Manual of Constructed Wetlands at Bayawan City

Barangay Villareal, Bayawan City, Negros Oriental, Philippines

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Background

Bayawan City is a 2nd class component city of the Province of Negros Oriental, located in the southwestern part of the Negros Island. The city has a land area of 269.92 sq.mi., constituting 12.90% of Negros Oriental's total area. It lies 102 km south of Dumaguete City, the provincial capital. The city is composed of 28 barangays, with a population of 122,000, according to the latest PSA Census

Figure 1. Site Location of Bayawan City

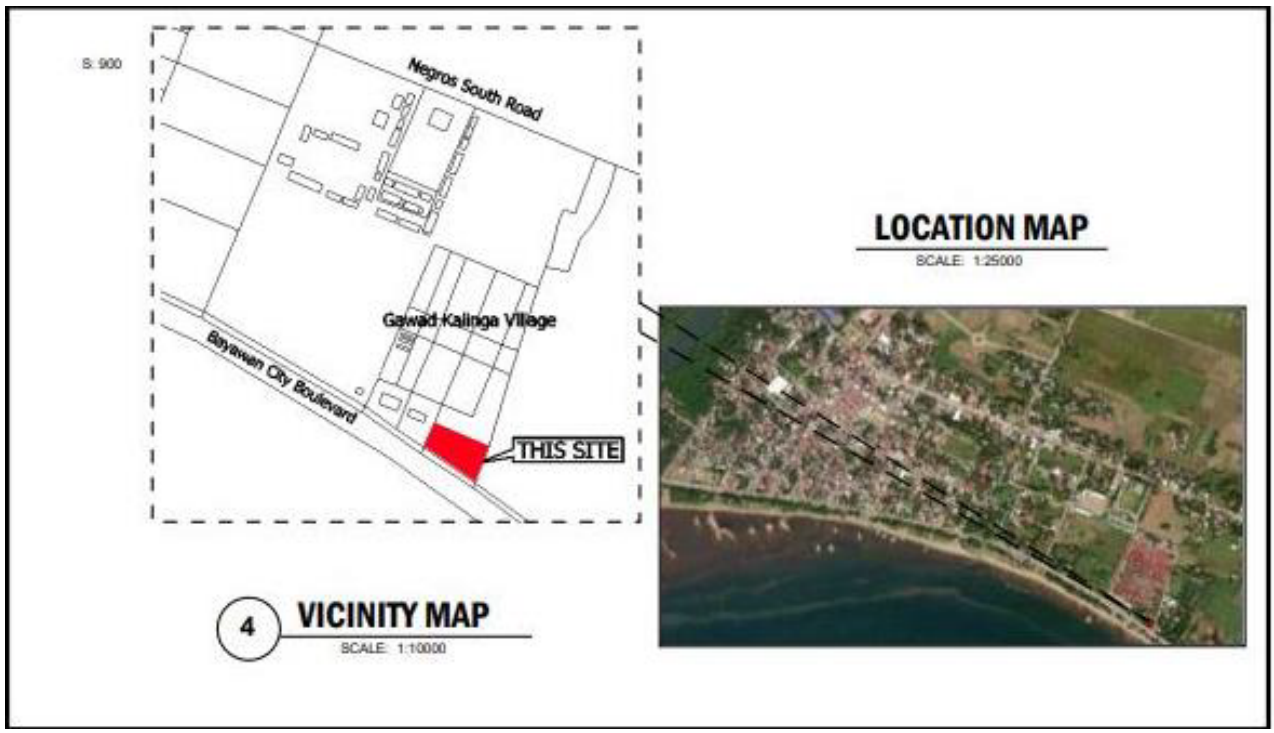


Figure 2. G.K. Fishermen's Village Vicinity Map

Cognizant of the imperative to protect the environment, Bayawan City has initiated several environmental management programs and projects that have gained regional and national recognition. Among these projects is the Bayawan City Constructed Wetland Treatment Facility.

Figure 3. Illegal Settlers with polluted canals

Years ago, the coastal area of Bayawan was about a 3 km stretch full of illegal settlers, mostly fishermen. There were about 700 households, and the houses were made of light materials, making the community more vulnerable to flooding and typhoons. Additionally, the community living along the coast did not observe proper drainage and septage, which was very problematic. Addressing this issue, and as part of its social responsibility, the city acquired a 7.4 hectares area adjacent to the shoreline to relocate the community with 750 housing units, which brought life to the Bayawan City Constructed Wetland project. The project was formulated in February 2005 and started operating on September 2006. It is located at the current Fishermen's Gawad Kalinga Village in Bara ngay Villareal.

The conceptualization of the project aims to protect coastal waters from pollution with domestic wastewater, protect the health of the local residents through improved housing with safe sanitation and wastewater treatment facilities, and demonstrate constructed wetland technology. With the aid of local and foreign consultants, the planning process was a joint undertaking, supporting knowledge exchange and introducing the constructed wetland technology. The City Engineering Office 5 carried out the construction, and the constructed wetland was inaugurated in September 2006 and has been in operation ever since.

Figure 4. 7.4 Hectare Acquired Area

Figure 5. Gawad Kalinga Fishermen's Village

Figure 6. Inauguration of Bayawan Constructed Wetland

Figure 7. Bayawan City Boulevard and Fishermen's Village

Figure 8. Bayawan City Boulevard

After the implementation of Constructed Wetlands

Design and Concept

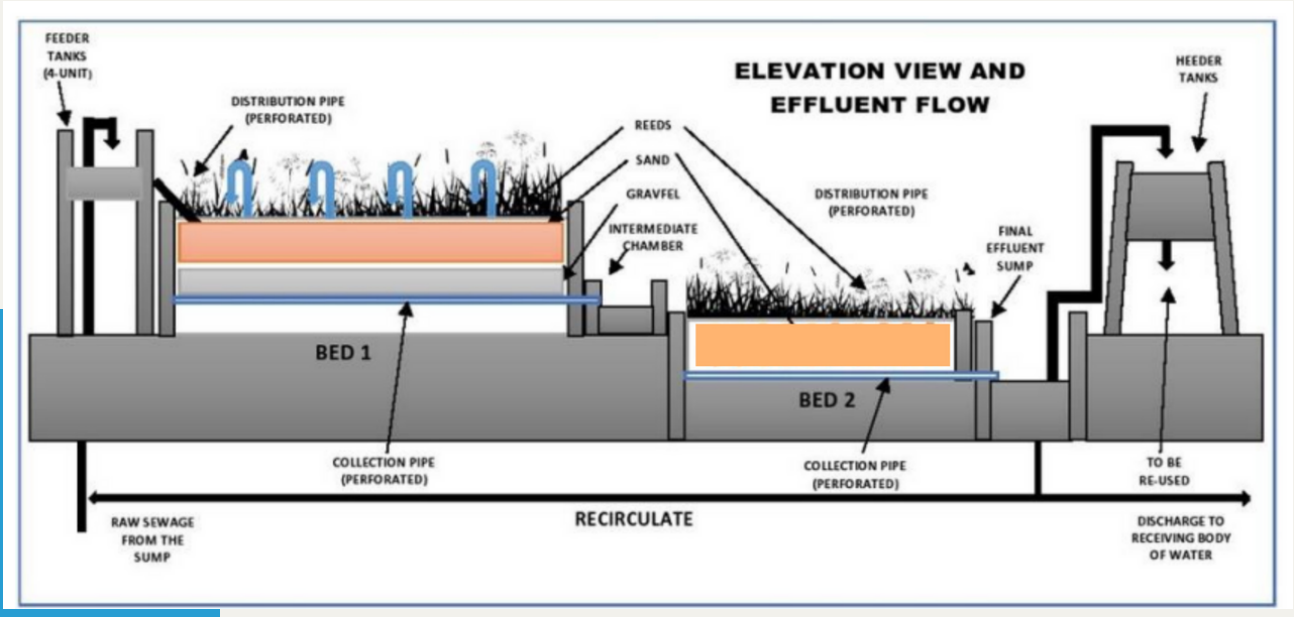
Site Development Plan

G.K. FISHERMANS'S VILLAGE AND CONSTRUCTED WETLAND
(SITE DEVELOPMENT PLAN)

G.K. Fisherman's Village consists of 750 households, mostly fishermen who were relocated from the coastal area. Houses are clustered, where three-chambered septic tanks serve 10 houses. The estimated wastewater generated from the household is 185 cu.m. per day. The sludge is retained at the septic tank for declogging to the septage treatment facility located at the Bayawan City Waste Management and Ecology Center, while the effluent flows to the constructed wetland.

Design and Concept

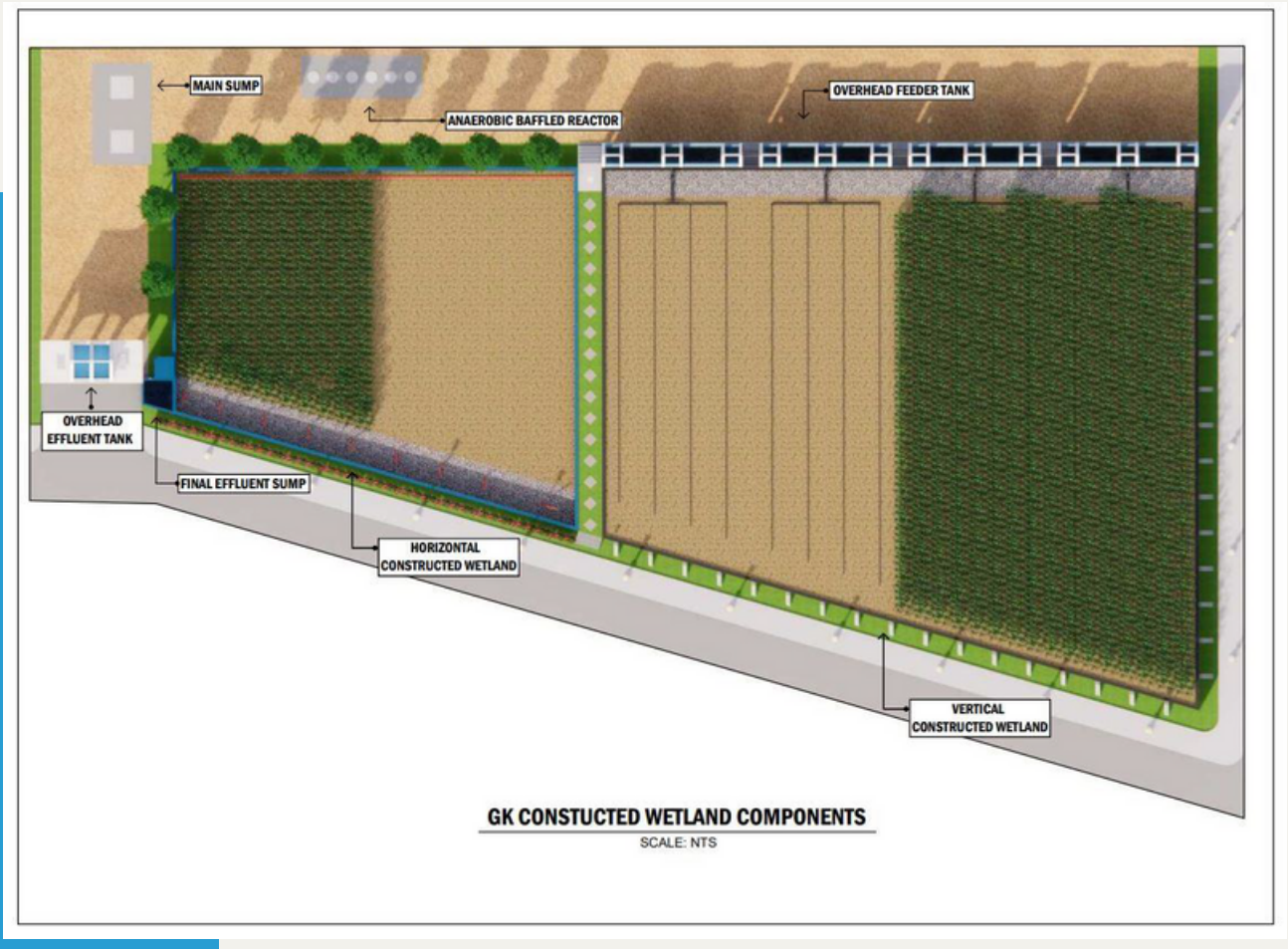
Effluent Flow Diagram



The diagram shows the effluent flow discharged from the constructed wetland. Wastewater from the G.K. Fishermen's Village is stored in the main sump. The wastewater flows through the anaerobic baffled reactor and is pumped to the feeder tanks. The wastewater from the feeder tanks is discharged to the vertical constructed wetland through the distribution pipes. The wastewater is filtered by the vegetation and the sand and gravel layers. The wastewater is discharged to the intermediate chamber and flows to the horizontal constructed wetland for further treatment. The effluent is recirculated, stored in the header tank, or discharged to the receiving body of water.

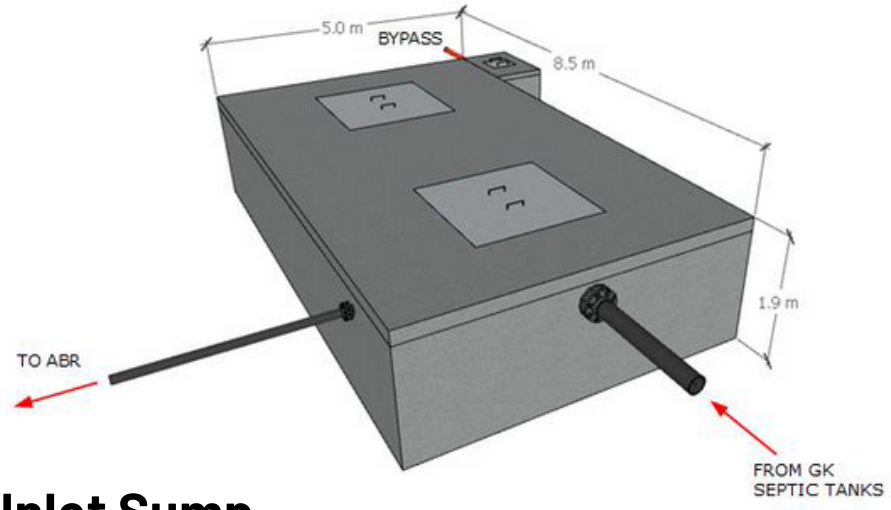
Design and Concept

Components and Construction



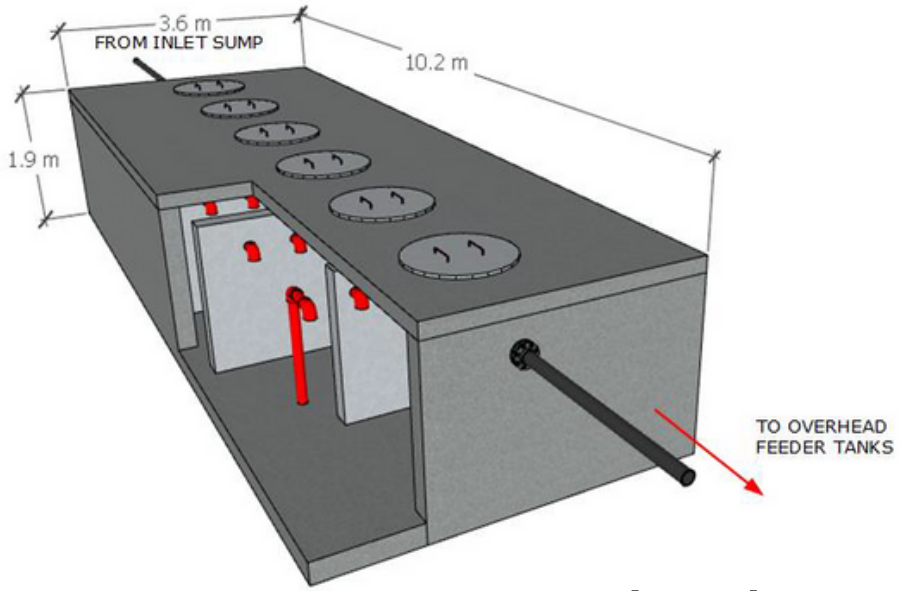
Components and Construction

Design and Concept



Inlet Sump

The inlet sump serves as the inlet structure of the wastewater treatment facility. It has a volume of 55 cu.m., which caters the wastewater from the G.K. Fisherman's Village. It is constructed underground so that wastewater flows by gravity. It is provided by a bypass line for emergency purposes like power interruption, flooding, typhoon, and others. It has two manholes for inspection and maintenance purposes.

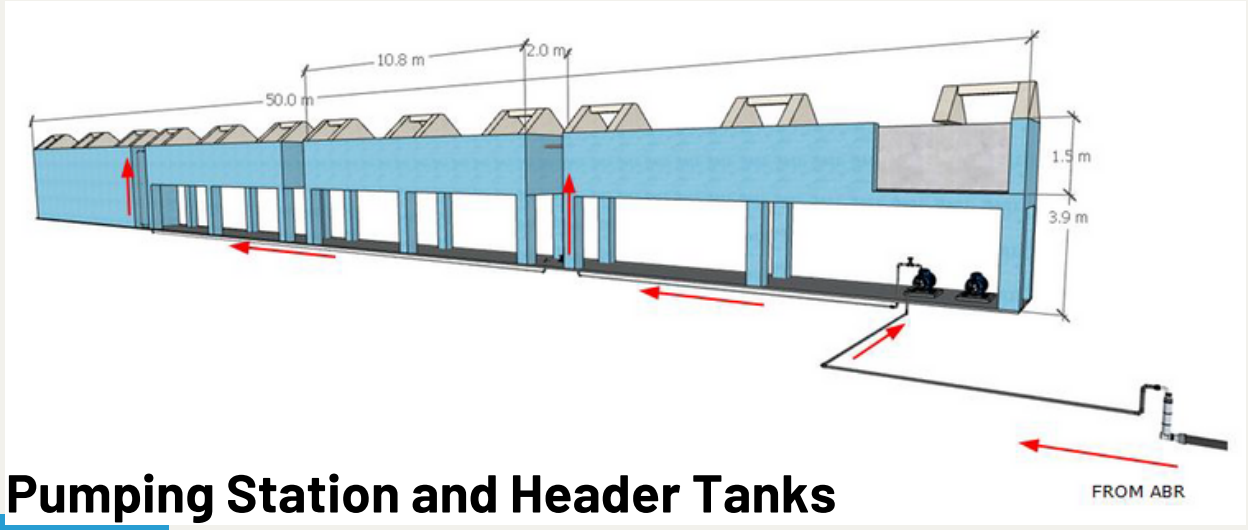


Anaerobic Baffled Reactor (ABR)

ABR is a series of baffles with PVC pipes to allow the mixing of wastewater, increasing the retention time inside. It is under anaerobic condition utilizing anaerobic bacteria to decompose organic matter

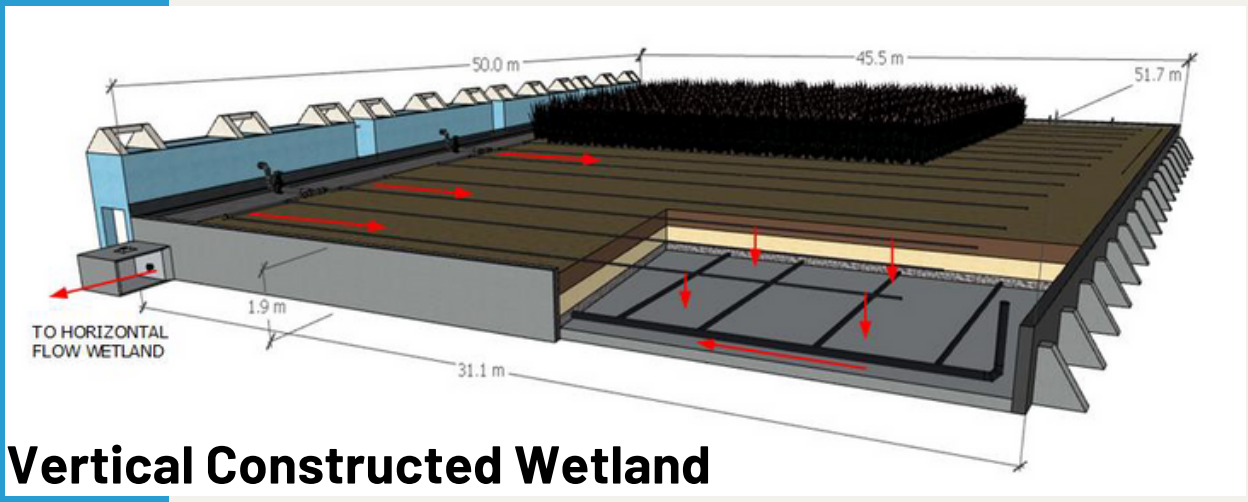
Components and Construction

Design and Concept



Pumping Station and Header Tanks

Two centrifugal-type sewage pumps are installed to convey wastewater to the header tanks. Under normal operation, only one pump is used and the other is on stand-by. Four header tanks are constructed to store the wastewater before discharging it to the vertical constructed wetland.

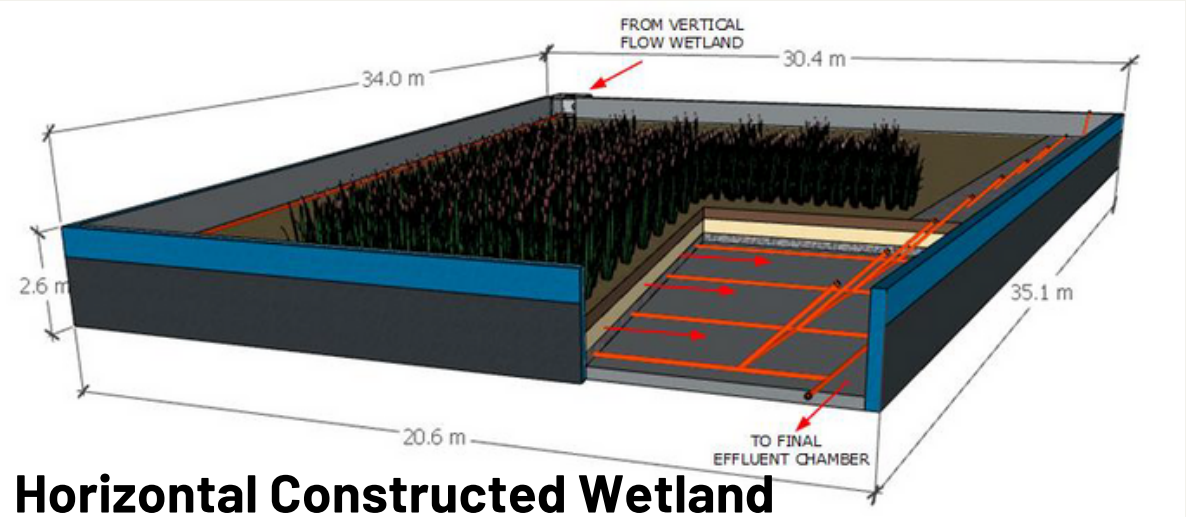


Vertical Constructed Wetland

It is a concrete structure that uses an HDPE liner at its base. It covers a total of 1,900 sq.m. Wastewater from the header tanks is discharged through the HDPE perforated distribution pipes. Gate valves control the discharge frequency in every header tank. The wastewater flows down and is treated by the wetland vegetation. An additional filtration process occurs through the sand and gravel layers. The treated liquid is collected by the collection pipes located at the bottom of the tank. The partially treated effluent is discharged to the intermediate chamber before going to the horizontal constructed wetland for further treatment.

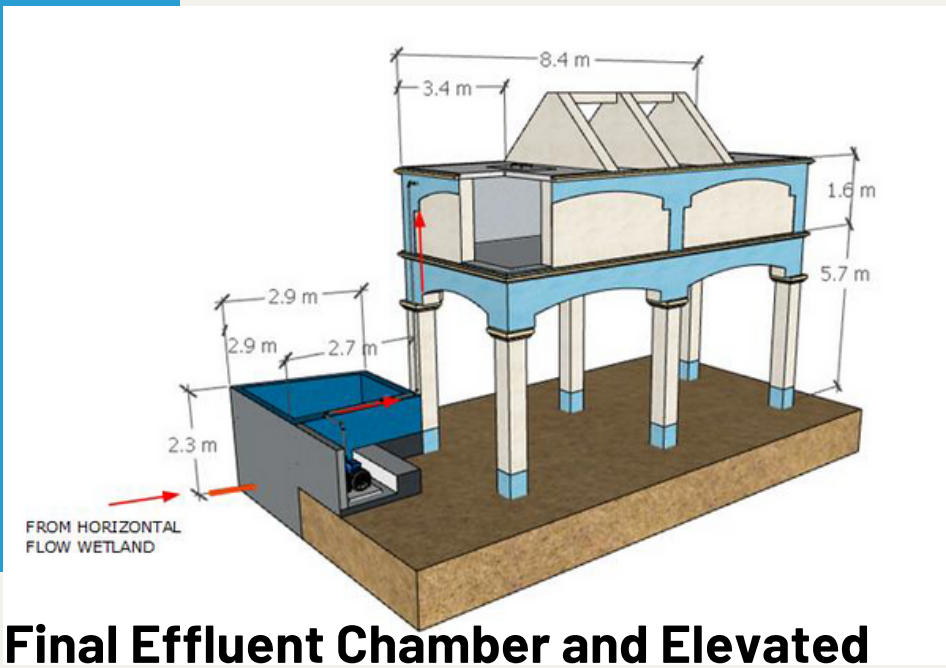
Components and Construction

Design and Concept



Horizontal Constructed Wetland

It is a concrete structure that covers a total area of 900 sq.m. The discharged liquid collected inside the intermediate chamber from the vertical constructed wetland flows through the inlet PVC pipe of the horizontal constructed wetland. The liquid flows through the porous substrate until it reaches the outlet pipe. As the liquid slowly flows horizontally, the wetland vegetation treats the liquid through a network of aerobic, anoxic and anaerobic zones. The liquid is then discharged to the intermediate final effluent tank.



Final Effluent Chamber and Elevated Storage Tank

The final effluent chamber is a concrete structure that can store up to 12 ms. It is used as a storage and for monitoring the discharged water from the vertical flow and horizontal flow wetlands. The treated water is finally released to the sea, while portions are recirculated back to the wetland or pumped to the overhead tank for irrigation, firefighting, and construction purposes.

Summary of Construction Cost

Item	Component	Cost (Pesos)
1	Main Sump	250,000.00
2	Anaerobic Baffled Reactor	650,000.00
3	Header Tanks	1,100,000.00
4	Vertical Flow Constructed Wetland	4,250,000.00
5	Horizontal Flow Constructed Wetland	3,000,000.00
6	Final Effluent Chamber	150,000.00
7	Elevated Storage Tanks	400,000.00
8	Pumps and accessories	200,000.00
	TOTAL PROJECT COST	**10,000,000.00**

Operation

ITEM	FREQUENCY	ACTIVITIES
1	HOURLY	Always monitor the desired water level at the main sump, bypass line shall only be used in emergency cases.
2	DAILY (8 – 10 AM)	Operate the motor pump in filling-up two header tanks (Header Tank 1 and 2).
3	DAILY (3 – 5 AM)	Operate the motor pump in filling up two storage tanks (Header Tank 3 and 4).
4	DAILY (7 – 9 PM)	"Direct flowing" to vertical wetland bed. (Opened valve and motor pump is running.
5	DAILY (1 – 2 AM)	Storage tanks are dropped to vertical wetland bed.
6	DAILY (3 – 5 AM)	"Direct flowing" to vertical wetland bed.
7	DAILY	Pumping final effluent to elevated storage tank.
8	DAILY	Cleaning of work area and surroundings.
9	DAILY	Site security and record keeping of daily activities.
10	WEEKLY	Regular inspection and clearing of piping system.
11	WEEKLY	Regular inspection of electrical and control system.

Maintenance

ITEM	FREQUENCY	COMPONENT	ACTIVITIES
1	WEEKLY	Main Sump	Declogging of sludge in main sump.
2	MONTHLY	ABR	Cleaning of inlet screen in ABR suction pipe.
3	MONTHLY	Pumping Station	Greasing and oiling of motor pumps.
4	MONTHLY	Wetland Bed	Removing of weeds and cultivating of soil.
5	MONTHLY	Waste Water Facility	Inspect for and repair any structural damage and leaks.
6	QUARTERLY	Final Effluent Chamber	Taking sample for laboratory analysis as required by DENR-EMB.
7	EVERY 6 MONTHS	Wetland Bed	Flushing of pipes in wetland beds.
8	EVERY 6 MONTHS	Header Tank	Greasing of gate valve of header tanks.
9	EVERY 6 MONTHS	Final Effluent Chamber	Cleaning of final effluent chamber.
10	YEARLY	ABR	Declogging of sludge in Anaerobic Baffled Reactor.
11	YEARLY	Header Tank	Cleaning and removing of sludge in header tanks (if it is already dried up).
12	YEARLY	Wetland Bed	Repainting of wetland beds.
13	YEARLY	Wetland Bed	Trimming of the reeds.
14	YEARLY	Wetland Bed	Harvesting of reeds.
15	YEARLY	Wetland Bed	Replanting of withered reeds.

Trouble-shooting

ITEM	TROUBLES	REMEDIES
1	Pump won't start.	a. Check electrical wirings.
2	Pump is running but no discharge.	a. Check pipe, maybe clogged-up inlet screen. b. Check inlet and outlet valves. c. Check sump level, maybe low level. d. Check accumulated sludge in sump.
3	Low discharge.	a. Check pipes for clogged-up. b. Check filters for clogged-up.
4	Uneven distribution of waste water to vertical wetland beds.	a. Check broken and clogged-up distribution pipes.
5	Withered reeds.	a. Replace and replant new reeds.

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Acknowledgments

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