, a) It is recommended to recheck the design of Anaerobic and Facultative Ponds because the size of Anaerobic Pond (AP) seems smaller and Facultative Pond (FP) relatively larger and the size of the Anaerobic Pond for future provision should be as per design flow. b) It is advised to adopt 4m depth of the Anaerobic Pond and 2 days retention period as per Design Criteria (Prof. Duncan Mara) and 2m depth and 5days retention period for Facultative Ponds. The length to breadth ratio should be in between 2:1-3: 1.	a. Process design is safe for temperature 20^0C and above. Sizing of both ponds are as per the design. Temperature during very cold months (about 1-2 months) can be less than 20^oC and during such scenario performance of the treatment plant will be lower. Land area is not adequate to design the system for minimum monthly temperature, which is the preferred design criteria. b. Depths and detention periods of the both ponds are within the commonly practiced (recommended) range. Designs were carried out based on design temperature and loading rates based on the adopted temperature. Depending on these two criteria depth and detention time can vary. It is common practice to check whether they are within range or not. Same was done in this design. Anaerobic ponds with 2 days detention period were too big to accommodate in available land area.	

		Ponds are designed in such a way that hydraulic regimes within the ponds behave more close to the ideal Plug-flow condition than the complete-mix regime. Therefore length to breadth ratio can be much higher than 3:1, up to 10:1 as per Duncan Mara.	
	c) It is recommended to have a provision of inter connections in between the Anaerobic and Facultative Ponds which have not been observed (Drawing No: BIRG/SD/01-5 and BIRG/SDP/01-6).	c. Interconnections have been made based on PMSC advice.	
	d) It is recommended to provide Sludge Collection Mechanism from the Anaerobic and Facultative Ponds and Transport to the Sludge Drying Beds.	d. Flexible delivery pipe with transportable sludge pumps will be used to connect the piping Manifold of SDB shown in plan of SDB.	
	e) It is suggested to fix out the access gravel road alignment in between Anaerobic and Facultative Ponds for ease construction, installation, observation, operation and maintenance without unnecessary curves. Also yellow colour is not matching for foot trail,	e. Comments are incorporated.	
	f) Treated effluent flow direction should be towards the river flow and one meter above the highest flood level.	f. Effluent is discharged in a drain MD1 not in the river. So HFL is not applicable. Design provides highest possible difference between outlet point and estimated max water level in MD1.	
	g) Watchman Quarter is enough and no need of Watchman Cabin, likewise separate transformer yard,	g. Comments incorporated.	
	h) Waste water flow directions in between the AP and FP are missing.	h. They are shown.	
9.	Refer to Drawing No: BIRG/ LP/ 01-7,		
	a) All the internal sewer pipe network and inlet and outlet connection, collection chambers detail should be to the scale,	a. All are now drawn in scale.	
	b) Proposed walkway starting from watchman quarter to the corner of Facultative Pond is irrelevant or unnecessary (Drawing No: BIRG/ SDP/ 01-6, BIRG/ LP/ 01-7),	b. Correction made as per suggestion.	
	c) It is advised to increase the lettering font of WWTP-WSP Components,	c. Corrections made as per suggestions.	

	legend to make readable. More over every drawing of WWTP Components should be in black colour not in red colour (Drawing No: BIRG/ SDP/ 01-6, BIRG/ LP/ 01-7), d) Baffle Wall in the Facultative Ponds are less significance considering cost, function, operation and sludge removal.	d. Baffle walls are removed.	
10.	Refer to Drawing No: BIRG/HFD/01-8, a) It is advised to recheck all the water levels considering ground level, trunk sewer invert level, head loses etc. in hydraulic flow diagram, b) The sewage flow direction in between the WWTP Components is missing, c) It is advised to provide single Distribution Chamber after Parshall Flume. Likewise Collection Chamber No.1 after Facultative Pond is unnecessary. d) Cascade is quite appropriate for treated effluent outfall structure, e) It is recommended to provide sump for sludge collection at 1/3rd of Grit Chamber from the beginning.	a. They have been rechecked. b. It is clearly given in Schematic Dia gram Drw. No.BIRG/SD/01-5;6;7;8 but wherever missing it has been provided. c. This is one chamber but with partition only for smooth division of flow. Outlet chamber after Facultative pond has been removed. d. Provided. e. No sump has been provided. Slopes from both ends are directed toward sludge withdrawal point. There is no such fixed rule to provide at on third length.	
11.	Refer to Drawing No: BIRG/GAPS/01-9, a) The diameter of incoming sewer and overflow pipe must be same. b) How provision of over flow could be made from 6m below the FGL or from level 73.8m. c) Single Bar Screen with bypass system, vertical bars are enough and two Bar Screens are not required, d) It is clear that the design number of submergible pumps are in operation at least one will be in stand by position so, it is restricted to join all suction	a. Corrections made. b. As level will not permit, over flow pipe will be fixed just about 1.0-1.2 m below FGL at Inlet Chamber of SPS to MD-1 as MWL of MD-1 is about 78.0 m during emergency condition. c. Two Bar Screens, manually cleaned and mechanically cleaned are provided. Manual will serve as backup in case of breakdown of the mechanical. d. Comment has been incorporated.	

	pipes to single vertical pipe with same diameter. It is suggested to make provision of all suction pipe outlets to the collection chamber. More over provision of sump is not properly made in the drawing, e) Section B-B should be through Sluice Valve, Bar Screen and other components. f) provision of conical shaped inlet and outlet approach channel at both the ends should be made. g) Plan A-A and Section B-B should be vertically in the same position and thickness of the wall, h) Half part of the Sump Well is useless (be sure for dry pit or wet pit or both?) and slope inside the sump well is not properly maintained.	e. Section has been redrawn. f. Not clear, what this is? g. Corrections made. h. It is the normal practice of submersible Pumps. They are not installed all across the wet well to cover the whole area. Submersible pumps are placed in wet pit of a wet well.	
12.	Drawing No. BIRG/PSAD/01-10 is the duplication of DRG No. 9 and less informatory so it is suggested to remove from the drawings.	It is the Architectural drawing. It includes some architectural information, which is not provided anywhere else. Therefore they are useful and required.	
13.	The sludge collection chamber at Grit Chamber is not drawn as per international practice and suggested to position 1/3rd from the beginning, mounting with sludge removal pump and recommended to present only Grit Chamber without other component connections (Drawing No. BIRG/ PGA/ 01-11).	It is the usual practice when Inlet works are elevated. It is manually cleaned.	
14.	All the Drawings such as plans, profiles, elevations, cross-sections, details except Schematic Diagram should be drawn to the scale. Similarly, the entire inlet Distribution Chambers with inlet and outlet pipes/channels before the major WWTP Components and outlet Collection Chambers after the same should be drawn separately.	Suggestions were accepted and done accordingly.	
15.	Cross-sections of Anaerobic and Facultative Ponds with inlet and outlet pipe details including sludge removal should be also to the scale having different vertical and horizontal scale (Drawing No. BIRG/ SAF/ 01-15, BIRG/ APCF/ 01-16, BIRG/ FPCF/ 01-17).	Drawing has been made as per title. Additional information required have been added.	

16.	Plan, Profile, Cross-sections and Details of Distribution Chambers for Anaerobic and Facultative Ponds and Collection Chambers are found not properly designed and drawn (BIRG/ICAP/01-18 and BIRG/ICFP/01-19)	Sizes of Inlet to Anaerobic Pond, Inlet to Facultative Pond and Outlet to Facultative Pond are done based on weir calculation and weir length calculation has been presented in hydraulic design chapter. Width of each unit has been taken to control the laminar flow without any turbulence at all. Drawings are improved.	
17.	Refer to Drawing No. BIRG/ SDB/01-22, a) Plan and Profile/ Cross-section of Sludge Drying Beds should be in the same drawing by selecting an appropriate scale, b) Stone bats seems unnecessary and gravel and sand is enough filtering, supporting media, c) Lateral perforated drainage pipe with c/c certain interval are missing in the drawing.	a. Plan and profile are shown in same sheet BIRG/SDB/01-40. However, sectional details are also shown in BIRG/SDB/01-41. b. Stone bats are replaced with gravels. c. They are at 5.5 m c/c (apart).	
18.	Unnecessary, less informatory, duplicated, repeated items such as plans, cross-sections, and details should be removed considering Comment No. 13. It is advised to prepare drawings by maintaining international standard, quality and best professional engineering practices	Suggestions were accepted and improvements in the drawings are made accordingly.	
19.	RCC Structural Drawings of all WWTP Components with reinforcement have not been observed in the submitted Drawings.	RCC structural drawings of the component structures are included in the Final Drawings.	