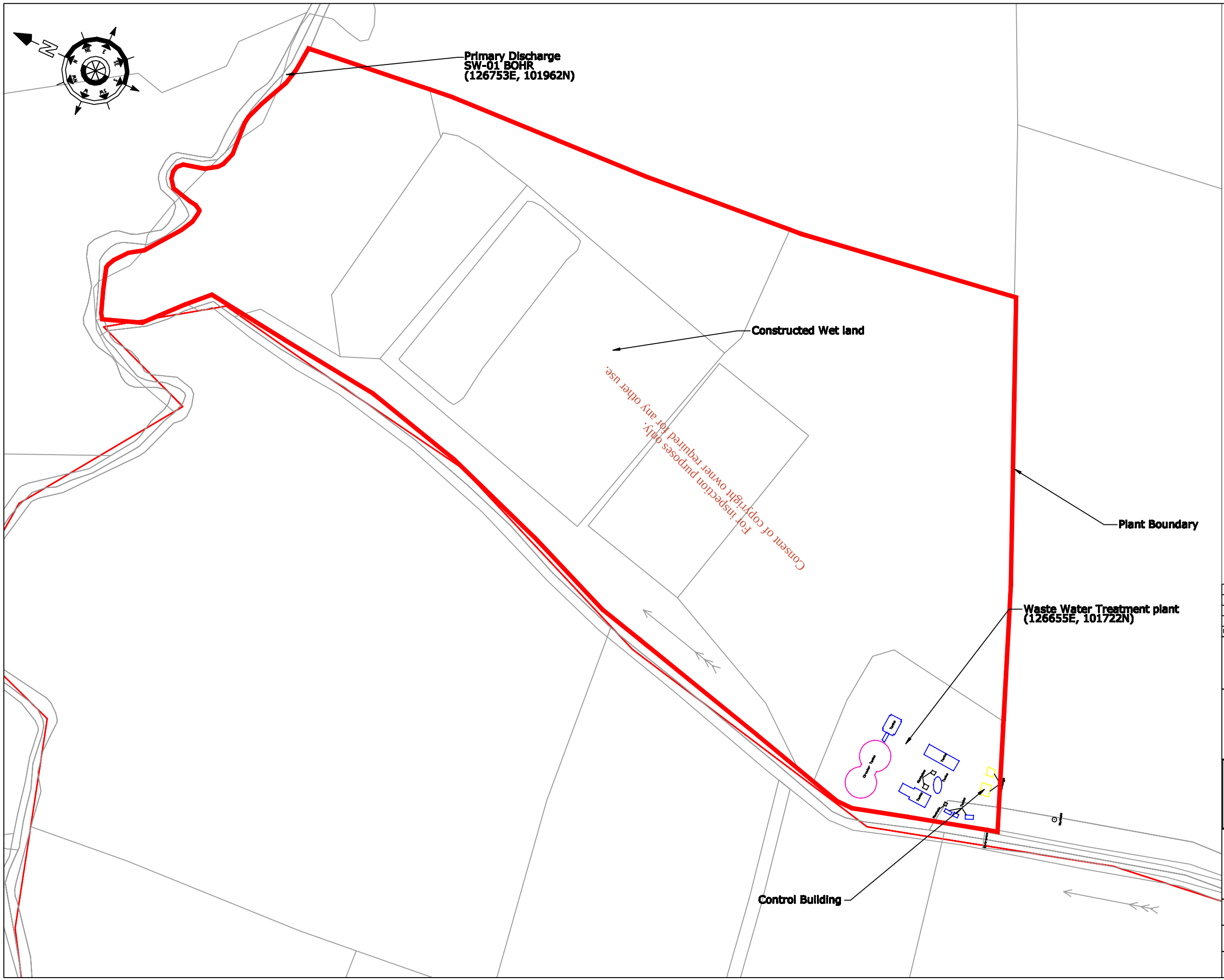
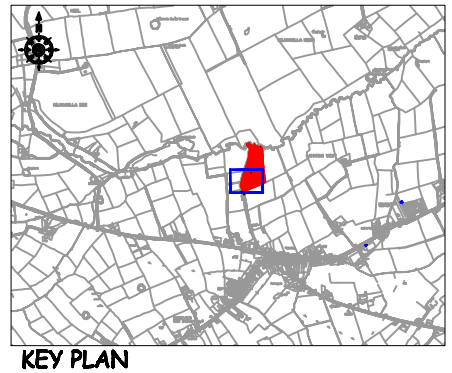



## NOTES

1. Dimensions are not to be scaled from drawing. For any discrepancies found consult with the design office.
2. This drawing is to be read in conjunction with the Specification.
3. This drawing is to be read in conjunction with all other contract drawings.



KEY PLAN

| No. | Date | Drwn | Surv | Chkd | Revision Description |
|---|---|---|---|---|---|
| | | | | | |

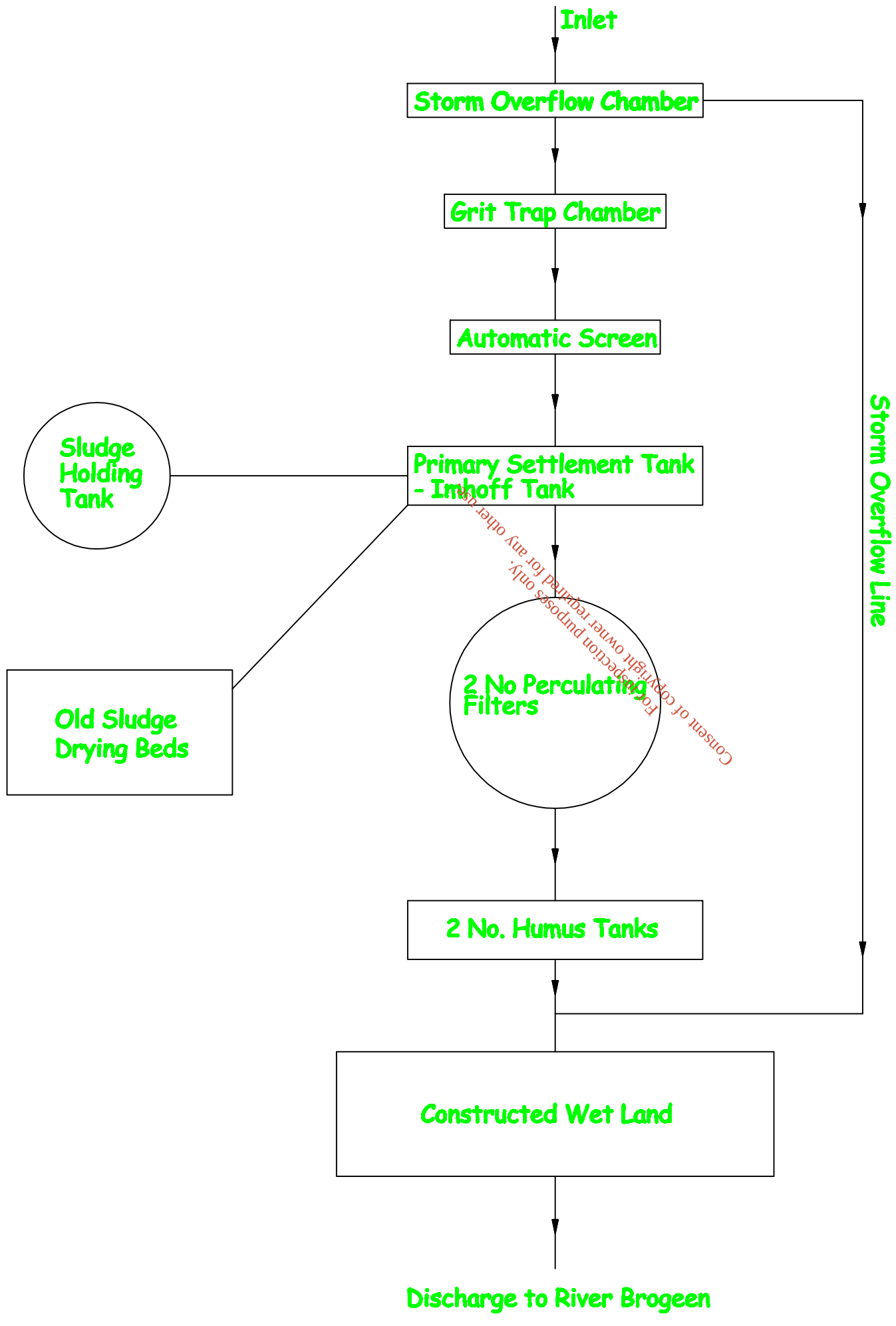
Cork County Council,
Northern Division.

N. O'KEEFFE, B.E.,
COUNTY ENGINEER,
COUNTY HALL,
CORK.

Job Title:
**Boherbue & Environs**
**Waste Water Discharge**
**Licence Application**

Drawing Title:
**Waste Water Treatment Plant**
**Site Layout**
**Attachment C1 - Map 10**

| Scales: | Surveyed by: | Drawn by: |
|---|---|---|
| 1:500 @ A3 | D.L. | D.L. |
| Designed by: | Checked by: | Date: |
| F.J. | F.C. | June 2009 |
| Drawing number: | | Rev: |
| C1 - Map 10 | | - |





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| No. | Date | Drwn | Surv | Chkd | Revision Description |
|---|---|---|---|---|---|
| | | | | | |

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N. O'KEEFFE, B.E.,
COUNTY ENGINEER,
COUNTY HALL,
CORK.

Job Title:
**Boherbue & Environs**
**Waste Water Discharge**
**Licence Application**

Drawing Title:
**Schematic showing Existing Treatment Plant Process**
**Attachment C1 - Drawing 1**

| Scales: | Surveyed by: | Drawn by: |
|---|---|---|
| N.T.S | D.L. | D.L. |
| **Designed by:** | **Checked by:** | **Date:** |
| F.J. | F.C. | June 2009 |
| **Drawing number:** | | **Rev:** |
| C1 - Drawing 1 | | - |

## I. DESIGN PARAMETERS

The Constructed Wetland waste water treatment system proposed for Boherbue is a Lagoon Marsh-Pond-Marsh system. The Marsh-Pond-Marsh reproduces a natural wetlands in all its aspects. The nutrient loading rate (Kg.BOD/ha) and the Hydraulic loading rate ($m^3$/ha) are limited to allow for natural variations in biodegrading performance, hydrological performance, and the prevailing climatic conditions. The This is a Marsh-Pond-Marsh system as shown in Drawing No. CW-720. Like conventional wastewater treatment systems constructed wetlands rely on microbes, bacteria, fungi, algae, and protozoa to treat organic wastes in wastewater. Their effectiveness in doing so depends on developing and maintaining optimal environments for desirable microbial populations in the system. The Constructed Wetland exploits the properties of both the soils and the plants.

The Lagoon is designed as a stabilization pond with a dry weather retention time of 15 days. A Constructed Wetlands involving a marsh-pond-marsh system can be compared with the conventional municipal wastewater treatment plants. The initial marsh can be compared with the biological "trickling filter". In Constructed Wetlands the media, which hold the thin film biological reactor and through which the wastewater flows, is the detrius formed from the annual plant growth and dieback. Unlike static gravel trickling filters, this thin bed reactor is in a constant state of evolution and flux, and is therefore self-maintaining. The plants that are grown in the Wetlands have evolved structures to cope with the adverse conditions encountered.

The pond in this type of Constructed Wetland could be compared to the clarifier. Its essential function is to reoxygenate the wastewater and allow for the nitrification of the wastes. The reoxygenation and nitrification is promoted by emergent and floating plants. A section of this pond (or when high **P** removal is required an additional pond) may be set aside to promote the growth of *Lemna*. The *Lemna* mat developed on the surface of the pond is able to absorb nutrients, particularly phosphorous, which otherwise eutrophy the receiving waters. The *Lemna* suppresses the algae growth by depriving it of light. Dissolved organic matter is used by bacteria whose wastes settle on the bottom of the pond. Anaerobic microbial digestion on the bottom of the pond then results in gases being given off, such as methane and sulphides.



The marsh following the pond re-establishes anaerobic conditions and this promotes the activities of denitrifying bacteria with the resultant denitrification of the wastewater. This marsh also acts as a final filter and a buffer in the event of exceptionally high flows. It also filters and traps any floating aquatic plants or algae discharged from the pond.

## II. PERFORMANCE.

The Constructed Wetlands are designed to achieve specific targets and objectives in the reduction of biochemical oxygen demand ($BOD_5$), suspended solids (SS), and nutrients such as phosphorus, ammonia and other forms of nitrogen. Other pollutants of concern may also be removed, such as pathogens, inorganic and organic compounds and heavy metals. The loading rates, plant and substrata selection and construction of the system are all adapted to achieve the targeted results. The influent to the Constructed Wetland Marsh is the discharge from the Lagoon. The influent to the lagoon consists of the existing Boherbue treatment plant discharge and the by- pass flow. The projected loadings are given on drawing No. CW-720.

### 1. Loading Rates.

Loading rates for all biological treatment units are stated in terms of applied organic loadings, Kg-$BOD_5$/day. Boherbue is situated in a high rainfall area and has a combined foul and waste-water collection system. The Hydraulic loading rate is therefore the limiting design factor for Boherbue. The inlet Lagoon is designed not only as a stabilization pond but is also designed with a 850mm freeboard or 1000$m^3$ to accommodate the peak daily flow of 1850$m^3$/Day. The outlet from the Lagoon is through 4 No. NB100 pipes with "Tees" on the inlet and adjustable "Elbows" on the outlet. The total flow through these four outlets will be approx. 4x9$m^3$/Hr which will result in a hydraulic loading of 1180$m^3$/ha/Day. The mass loading based on a p.e. of 800 and a 35% reduction of BOD in the preliminary treatment is 21Kg-$BOD_5$/ha/Day. Typical loading rates for M-P-M systems based on the performance of established systems are given in Table 2. These loading rates are designed to achieve a 20 mg/l BOD and 25 mg/l TSS discharge with an 80% reduction in total N.

**Table 2**
**Constructed Wetlands**
**Marsh-Pond-Marsh Systems Loading Rates.**

| Parameter | Loading Rate | Removal Rate | Hydraulic Loading | Remarks. |
|---|---|---|---|---|
| $BOD_5$ | 80 kg/ha/day | 62 kg/ha/day | 750 $m^3$/ha/day Influent 107 mg/l Effluent 24 mg/l | These are conservative loadings. |
| TSS | 100 kg/ha/day | 85 kg/ha/day | 750 $m^3$/ha/day Influent 133 mg/l Effluent 20 mg/l | |
| TKN | 7.5 kg/ha/day | 4 kg/ha/day | 750 $m^3$/ha/day Influent 10 mg/l Effluent 4.7 mg/l | |
| $PO_4$ | 4 kg/ha/day An additional 1.5 ha pond required. Rates refer to this pond only | 1.2 kg/ha/day | 500 $m^3$/ha/day Influent 4 mg/l Effluent 0.7 mg/l | A separate additional pond for *Lemna* production and harvesting is required |



## III. DESCRIPTION OF WORKS.

The proposed system consists of the construction, testing and commissioning of a Constructed Wetland and other works for the provision of waste water treatment at Boherbue, Co. Cork. The Constructed Wetland consists of a lagoon for preliminary treatment; an inlet marsh for BOD and SS removal; a constructed pond with 500 mm to 1000 mm water depths for further reduction of BOD and for nitrification and denitrification; and finally an emergent marsh further denitrification, BOD, and SS removal.

The installation is shown on drawings CW-720 and CW-721 and consists of:-

1) The construction of a new diverting manhole on the existing plant discharge pipe line as shown on CW-721.

2) The supply and installation of a new 10m NB380 precast concrete pipe from the manhole to the lagoon inlet chamber.

3) The formation in the ground of the embankments and excavation as shown on CW-720.

4) The supply and installation of 1000mm precast concrete pipe from the lagoon inlet chamber to the lagoon.

5) The supply and installation of four No. NB100 and two No. NB150 uPCV pipe work assemblies as shown on drawing CW-721.

6) The construction of an outlet control manhole as shown on drawing CW-720.

7) The Spreading of 1000m$^3$ of top soil to a depth of 150mm over the Marsh areas and 100mm in the Pond.

8) The planting of the Constructed Wetland as per the planting specification.

## IV. SCOPE OF WORKS and SUPPLY.

### A. Diverting Manhole

A manhole shall be constructed on the existing 15" (NB380) precast concrete discharge line from the treatment plant to the stream. The manhole shall be of reinforced concrete construction 4m long by 0.5m wide and 2m deep with an invert level of +14500. A flume for flow measurement shall be incorporated in the flume as shown on drawing CW-721.



### B. Feed Line to Constructed Wetlands.

A 10m long 15" (NB380) precast pipe shall be installed from the above manhole to the Lagoon inlet chamber

### C. Lagoon Inlet chamber

The Lagoon inlet chamber shall be 2.5m wide by 18.5m long excavated in to a finished level of +11250. The chamber shall be enclosed in embankments formed from the excavated soil to an invert level of +14300. The outlet from the lagon chamber shall be through a 1000mm Diameter 7.5m long precast concrete pipe

### D. Lagoon

The Lagoon shall be 20m by 62m excavated to a finished level of +11250. The chamber shall be enclosed in embankments formed from the excavated soil to an invert level of +14175. There shall be six outlets from the lagoon, four number NB100 installed with an invert level of +11000 and two NB150 installed with an invert level of +11750. See drawing No. CW-721 for details of the outlet design. Before installation a mock-up shall be fabricated and submitted to the engineer for approval.

## E. Constructed Wetlands

The Constructed Wetlands are located as shown on drawing CW-720. The Constructed Wetlands shall be constructed as detailed on the above drawings with the comparative invert levels given.

### 1. Inlet Marsh

The inlet marshes shall be supplied through four NB100mm uPVC pipes, with swivel elbows as shown on drawing No. CW-721. The inlet sections of each marsh shall have beds of limestones over which the pipes shall discharge. The bed of limestones, shall be formed with broken stones of a size greater than 100 mm and less than 150mm. The soil, which should be a loamy soil allowing for easy rhizome and root penetration, shall be laid on the clay base to the depths and levels shown.

The inlet Marsh-Pond section of the constructed wetland shall be constructed basically as a shallow pond or lagoons enclosed in earthen dikes. The dike freeboard shall be designed to accommodate an organic matter accumulation from plant detrius at a rate of 20 - 25 mm/year in the marshes and extend 1000 mm above the initial water level.

The dikes enclosing the cells shall be 1400 mm high, 750 mm wide on top with 2:1 slopes. Dikes should be rolled and compacted and sides should be cultivated, fertilized and seeded with grass.

The Marsh - Pond section shall be excavated to the depth shown on CW-720. It is anticipated that these depths shall expose the site's impermeable high density clay. For plant substrata, 150 to 200 mm of existing topsoil stored during the course of the excavation should be placed back on the clay.

The bottom slopes for the marsh shall be essentially flat. The slope across the width of the marsh shall be flat to ensure equal flow distribution of wastewaters. The slope along the length shall not be > 0.02 '%'.



### 2. Vegetation

The vegetation is a major factor in successful Wetland development and care should be taken in this aspect of the work. The plants should be harvested and transferred to suitable containers for delivery to the site. The collecting and planting should be co-ordinated so that they are planted within 48 hours or less of collection. The assembling and planting should be co-ordinated so that plants are transplanted within 36 hours or less of collection. A diverse natural ecosystem is desirable, and a list of suitable Plants and their planting density and location is given in Table 1.

TABLE 1.

MARSH

TYPHA LATIFOLIA BULRUSH up to 2.5m :Male & Female flowers Jun TRANSPLANTED in AUTUMN at 1.5m centres

TYPHA ANGUSTIFOLIA LESSER BULRUSH up to 3m :Male & Female flo July: TRANSPLANTED in AUTUMN at 1.5m centres

SAGITTARIA SAGITTIFOLIA ARROWHEAD STOLONIFEROUS Flowers white with July - Aug: TRANSPLANTED in AUTUMN at 1m centres.

PHRAGMITES AUSTRLIS COMMON REED 1.5 to 3m : Flowers July - TRANSPLANTED in AUTUMN at 1m centres

SPARGANIUM ERECTUM L. BRANCHED BUR REEED Flowers June - Aug: TRA in AUTUMN at 1.5m centres

POND

NUPHAR LUTEA YELLOW WATER-LILY Leaves floating flowers 4 June-Sept. TRANSPLANTED in AUTUMN at 3m centres

POTAMOGETON PECTINATUS FENNEL PONDWEED flowers June-Sept. TRANSPLAN at 3m centres

POTAMOGETON FILIFORMIS SLENDER LEAVED PONDWEED : TRANSPLANTED in centres

LEMNA TRISULCA IVY LEAVED DUCKWEED Flowers June-July

LEMNA MINOR COMMON DUCKWEED Flowers June - July.

LEMNA GIBBA DUCKWEED Flat hemispherical front single root June-July



3. **Pond**

The discharge from the marsh passes into a 1.0m deep pond. The pond is formed as a continuation of the excavation formed for the marsh with the same clay underlay, but in this case only 100 mm of soil is replaced on the clay. The pond surface shall be colonised with duckweed Lemna and various algae within the water column. Submerged pondweeds with linear, filiform leaves such as Potamogeton, shall be planted in shallow portions of the pond. The outlet from the Marsh-Pond system is through a NB300 uPVC pipe installed as shown on drawing CW-721. The water level is controlled by an adjustable discharge system as detailed on drawing No. CW-721.

### 4. Outlet Marsh.

The outlet from the ponds flows onto the outlet Marsh which is identical in construction with the inlet Marsh. The inlet to this Marsh shall be through two NB150 uPVC distribution pipes installed in the dike as shown on drawing No. CW-720 at an invert level of +10750. The discharge from these pipes shall be through four No. NB100 uPVC pipes with adjustable elbows teed into the above distribution pipes as detailed on drawing CW-721. The pipes shall discharge over beds of limestones, of a size greater than 100 mm and less than 400 mm. The discharge from the outlet marsh to the stream shall be through two open drains arranged to cascade the flow to the stream.

## V. ENVIRONMENTAL IMPACT STATEMENT.

The Lagoon and Constructed Wetlands wastewater treatment system is designed to receive and treat the waste-water and storm water from town of Boherbue, Co. Cork. The system is designed for 800 p.e. and dry weather flow of 160m$^3$/day, with an average BOD loading of 280mg/l. The system is designed for BOD, TSS, NH3 and Total Nitrogen removal. In view of the fluctuating mass and hydraulic loadings anticipated from the combined system, the Lagoon has been designed to buffer the flow and achieve an even flow to the Marsh-Pond-Marsh Constructed Wetlands. Under the most adverse conditions the impact of the discharge of the pollutant loadings on the receiving waters will conform to the standards set out in Memorandum No.1 of the Technical Committee on Effluent and Water Quality Standards and the Freshwater Fish Regulations for salmonid waters. No single discharge will cause the receiving water BOD to increase by more than 1 mg/l at 95% ile. The effluent shall have a BOD of less than 20mg/l; COD less than 125mg/l; TSS less than 25mg/l.



Constructed Wetlands are former terrestrial environments that have been modified to create poorly drained soils which are planted with wetlands flora. The soil, plants, and the fauna that exists in this environment are selected to emulate a natural wetlands. The Constructed Wetlands is an artificially designed marsh and pond that emulates in every respect a naturally occurring ecosystem. All natural wetlands occur in low-lying areas, and are enriched by nutrients washed down from uplands. It is, in fact, this enrichment that gives natural wetlands their very high productivity and diverse flora and fauna. In this Constructed Wetlands the nutrients are supplied by the organic and other waste products arising from the waste waters. Constructed wetlands are essentially wastewater treatment systems and are designed and operated as such. Constructed wetlands are designed to transform many pollutants into gaseous forms for release to the long-term biogeochemical reservoir in the atmosphere or to trap others in the substrata.

The proposed constructed wetlands are located on poorly drained land with an underlay of clay adjoining the existing treatment site as shown on drawing no CW-720. The design and operation of the Constructed Wetlands is described in the attached drawings and specification.

Being a natural system the Constructed Wetlands will have no adverse environmental impact. No smells will arise from the operation, there is no noise associated with it, and the wild life attracted to it will enhance the bio-diversity in the locality. The ground water will not be contaminated by the wastewaters flowing into the Wetlands as the site is underlain with an impervious clay.

It has been the experience in other Constructed Wetlands that the marsh and ponds created for the treatment of wastewater have attracted a high density of wildlife, including duck.

## Table of Environmental Factors.

| | |
|---|---|
| Effluent | By improving the quality of the waste water the effluent will no longer effect the receiving water. |
| Noise | There are no moving parts or machinery involved in the Constructed Wetlands and no noise is produced. |
| Odours | The design of the system is such that no odours will arise. The inlet is to the Marsh is the only location where odours can arise, and the design incorporates procedures that have proved effective in eliminating all odours. |
| Groundwater | The system is constructed on an impervious clay and the system will not contamination of groundwater. |
| Safety | There are no rotating machinery or dangerous or toxic chemicals involved. The ponds are shallow, varying in depth from 500mm to 1000mm. The whole installation is in an enclosed site, and there is no danger of small children entering the ponds. |



The design parameters taken into account for the Boherbue Constructed Wetlands are as follows:-

1. Inlet marshes. The inlet marshes are designed to reduce the organic loading of the wastewater and bring the BOD down to less than 20mg/l.

2. The pond is designed to provide varying conditions so that the organisms that perform the mineralisation (ammonification), nitrification/denitrification processes will function. These processes take place when there is a limited supply of organic compounds. The varying depths in the pond create suitable conditions for the different autotroph bacteria. The pond is planted with submergent plants which help to oxygenate the water and create a suitable environment.

3. The outlet marsh is similar in design to the inlet marsh, but in this case their function is to remove any plant or algae that may be discharged from the pond, and therefore reduce the suspended solids and the TSS and BOD to below the discharge requirements.

4. The topographical factors of this site allows the introduction of an open discharge drain with cascades. This will increase the dissolved oxygen in the discharged waters and remove further residual ammonia ($NH_3$)