DREHID WASTE MANAGEMENT FACILITY

PLANNING REPORT

May 2023

VESI Environmental Ltd. Unit B, Eco Park, Dunhill, Co. Waterford, Ireland.

E: info@vesienviro.com W: www.vesienviro.com

Table of Contents

List of Figures

List of Tables

List of Drawings

22461_3_01 Existing site layout
22461_3_02 Proposed site layout
22461_3_03 Cross Sections
22461_3_04 Typical Details

Document Control: 22461_3 PLANNING Report			
Prepared	**Checked**	**Rev/ Issued For**	**Date**
CH	AC	A - Client Review	8/07/2022
CH	AC	B – Client Review	21/07/2022
CH	AC	C – Client Review	2/09/2022
CH	AC	D – Client Review	16/01/2023
CH	AC	E - Planning	01/06/2023

1.0 INTRODUCTION

Bord na Móna Plc (BnM) is applying for planning permission to further develop it's existing Drehid Waste Management Facility (WMF) at a site located in Killinagh Upper, Carbury, County Kildare. The proposed development comprises the construction of new waste treatment infrastructure to be co-located adjacent to the existing Drehid WMF and will utilise much of the existing infrastructure in place at the site. As part of the development and application, an Integrated Constructed Wetland (ICW) is proposed for the treatment and management of stormwater runoff from the proposed expansion.

This planning report provides details on the proposed ICW for the treatment and management of stormwater runoff at the facility and accompanies the overall planning application. BnM has retained VESI Environmental Ltd. to undertake the ICW design.

It is proposed that stormwater runoff will be fed by gravity to a series of densely vegetated wetland treatment cells before discharging into an existing drainage network at the southern boundary of the proposed development area, see Figure 1 and Figure 2. The multi-cell constructed wetland, based on the Integrated Constructed Wetland concept, focuses on the explicit integration of total water management, ecological reanimation, and biodiversity support. The treated water from the ICW will be substantially reduced in volume, particularly during drier periods and the quality of any discharge.

The ICW design endeavours to optimize natural biological, chemical and physical processes of pollutant removal in a way that is compatible with the local aquatic and terrestrial communities and in a way that does not incur negative impact on adjacent aquatic and terrestrial ecosystems. ICWs are comprised of a series of densely vegetated cells with free surface water flow, the basic hydrological route for the influent through the system.

The ICW concept effectively integrates the following three objectives:

- The containment and treatment of influents within emergent vegetated areas using wherever possible local soil-material.
- The aesthetic placement of the containing wetland structure into the local landscape towards enhancing a site's ancillary values.
- Enhanced habitat diversity and nature management.

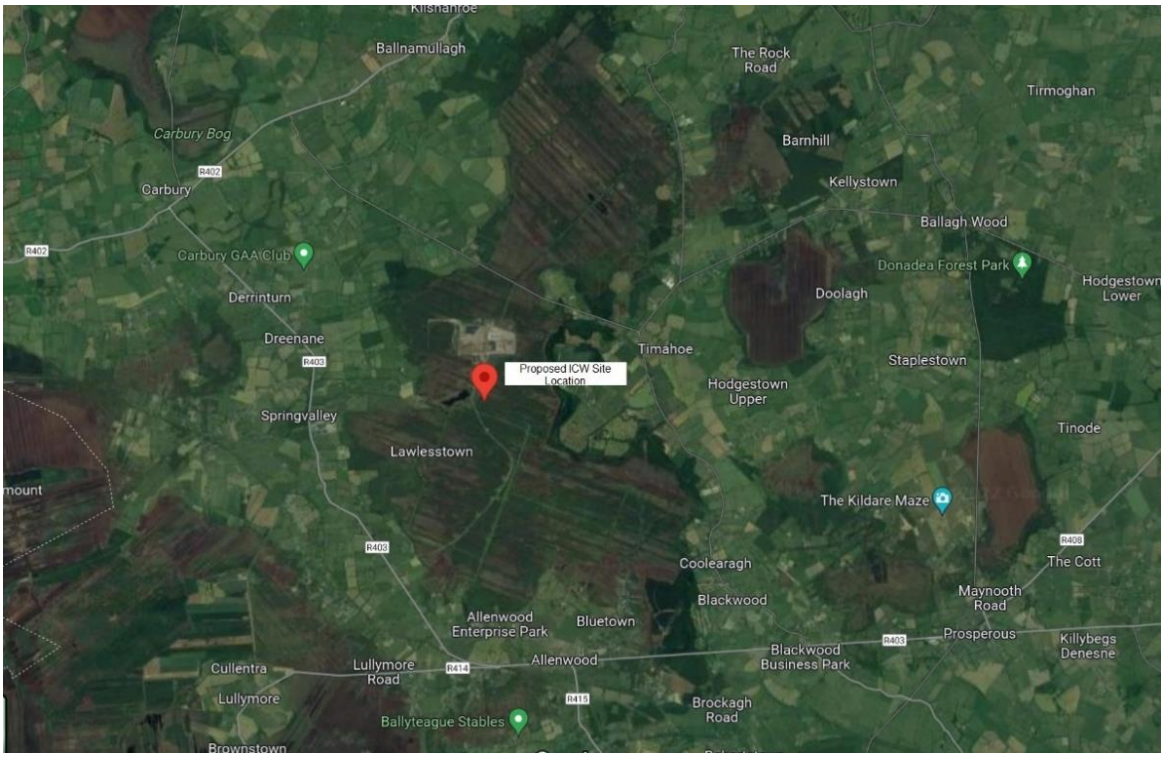


Figure 1: Proposed ICW site location

Figure 2: Proposed site location

This emphasis on explicit integration facilitates processing synergies, robustness and sustainability that are not generally available in other constructed wetland designs. The benefits of ICWs are primarily due to larger scaling patterns and their greater biological complexity. ICW systems have been successfully applied to a range of effluent types in different situations when appropriate assessment, design and construction are conducted. The ICW design approach has the following critical criteria:

- Site assessment and site-specific design
- Containment and cleansing of stormwater run-off on-site, removing consequential environmental costs
- A fully integrated infrastructure for containment and cleansing
- The appropriate building materials used in the construction are, ideally, found locally or on site
- Robust system able to withstand extreme load variations, should they occur
- Sustainable design and construction to ensure long life (50-100 years)
- Minimal management and capacity for self-regulation
- The site is not irrevocably lost and is ideally enhanced
- Appropriate plant species and distribution are used
- Opportunities are provided for habitat development and biological diversification
- Legislative context - Water Framework Directive, Nitrates Directive, Convention on Biodiversity
- An ecological approach rather than solely environmental approach is taken.

2.0 SITING

The proposed location for the ICW is to the south of the existing Drehid WMF and southwest of the proposed expansion, in an area of waterlogged (June 2022, due to blocked drainage) cutover bog. The proposed development area is not currently in use and lies within the Bord na Móna ownership boundary. The ICW design has been laid out in such a manner as to retain existing surface water drainage features surrounding the proposed development area.

The proposed ICW will be located immediately south of the proposed attenuation lagoons. Collected stormwaters from the lagoons will flow by gravity to the inlet of the ICW. The location of the proposed ICW and attenuation lagoons as part of the landfill expansion are shown in Figure 3.

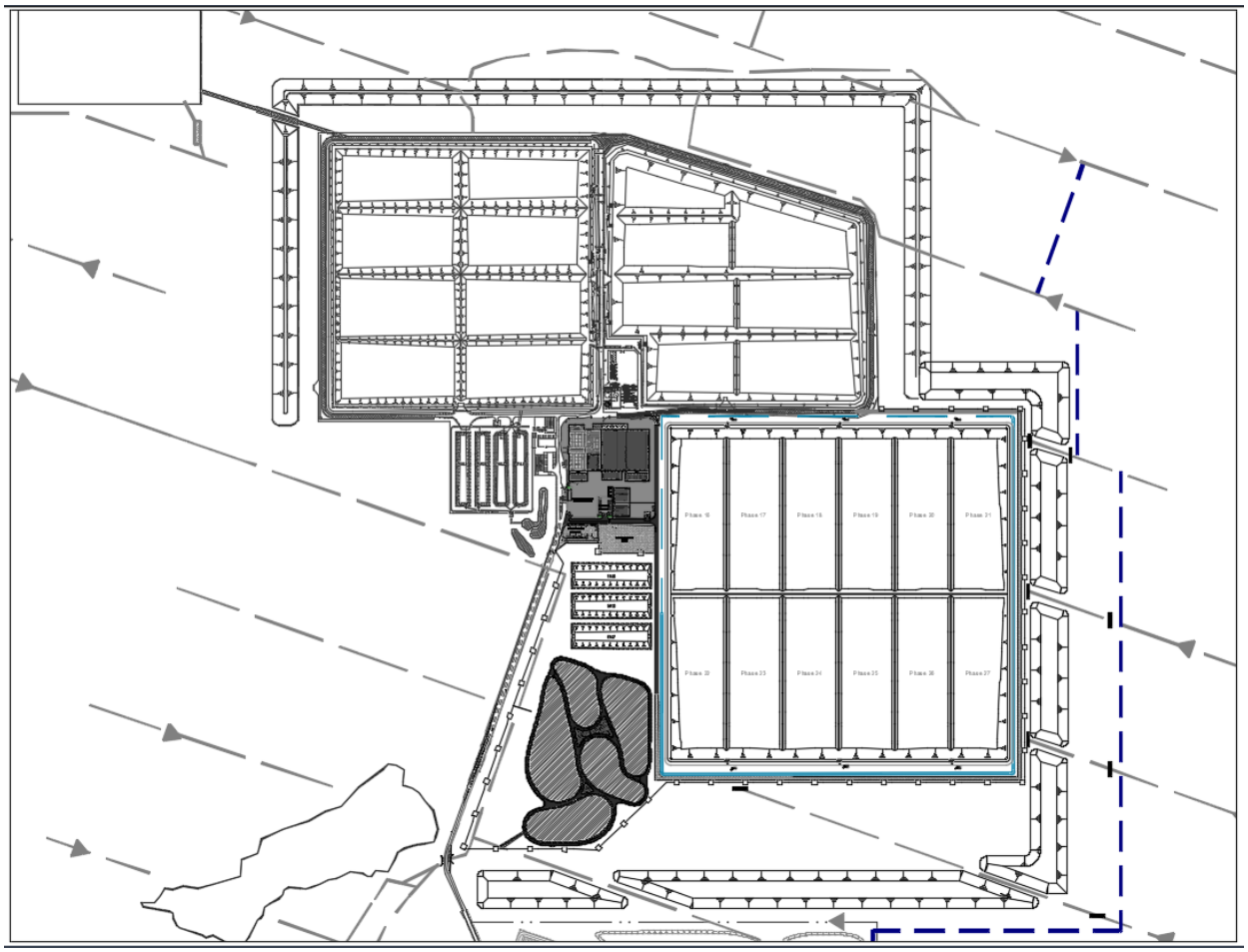


Figure 3: BnM Drehid WMF Expansion: Preliminary site layout and facility footprint

3.0 SITE ASSESMENT

The site assessment stage includes a desk study and site investigations. Site investigations were carried out in June and November 2022, consisting of site visits, trial pit excavations and discussion with Bord na Móna. These investigations provide critical information for the Site Assessment Report and this Planning Design Report.

3.1 Desk Study

Based on the desk study findings, the ground water response is classified as R1, which is suitable for development once the construction requirements are met as specified in Integrated Constructed Wetlands Guidance Document for Farmyard Soiled Water and Domestic Wastewater Application (Department of Environment, Heritage and Local Government. 2010). (Please see Appendix A, Site assessment form section 2.8 Overall Desk Study Assessment). No documented features noted that would preclude the site from ICW development, once the construction requirements are met as specified in Integrated Constructed Wetlands Guidance Document.

3.2 Site Investigation

Site investigations were carried out on the 8th June and 30th November 2022, both of which included a walkover of the site and the excavation of trial pits within the proposed ICW site. Soil samples were taken and sent for accredited laboratory analysis (Particle Size Distribution). Details are provided in the Site Assessment Form (Appendix A).

3.3 Comments from the Site Assessment

The information gathered and reviewed as part of the site assessment has highlighted some constraints. One of the main issues is the depth of peat (~2 m) on the proposed site. These peat soils will need to be excavated, suitable clay soils used to form with ICW cells and some of the peat reused as planting medium and surface dressing. The cohesive soils underlying the peat are described as clays with silts and sands. The information gathered as part of the site assessment, determines the area proposed for the development of the ICW is suitable for construction and operation, in line with the Guidance Document for ICWs (2010). (See Appendix A Site Assessment Form).

The ICW cells shall be underlain with a minimum of 500 mm of suitable low-permeable soils ($1x10^{-8}$ m/s) over the existing subsoils to ensure that the minimum values specified in R1 rating is provided. These will ideally be sourced on-site to minimise traffic and movement of materials across the site. Trial pit investigations indicate that there are suitable soils on-site. However, there is a depth of peat (~2 m) above the on-site clays that will require excavation and replacement with cohesive subsoils for the containment of waters within the wetland and the formation of the cells. The soils excavated to build the proposed landfill expansion will be used to build the ICW. These soils will be of suitable material, with a permeability of less than $1x10^{-8}$ m/s. Existing soil testing has been reviewed, with suitable soils on site. Testing shall also be carried out on the soils before and during construction.

Due to elevations across the proposed ICW area, it is not envisaged that electrical inputs will be required for pumping from the attenuation lagoons or through the ICW system. The stormwater ICW will be managed by a gravity fed system from inlet to outlet, with flows discharging into the existing drain to the south of the proposed ICW development area.

The development site and the surrounding lands have also been assessed for ecological impacts. It is considered that the ICW development will have no impact on these, rather there will be a biodiversity net gain.

4.0 INTEGRATED CONSTRUCTED WETLAND DESIGN

ICWs can and have repeatedly been demonstrated to achieve exceptionally high treatment efficiency for a range of effluent types and concentrations, including that similar to stormwater runoff quality at Drehid WMF. These include;

- Dungarvan Landfill, Co. Waterford (Waste Licence No. W0032-03)
- Churchtown Landfill, Co. Donegal (Waste Licence No. W0062-01)
- Galmoy Mines Tailings Management Facility, Co. Kilkenny (Waste Licence No. P0517-02)
- Roadstone, Belgard Quarry, Co. Dublin (License No. WPW/472/007-1)
- Drehid Waste Management Facility, Co. Kildare (Reg. No. W0201-03)

Figure 4. Dungarvan Landfill catering for landfill leachate since 2007, Co. Waterford.

Figure 5. Churchtown Landfill ICW, catering for landfill leachate since 2014, Co. Donegal.

Figure 6. Galmoy Mines ICW, catering for Tailings Management Facility runoff since 2014, Co. Kilkenny.

Figure 7: Roadstone Belgard Quarry ICW, catering for surface water runoff since 2016, Co. Dublin.

4.1 ICW Aims

The primary aims of the ICW system are:

- achieve high treatment efficiency and meet minimum threshold limits in the discharge
- deliver long-term stormwater management at a low operational and maintenance cost

In addition to the above aims, an ICW will provide a range of ecosystem services, including:

- carbon sequestration (storage)
- flood attenuation - avoidance of quick discharge of intercepted water by releasing water slowly
- retrieval (recycling) of water-vectored materials such as metals and organic matter
- develop new wetland-dependent resources
- facilitate biodiversity and reanimation of habitats
- facilitate awareness of the values of wetlands and act as a form of education.

Figure 8: Drehid proposed ICW site surveyed area, with existing WMF in background

While ICWs can achieve consistent good water quality, they also facilitate significant hydraulic losses through containment and evapotranspiration, thus reducing and at times, eliminating discharges especially during dry weather periods when receiving waters have reduced flows. This is a significant performance parameter not generally achieved by conventional treatment systems.

The design of ICWs is such that incoming waters are held within the treatment cells for as long as hydraulically possible. The hydraulic retention capacity of the ICW is critical for reducing the mass loading, through flow attenuation and evapotranspiration, from the ICW to its receiving surface water, in this instance the existing surface water drain to the south of the proposed development boundary.

4.2 ICW Design

4.2.1 ICW sizing requirements

The main factors taken into consideration when sizing an ICW include:

- Hydraulic loading;
- Concentration of contaminants;
- Rainfall;
- Topography;
- Ground conditions; and
- Receiving water capacity.

The design of the ICW is based on a flow of 187.43 l/s (up to 16,194 m^3 per day). Water quality parameters for the collected stormwater on-site was provided by Bord na Móna and are summarised in Table 1, below. The data below is average concentrations recorded at the inlet to the existing attenuation lagoons (SW7), adjacent to the site offices, between 25th August 2021 and 26th April 2022. The average concentrations of SW7 are taken as the closest monitoring point to the Integrated Constructed Wetland. The new ICW is expected to receive similar water quality from the runoff of the new facility. It is acknowledged that there are nutrient transformations within the attenuation lagoons, however these are considered minor beyond that of sediment deposition.

Table 1: Inlet concentrations to existing attenuation lagoon (n=32)

Parameter	Unit	Min	Max	Avg
Ammonia	mg/l NH_3-N	0.02	4.2	0.66
Ammonia	mg/l NH_4	0.03	5.4	0.85
Chloride	mg/l Cl	15.3	115	40.64
Nitrate	mg/l NO_3	4	10.9	5.82
Total Oxidised Nitrogen	mg/l	1	2.5	1.38
Orthophosphate	mg/l P	0.03	0.03	0.03
Conductivity	uS/cm @ 20 C	456	1056	750.6
Suspended Solids	mg/l	5	306	48.59
BOD with ATU	mg/l O_2	1	33	5.44
COD	mg/l O_2	11	65	23.33
pH	pH units	7.3	8.4	7.81
Total Phosphorus	mg/l P	0.05	0.75	0.21

ICW systems typically require substantially larger treatment area as part of their design, compared to other constructed wetlands. This is due to the larger area for delivering targeted hydraulic impedance, attenuation, residence time and evapotranspiration. The proposed ICW system applies a sizing of 2.5 m^2/m^3 for the purposes of passive treatment, similar to other comparable polluted waters, such as those described in Section 3. The area requirement, while providing capacity and treatment for 187.43 l/s also has the additional robustness of delivering even higher levels of treatment during dry weather whilst concurrently reducing hydraulic discharges to the receiving watercourse.

The proposed ICW design consists of a series of 5 treatment cells, encompassing a development area of 7.9 Ha. Collected stormwater runoff will first be diverted from the facility expansion to newly constructed attenuation lagoons. From there a 225 mm diameter pipe will facilitate the gravity flow of water from the attenuation lagoons to the initial ICW treatment cell. Collected stormwaters will flow sequentially through the treatment cells before discharging into the existing drain to the south of the system.

Table 2, below, provides treatment areas of each of the proposed 5 No. Cells, which totals 43,045 m^2. The design flow rate (187.43 l/s) requires 40,485 m^2 minimum treatment area. The additional treatment area in the design (2,560 m^2) provides a measure of additional treatment capacity and hydraulic retention.

Table 2: ICW treatment cell areas

Cell No.	**Cell area**
Cell 1	9,570 m^2
Cell 2	6,94 m^2
Cell 3	5,703 m^2
Cell 4	12,262 m^2
Cell 5	8,567 m^2
Total ICW area	**43,045 m^2**

Figure 9: Proposed ICW layout

4.2.2 ICW Operation

An existing surface water drain (immediately southwest of the proposed development area) will receive the discharge from the ICW. The drain flows in a westerly before directing waters west to the Cushaling River and on to the Figile River (EPA code: 14F01) approximately 800 m southwest of the ICW discharge point.

Table 3: Discharge consent and projected treatment performance

Parameter	Discharge consent limits (current)	Projected ICW discharge
Suspended solids	35 mg/l	20 mg/l
BOD	25 mg/l	5 mg/l
NH_4	0.5 mg/l	0.14 mg/l

Comparable data is shown in Figure 10, below, which shows the average inlet concentrations of ammonia-N (NH_3) to the existing stormwater attenuation lagoons on-site at Drehid, and the corresponding discharge values for the existing ICW.

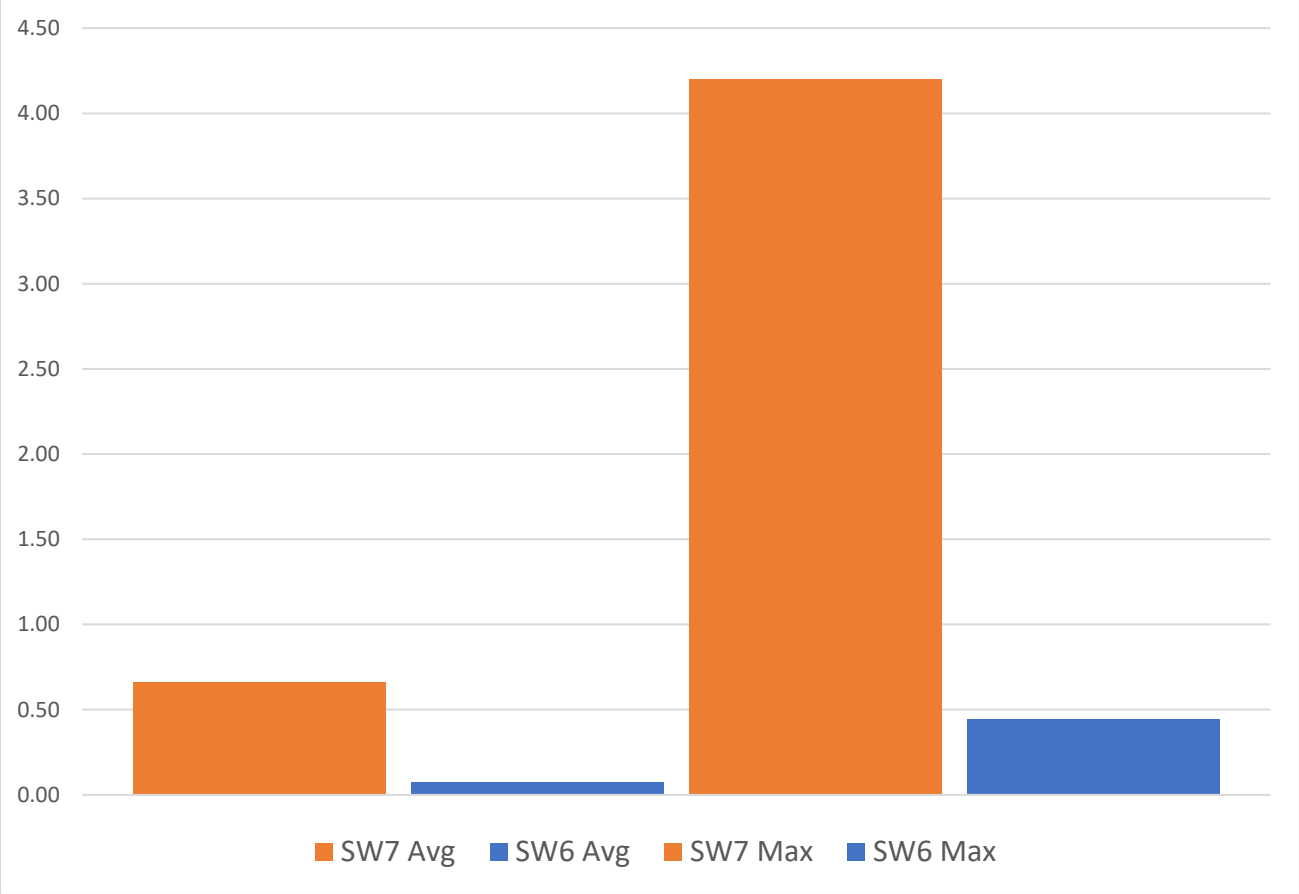


Figure 10. Comparable Ammonia (NH_3) reduction in existing ICW on-site.

Table 4 below provides additional values for the performance of the existing ICW, located south of the Bord na Móna offices. The performance of this ICW, and other stormwater treatment ICWs, influences the scaling of the proposed ICW for the Drehid WMF expansion. The ICW inlet values are taken as SW7 (inlet to existing attenuation lagoons). There is some level of water treatment within the attenuation lagoons however these values are used to demonstrate the expected performance of the proposed ICW.

Table 4. Average sampling values for SW7 (inlet) and existing ICW (outlet)

	Inlet	Outlet
Average	0.66 mg/l	0.07 mg/l
max	4.2 mg/l	0.44 mg/l
min	0.02 mg/l	0 mg/l
SD	0.78	0.09
n	33	66
No. < 0.14	7	56
No. < 0.5	18	66

The proposed ICW for Drehid will account for seasonal flow variation, which will minimise flows during drier weather conditions, as described in the paragraph below.

Discharge volumes

The dense vegetation in the 5 No. ICW treatment cells is such that a substantial volume of water will be lost to the atmosphere through evapotranspiration. Certain key emergent plant species used within the wetland can evapotranspire ~1,000 mm/ha of water annually (Barco., *et. al*., 2018*). This level of atmospheric loss plays a crucial role in the performance of the ICW. Reducing, even eliminating, discharge volumes during summer months provides additional protections to surface waters, including man-made drainage channels when water levels are decreased and are more vulnerable to nutrient discharges. The ICW is fully expected to provide excellent treatment for the through-flowing waters and reduce the relative mass loadings to the receiving drain.

*Barco, A., Maucieri, C. and Borin, M., 2018. Root system characterization and water requirements of ten perennial herbaceous species for biomass production managed with high nitrogen and water inputs. *Agricultural Water Management*, *196*, pp.37-47.

4.2.3 ICW layout

Access to the ICW will be from the attenuation lagoons to the north. Additional access roads around the ICW are included as part of the design. Access around the ICW cells is typically 3.5 m wide to allow for machinery, such as the larger BnM plant and any machinery needed for the construction and maintenance of the ICW. Access around all sides of each treatment cell is essential to allow for appropriate maintenance, while being achieved in a safe and easy manner.

Details of the ICW layout, access, features and landscaping is provided in drawing 22461_3_02.

The operational water depth within each treatment cell is between 150 mm and 200 mm, with capacity to allow for increased water depth during high rainfall events. The treatment wetland cells will have a minimum embankment height of 1 m. The cell embankments will be sloped with a minimum gradient of between 1:2. The cells are connected using 225 mm diameter uPVC pipes. These outlet pipes are placed at the base of the wetland cell floor and water levels can be managed within each cell by placing adjustable bends on the outlet pipe of each cell. This allows for fall between the cells, ensuring gravity flow from the inlet to final outlet of the ICW.

The wetland cells will be densely planted with appropriate wetland emergent species, such as *Carex riparia, Glyceria maxima*, *Typha latifolia, Scirpus lacustris* and *Iris pseudacorus*. These plant species are similar to those growing in the surrounding peat lands and waterways.

There are a number of monitoring points within the existing facility site boundary. These include surface water and ground water monitoring locations. Monitoring points for the ICW will include the inlet and outlet along with the receiving waters.

4.2.4 Landscape fit

While the primary objective of the ICW is for the treatment of stormwater runoff from the proposed facility expansion, the development itself facilitates the conservation of wetland-dependent wildlife through reanimating this much lost ecosystem and can function as a significant educational resource. The layout, structure, and

composition of the wetlands is landscaped to be compatible with all aspects of its surroundings, even taking into account the sites own visual impact and wildlife habitats. Given that wetlands provide a much-diminished important suite of habitats for invertebrates, marginal and aquatic vegetation, amphibians, fish, and a range of breeding and wintering wildfowl, this undertaking will contribute most significantly to the surrounding area including that of acting as a wildlife corridor in the area. Further details of landscaping are provided in Section 5.2.

5.0 CONSTRUCTION AND LANDSCAPING

5.1 Construction works

The main earthworks activities involved in the development of the ICW are levelling, excavation, and placement of soils for the enclosing embankments around each cell and for the access roadways. The main earthworks are not expected to take longer than 4 – 6 months to complete, however this depends on the soil sourcing and overall project programme. The ICW cells are generally constructed starting from the top (Cell 1) and working down (Cell 5). As each cell is complete or near complete it can be planted, so that the planting works are carried out down through the system, behind the main earthworks. This process generally allows the commissioning of the system as soon as the earthworks and planting is completed.

The main earthworks involved in the development of the ICW is excavation, placement of soils for the base and enclosing embankments around each cell which also form the access roads, as well as levelling and compaction of soils. Topsoil/peat is placed for the planting medium and finishing the wetland. The design and layout are focussed on delivering a system where there is no requirement to import or export soils to or from the proposed facility expansion site.

Typically, the minimum level of machinery required for the earthwork's activities are tracked excavators. Other machinery may include tractor and trailer, dumper, bulldozer, and/or roller. The main construction stages are summarised below Table 5 below.

Table 5: Main stages of ICW construction works	
Stage 1	Setting out cell layouts
Stage 2	Excavation of peat to subsoil silt/clay. Import of suitable clay subsoils (from within the facility) to build up cell base and embankments to design level. Layering, tracking and compaction of soils for cell liner - minimum depth of soil liner. Seal must be proven at base of ICW treatment cells through in-situ falling head tests.
Stage 3	Creation of embankments: • sloping embankments ○ Cell 1-5: 1:2 • height of embankment ≥1.0 m • width of embankment tops min. 3.5 m wide (stability and access around the wetland) Placement in layers and compaction during construction.
Stage 4	Distribution of peat soils over the base of each cell as growing medium
Stage 5	Interconnecting pipework, treatment cells
Stage 6	Placement of riprap beneath interconnecting pipework (inlet and outlet) in each cell (inhibit encroachment of wetland vegetation)
Stage 7	Planting each cell with emergent vegetation – Each cell planted with 1-2 plants/m^2.
Stage 8	Landscaping of ICW cells and embankment area

The requirement on site will be to ensure that there is a minimum of 750 mm thickness of compacted/cohesive material at the base of each cell, with the upper 500 mm having a permeability of less than $1x10^{-8}$ m/s. The upper 500 mm will be placed in layers 100-150 mm and compacted, along with testing at intervals to ensure the required permeability is achieved throughout. The compaction and tracking shall achieve the required permeability uniformly over the entire cell area including the embankments. See drawing 22461_3_04 for general arrangements. There will be requirement during works to demonstrate by means of field permeability testing within each cell that the required permeability value has been achieved. This can be carried out by in-situ testing using in-field Falling Head Tests. It is recommended that 2 No. falling head tests be permanently installed in each of the cells to allow for ongoing assessment of the seal of the clay liner within each cell. Should test results fall below the required permeability, reworking of the clay liner will be carried out to achieve the desired permeability. Additionally, the subsoils being placed and compacted, will prevent groundwater or surface water ingress to the site during operation. During construction, it may be required that a suitable sump be created during the construction of each cell to intercept groundwater that may ingress. This can then be pumped to the new stormwater lagoons.

Following completion of the sub-base, peat sourced within the site is placed loosely on top of the finished sub-base material to a depth of 250-500 mm. Each cell base *must* be level throughout. This surface layer is the final, finished elevation. In order to facilitate rapid vegetation establishment, the peat shall not be compacted, as compacted soils inhibit the vegetation colonisation rates.

5.2 Wetland planting and landscaping

The landscaping of the ICW site will include planting emergent species within each wetland cell and tree species around the site.

5.2.1 Wetland cell planting

The planting of the wetland and cell areas with marginal, aquatic and emergent plants provides the following functions:

- Treatment of influent waters
- Mitigate potential odours from initial wastewater
- Slow hydraulic flows
- Reinforcement of wetland soils
- Oxygenation of the soil substrate to help the breakdown of organic pollutant
- Enhance the aesthetic value of the area
- Create and enhance the biodiversity of the area
- Reduce maintenance
- Deter access by humans to the water

The wetland cells will be densely planted using a selection of plant species, such as *Carex riparia, Typha latifolia,* and *Glyceria maxima,* along with a quantity of other suitable emergent plant species. The total cell area to be planted is 43,000 m^2, with a total of c.50,000 plants required. The density of planting within each cell is recommended at 1-2 plants/m^2. A detailed planting plan will be prepared prior to construction. Plants will be physiologically mature and native.

5.2.2 Trees and shrubs

Additional landscaping is recommended around the ICW site using native trees and shrubs. Trees will not be grown on the ICW embankments where access could be restricted or where there would be a possible risk of exfiltration via roots. Additionally, planting of trees along embankments can create “shadowing” of wetland vegetation, which can inhibit their growth and create areas devoid of emergent vegetation. The tree species selected are in keeping with the local vegetation of the site. The tree species planted can be of bare-root stock. The trees will be focused on a few select areas where suitable ground conditions can be achieved. The final landscape plan for the trees and shrubs will be prepared and agreed prior to construction.

Table 6: Tree planting within the site	
Botanical name	**Common name**
Alnus glutinosa	European Alder
Betula spp	Birch spp.

The design of an ICW ensures that the ICW structure will 'fit' well into the landscape; e.g. by making the enclosing embankments curvilinear and conforming them to the site's topography. Vegetation development within the ICW and surrounding area further enhances the visual natural appearance of the system.

5.2.3 Grass seeding

The areas within the proposed ICW surrounding the treatment cells are to be shaped and finished following disturbance as part of the overall works, in order to integrate with the existing lands and proposed works. The requirement and extent of these areas to be sown with grass seed will be assessed during the construction stage as time of year may determine some landscaping unnecessary and self-colonisation either in part or in whole more suitable.

5.3 Impact Assessment

The development of an ICW for the treatment of stormwater runoff has examined and assessed potential impacts to the immediate area. These include:

- Population and human health;
- Biodiversity;
- Land, Soil, Geology and Hydrogeology;
- Surface Water;
- Noise;
- Climate and Air Quality;
- Cultural Heritage;
- Landscape.

5.3.1 Population and Human Health

The works being carried out are on a private site, with no public access. Access to site will be permitted only to site personnel.

5.3.2 Biodiversity

The proposed ICW is to be sited in an area of wet, cutover peat. This habitat would be classified as being relatively low in ecological significance, especially when compared to what it would be in its untouched state (pristine bogland). Proposed works are not expected to have a negative impact on the site's biodiversity, or existing ecology. The completed works will substantially improve the biodiversity of the site, by providing much-

lost wetland habitats. An Appropriate Assessment and Natura Impact Statement have been developed as part of this planning application and accompany this application.

5.3.3 Lands, Soil, Hydrology and Hydrogeology

The proposed ICW will be designed to integrate into the surrounding lands. The construction of the ICW will be delivered to ensure the requirements for R1 rating (ICW Guidance document) are achieved. This will ensure no impact on surrounding lands, soils, and hydrogeology. The construction of the ICW will require excavation of peat material to subsoil base levels and import of subsoil clays (from within the facility) to build up the ICW. There will be no requirement to import or export material for the ICW. The finished elevation of the ICW (embankments) will be less than 1 m above existing ground level and surface drainage will not enter the ICW, other than the stormwater flows directed through the attenuation lagoons. The compaction of the subsoil clays to form the liner will be carried out to achieve the required permeability for the site, which will also address and mitigate groundwater from the site.

5.3.4 Surface Water

Surface water features within the proposed development area consist of existing, open water drainage channels to the north, west and south of the proposed ICW location. The nearest listed surface water feature is the 'FIGILE_010' system, located approximately 800 m southwest of the proposed development area. The ICW is proposed to discharge into an existing drain, south of the ICW, which flows west into the Cushaling River, which in turn connects to the Figile River.

5.3.5 Noise

Works on the ICW are expected to be carried out during daylight working hours, with no works being carried out at night or early morning. The works entail primarily earthworks, movement of materials and vehicles. It is not expected that there will be any noise disturbance from the site audible to the public. Furthermore, the proposed works will not impact negatively on existing site users and works as the noise emission from the machines will be similar to that already in use on and adjacent to the site.

5.3.6 Climate and Air Quality

During construction works, there will be operational emissions from plant machinery on-site. These will present some air quality pollution while operating on-site. Control measures and site inspections will be in place to mitigate any potential spillages from machines. All plant and machinery will be in good working order ahead of works and maintained during the works. Dust suppression and/or mitigation will be carried out when required to prevent impact on surrounding vegetation and landscape.

5.3.7 Cultural Heritage

While there are archaeological finds of significance within the ownership boundary, they are not present within the proposed ICW area. However, peat stripping during construction will be overseen by an archaeologist as discussed in Chapter of the accompanying EIAR.

5.3.8 Landscape

The ICW explicitly incorporates landscape and topography into the design concept. The ICW design for the Drehid facility expansion is designed to be close to existing ground level, minimally impacting on the current landscape. At present, the proposed development area consists of cutover bog habitat, some of which is waterlogged. The ICW design incorporates adjacent existing pathways and drainage networks, where possible, to ensure minimum alterations to the landscape. The introduction of the ICW treatment cells will enhance the existing landscape, reanimating much lost wetland habitats. Once established the ICW will integrate with the surrounding lands and restored similar to its original state.

5.4 Mitigation measures during construction & landscaping

Risk mitigation measures should be employed during the construction of the proposed ICW to limit the impact on the site and the surrounding environment through proper management and supervision.

Mitigation measures include:

- ICW setting out will include provisions for exclusion areas;
- Construction of the cells will be undertaken in sequence starting from the upper end of the site down to the lower end;
- No construction will be undertaken at night or during very wet weather;
- A detailed construction method statement will be prepared and will be followed by the contractor;
- All construction will be supervised;
- The re-fuelling of plant or machinery will not be permitted at the ICW construction site;
- All planting will also be supervised, and only native species from reputable sources will be used; and
- All plants brought to the site for use in the wetland will be checked for the possible presence of invasive species.

See further mitigation measures as outlined in accompanying information as part of the overall application for the facility expansion.

6.0 AFTERCARE AND MANAGEMENT OF ICW

A number of different operation and maintenance requirements will be undertaken on the ICW. A preliminary Operation and Maintenance Plan has been prepared as part of this design (see Appendix B).

Some of the main operation and maintenance procedures are listed below for the ICW:

- Water level management;
- Influent and discharge monitoring – flow and quality;

- Vegetation monitoring and maintenance within cells and around the site;
- Maintenance of access;
- Maintenance of inlet and outlet pipes;
- Maintenance of embankments - to provide for easy and safe access for monitoring; and
- Sediment/sludge management

A suitably qualified person with experience in ICWs will supervise the construction, monitoring, and maintenance of the ICW.

Safety considerations for both humans and animals are required and incorporated into the design of the ICW. Operational water depth is generally shallow (typically 150 mm – 200 mm deep) in ICWs. Generally, the context of the siting of an ICW will determine to what degree of exclusion should be imposed, if any. As the Drehid facility is a private site with a 2.4 m high post and chain link fence with barbed wire surrounding the perimeter of the Drehid WMF, there are no public protection issues to consider. However, suitable health and safety considerations should be made.

An on-site person will be required on a regular basis to oversee the maintenance of the ICW. The draft Operation and Maintenance Plan (Appendix B) will be finalised prior to the commissioning of the ICW. Training will be provided for the on-site operator to give guidance and ensure that the adequate procedures for the ICW system are implemented on an on-going basis.

7.0 SUMMARY

An Integrated Constructed Wetland system is designed as a suitable option for the management of stormwater runoff from the Drehid WMF expansion. The design of the ICW is in accordance with the Irish Department of Environment, Community and Local Government Guidelines on Integrated Constructed Wetlands. ICW systems have been successfully applied to a range of effluent types in different situations when appropriate assessment, design and construction are conducted.

The proposed ICW at Drehid WMF will consist of a series of 5 cells, through which inflowing stormwater will be reduced of its various dissolved and particulate constituents. The final discharge from the ICW will be of high water quality as it enters the existing drainage network. Discharge rates will be variable, with reduced flows expected during dry weather conditions.

The proposed ICW at Drehid WMF will provide additional values through appropriate landscaping, so that its structure ‘fits’ into the local environment and enhances the aesthetic and biodiversity values of the area. Due to the nature of the ICW system, including its ability to provide high water quality, enhance and create habitats, as well as a host of ecosystem services, should be viewed as a positive impact on the local environment.

A preliminary Operation and Maintenance Plan has been prepared for the operator of the ICW to provide details of the various operation and maintenance procedures required for the system, to ensure the compliance, performance and sustainability of the system, while also demonstrating that the operation of the ICW is not impacting negatively upon any surface or groundwater features. This Operation and Maintenance Plan will be updated to account for any additional monitoring required following final design and construction of the system.

APPENDIX A – SITE ASSESSMENT FORM

Drehid Waste Management Facility
Integrated Constructed Wetland

SITE ASSESSMENT

January 2023

VESI Environmental Ltd.
Block B, Dunhill Eco Park, Dunhill, Co. Waterford
T: +353 087 2151882
E: info@vesienviro.com
W: www.vesienviro.com

Site assessment form

Appendix C 'Integrated Constructed Wetlands - Guidance Document for farmyard soiled water and domestic wastewater applications', (Department of Environment, Heritage and Local Government).

1. GENERAL DETAILS					
APPLICANT NAME:	Drehid Landfill				
ADDRESS:	BNM Drehid Facility, Killinagh Upper, Carbury, Co. Kildare, W91 RC82				
SITE LOCATION AND TOWNLAND:					
TELEPHONE NO:	+353 (0)	FAX:		EMAIL:	
Remarks Following Preliminary Consultation					
Integrated Constructed Wetland to treat stormwater runoff arising from proposed landfill expansion					
Estimated Preliminary ICW Area Other Remarks					
80,000m^2					
2.0 DESK STUDY					
2.1 TOPOGRAPHICAL DETAILS					
GRID REFERENCE	ITM X: 674388 Y: 731227				
Maps					
1:50000		1:10,000		1:2500	X
Preliminary Assessment of Topography					
Level site forming a section of cut over bog part of the Facilities ownership property.					

2.2 CLIMATE		
Rainfall mm	Evaporation	Wind Direction
869.7 mm (DUNSANY) Long term average annual rainfall	740 mm (DUNSANY) Average annual evaporation	South West

2.3 SURFACE WATER		
Surface Water Features		Comment
Name:	Open man-made drains/ Drainage channels	Figile River EPA Code: 14F01. Order 1 stream ~800m west of site Abbeylough river EPA_Code: 14A01. Order 1 stream ~1km southwest of site Both flow west from the site. Unnamed surface water segment code: 07_1211 which flows north east into the MULGEETH EPA_Code: 07M54 Order 2 stream
Catchment Area (Ha)	NA	
Mean Flow Estimate	N/A	
Available Dilution	NA	
Water Quality “Q”	N/A	
Water Quality: Other	N/A	

2.4 GROUND WATER				
Source of Water (Tick as Appropriate)	Mains	Private X	Group	
Aquifer Category and description (see Appendix B)	Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones			
Is there a Ground Water Protection Scheme?	No			
Vulnerability Class (See Appendix B)	Extreme	High	Moderate	Low X
Topsoil Type	Cut peat			
Subsoil Type and Thickness (See Appendix B)	Cut over raised peat			
Groundwater Response (Refer to Appendix A)	R1			
Incidence of Karst, describe (Show location on map)	None on site. Nearest record is 10km Northeast of site.			
Public Supply Boreholes (Show location on map and indicate distance from proposed ICW site)	None on site.			
Domestic Supply Boreholes (Show location on map and indicate distance from proposed ICW site)	None on site			

2.5 CULTURAL SIGNIFICANCE	
Presence of Significant Sites (Archaeological, natural)	None on site. Closest natural is The Long Derries, Edenderry SAC (site code: 000925) ~7km to the southwest and Ballynafagh Lake SAC (site code: 001387) ~6km to the southeast. Nearest recorded historical feature is 600meters north of the proposed site, monument identifier KD00181 Classification: Togh. “Pieces of hazel brushwood in a haphazard arrangement, probably remains of a more substantial structure. Some evidence of burning was recorded”.

2.6 DRAINAGE	
Land Drainage - Maps - Local Knowledge (Inc soil types)	Open drain to North , south and west of site.

2.7 UTILITIES			
UTILITIES	Knowledge	Safety	Needs Further Investigation
Power Lines - above ground - below ground	None on site None on site		X
Gas mains	None on site		
Sewerage			X
Water mains			X

2.8 OVERALL DESK STUDY ASSESSMENT
Comments Arising from Desk Study Assessment
Based on the desk study the groundwater response is classified as R1, which is suitable for development once the construction requirements are met as specified in Integrated Constructed Wetlands Guidance Document for Farmyard Soiled Water and Domestic Wastewater Application (Department of Environment, Heritage and Local Government. 2010). This response level is subject to the following requirements: • The ICW shall be underlain by at least 1,000 mm of cohesive subsoil. • An upper portion of the subsoil, which will vary in thickness depending on the risk posed by the ICW, shall have a permeability of less than 1x10-8 m/s. • Where this is present in situ, (i.e. the subsoil is classed as clay (using BS5930) or, in certain situations, silt/clay, and has a clay content of ≥13% (where the particle size distribution is adjusted by excluding materials larger than 20 mm), and is free from preferential flow-paths, the surface of the excavated portion of the cell will require plastering with remolded subsoil. Where the subsoil is considered to have a permeability of greater than 1x10-8 m/s (i.e. is classed as silt or, in certain situations, silt/clay, and the clay content is 10%) the subsoil must be enhanced by compaction or puddling to achieve the required permeability standard. Where the subsoil is classed as sand, gravel, or silt (in circumstances where the clay content is <10%0, suitable subsoil or other material must be provided for the liner. • The upper 750mm shall have a permeability of less than 1 x 10^{-8} m/s. • Where the subsoil is sand/gravel, the upper 750 mm of the liner shall be installed with a permeability of less than 1x10-8 m/s. • The ICW shall be at least 60m away from any well or spring used for potable water. The site requires further on-site investigation regarding utilities, soils, topography and ecology.

3.0 VISUAL ASSESSMENT
3.1.1 ON-SITE HAZARD ASSESSMENT

Type of water-vectored pollution	Ammonium-N concentration	Volume
Stormwater runoff from proposed extension of landfill	0.02-5mg/l	187.43l/s

3.2 VISUAL ASSESSMENT OF RECEPTORS			
3.2.1 Topography / Landscape Position			
General Comments:			
Ground Slope	Steep (>1.5)	Shallow (1:5 – 1:20)	Flat (<1:20) X
Difference in level between source of influent and proposed base of ICW first pond			~1m

3.2.2 Surface Water	
General Description of Proposed Receiving Water	Man-made open drain to the southwest of the site which drains west. This links to Figile (EPA code: 14F01) and continues southwest for ~12km before turning south and joining the Barrow (EPA code: 14B01) a further 17km south.
Channel Width	N/A
Channel Depth	N/A
Water Depth	N/A
Evidence of Higher Water Levels	N/A
Estimate of Flow	0.067m^3/sec Figile stream (hydrotool) NATQ50 (m^3/s) (Easting 270940, Northing 230760)
Other Surface Water Features	N/A

3.2.3 Ground Water	
Give Descriptions of the Following:	
Rock Outcrops	None
Karst Features	None
Springs	None
Wells	None
Subsoil Cuttings/Exposures	None

3.2.4 Utilities	
Description of other utilities not identified in Desk Study	None

3.2.5 Heritage	
Description of Flora Description of Cultural Heritage	Cut over bog with grasses, scrub, reeds None noted on site

3.2.6 Human	
Existing Land Use	Cut away bog
Distance in m. to Nearest House (where relevant)	1km south west
Distance in m. to Nearest School (where relevant)	2.8km east Timahoe National School
Distance in m. to Nearest Gathering Place (e.g. Church, Community Centre) (where relevant)	2.3km south east Coolcarrigan house and gardens
Site Boundaries (distance in m. to nearest)	0m
Road (distance in m.)	1.85km north east
Evidence of Prevailing Climatic Conditions (particularly wind)	None

3.2.7 Drainage Systems	
Drainage Systems:	Field drain

3.2.8 Interpreting Results of Visual Assessment
Site location and topography favourable to ICW development. No siting related fatal flaws observed on site.

3.3 TRIAL HOLES							
Site investigation undertaken June 2022 (TP01-TP05) and November 2022 (TP-6-TP09)							
Trial Hole No.	TP01	Depth of Trial Hole (m)	2.1	Date and Time of Excavation	08/6/22 11.05am	Date and Time of Examination	08/6/22 11.10am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				2.1m – steady inflow at base of pit, seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.1	Peat	Soft	Brown and dark brown	Seepage in peat
2.1-2.4	Silty sandy gravelly CLAY with cobbles	Firm to stiff	Grey	

Trial Hole No.	TP02	Depth of Trial Hole (m)	2.0	Date and Time of Excavation	08/6/22 11.20am	Date and Time of Examination	08/6/22 11.25am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-1.9	Peat	Soft	Brown and dark brown	Seepages in peat
1.9-2.0	Silty sandy gravelly CLAY with cobbles	Very soft – soft	Grey	

Trial Hole No.	TP03	Depth of Trial Hole (m)	1.9	Date and Time of Excavation	08/6/22 11.30am	Date and Time of Examination	08/6/22 11.35am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-1.8	Peat	Soft	Brown and dark brown	Seepages in peat
1.8-1.9	Silty very sandy gravelly CLAY with cobbles	Very soft - stiff	Grey	

Trial Hole No.	TP04	Depth of Trial Hole (m)	2.7	Date and Time of Excavation	08/6/22 11.45am	Date and Time of Examination	08/6/22 11.50am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.6	Peat	Soft	Brown and dark brown	Seepages in peat
2.6-2.7	Silty sandy gravelly CLAY with cobbles	Firm - stiff	Grey	

Trial Hole No.	TP05	Depth of Trial Hole (m)	1.95	Date and Time of Excavation	08/6/22 11.55am	Date and Time of Examination	08/6/22 12.00pm
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-1.8	Peat	Soft	Brown and dark brown	Seepages in peat
1.8-1.95	Silty sandy gravelly CLAY with cobbles	Very soft – soft	Grey	

Trial Hole No.	TP06	Depth of Trial Hole (m)	2.7m	Date and Time of Excavation	30/11/22 11.40am	Date and Time of Examination	30/11/22 11.50am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.3	Peat	Soft	Brown and dark brown	Seepages in peat, particularly top 400mm
2.3-2.55	Silty very sandy very gravelly CLAY with cobbles	Very soft – firm	Grey	Inflow at interface
2.55-2.7	Silty sandy gravelly CLAY with cobbles	Soft-firm	Grey	

Trial Hole No.	TP07	Depth of Trial Hole (m)	2.6m	Date and Time of Excavation	30/11/22 12.00	Date and Time of Examination	30/11/22 12.10pm
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.0	Peat	Soft	Brown and dark brown	Seepages in peat, particularly top 400mm
2.0-2.6	Silty sandy gravelly to very gravelly CLAY with cobbles	Soft – firm	Grey	Inflow at interface

Trial Hole No.	TP08	Depth of Trial Hole (m)	2.8m	Date and Time of Excavation	30/11/22 12.15pm	Date and Time of Examination	30/11/22 12.30pm
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.2	Peat	Soft	Brown and dark brown	Seepages in peat, particularly top 400mm

2.2-2.8	Silty sandy gravelly CLAY with cobbles	Firm-stiff	Grey	Inflow at interface

Trial Hole No.	TP09	Depth of Trial Hole (m)	2.4m	Date and Time of Excavation	30/11/22 11.20am	Date and Time of Examination	30/11/22 11.30am
Depth of Ground Surface to Bedrock (m) (if present):				N/A			
Depth of Ground Surface to Water Table (m) (if present):				Seepages in peat. Standing water at surface locally			
Depth and Description of Topsoil:				N/A – sod over peat			

Depth	Soil/Subsoil Texture & Classification (Include Plasticity/Dilatancy Results)	Density/ Compactness	Colour	Preferential Flow paths
0.0-2.0	Peat	Soft	Brown and dark brown	Seepages in peat, particularly top 500mm
2.0-2.4	Silty sandy very gravelly CLAY with cobbles	Soft – firm	Grey	Inflow at interface

3.4 PARTICLE SIZE DISTRIBUTION TEST (BS 1377)		
PSDT Test Number	% Clay Content	Trial Hole No. and Depth of Test Location
1	11	TP1 – 2.1m
2	33	TP2 – 2.0m
3	8	TP3 – 1.8m
4	9	TP4 – 1.8m
5	15	TP5 – 2.7m
6	17	TP6 – 2.6m
7	11	TP7 – 2.3m
8	7	TP8 – 2.4m
9	12	TP9 – 2.3m
Evaluation of Trial Hole and PSDT Results: (include discussion here of significance of results)		

The results of the soil tests and trial pits show depths of peat >1.8m below existing ground level. The underlaying soils are grey silty very sandy gravelly CLAY. PSD test show clay content 8-33%. These soils are suitable for underlaying the ICW. Additional Clay soils will be required to build up the ICW cells following removal of peat.

Summary
A site assessment has been completed for the proposed ICW development site Drehid Landfill. The site is suitable for an ICW provided the installation and operation is undertaken as per the detailed design.

5.0 SITE ASSESSOR DETAILS

Signed: Louisa Griffin

Address: VESI Environmental Ltd, Block B, Dunhill Eco Park, Dunhill, Wo. Waterford.

Date of Report: 11/11/2022

Phone: 087 2151882

Email: info@vesienviro.com

APPENDIX A
Site images and photos

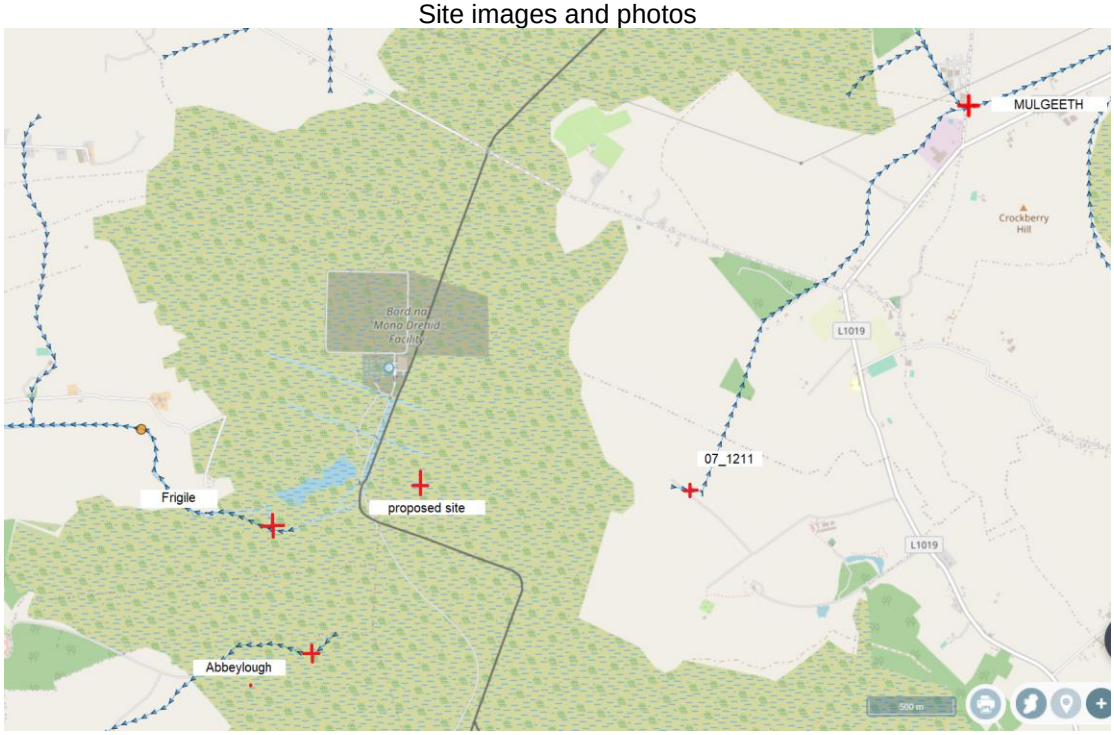


Figure 1: Proximity to nearest watercourse

Figure 2: site location

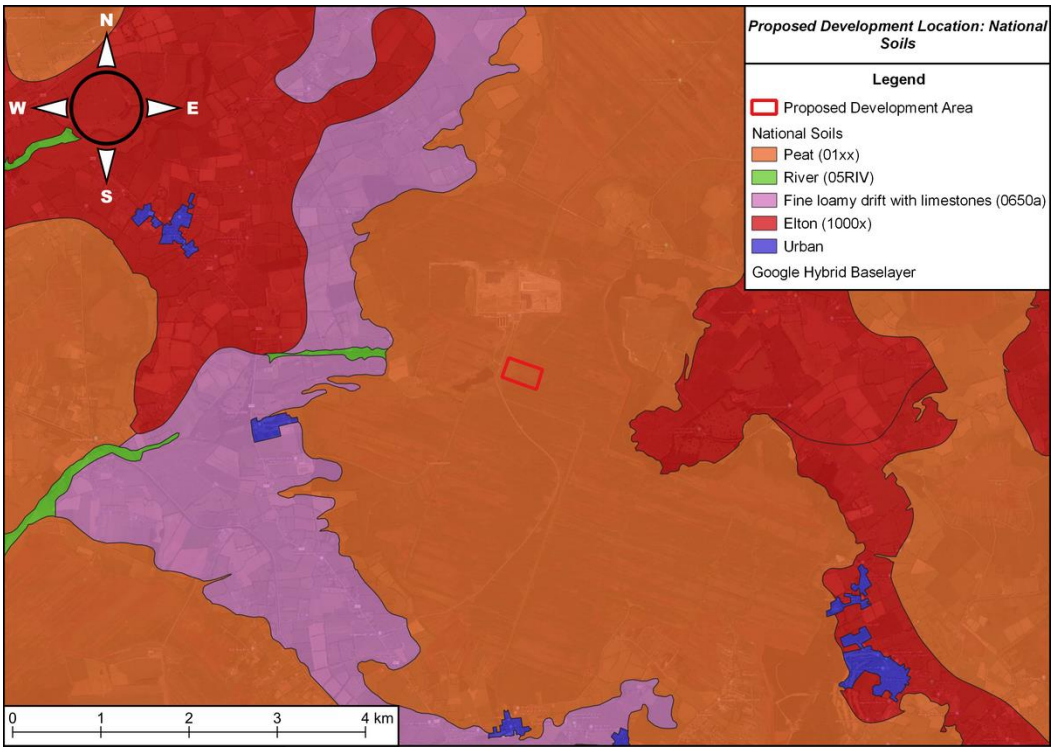


Figure 3: Teagasc Soils

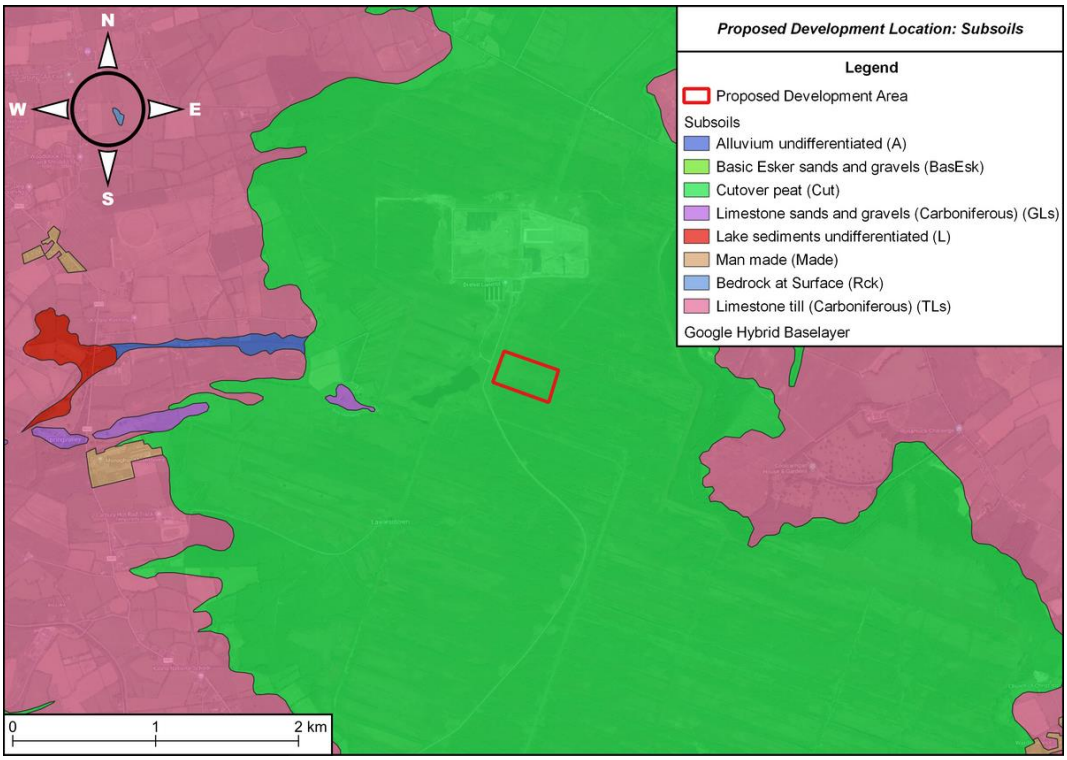


Figure 4: Teagasc Subsoil

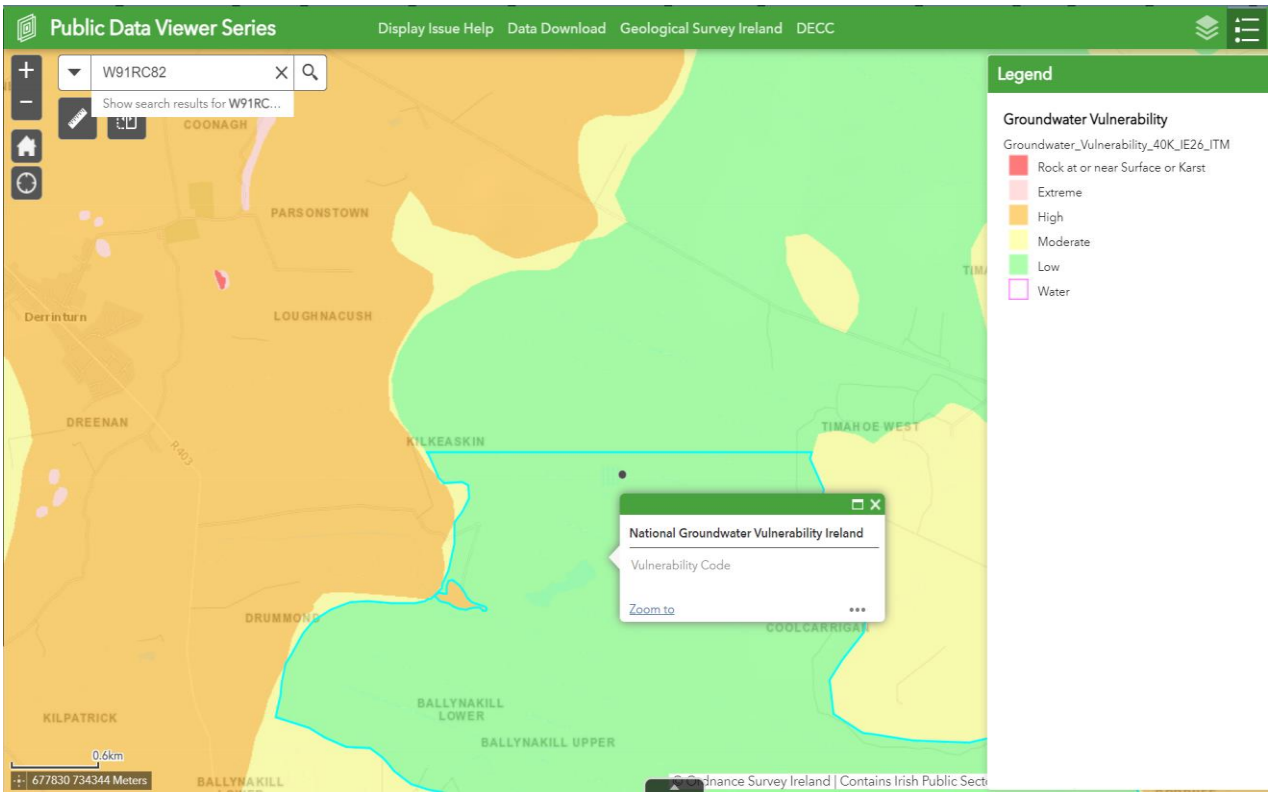


Figure 5: Groundwater Vulnerability

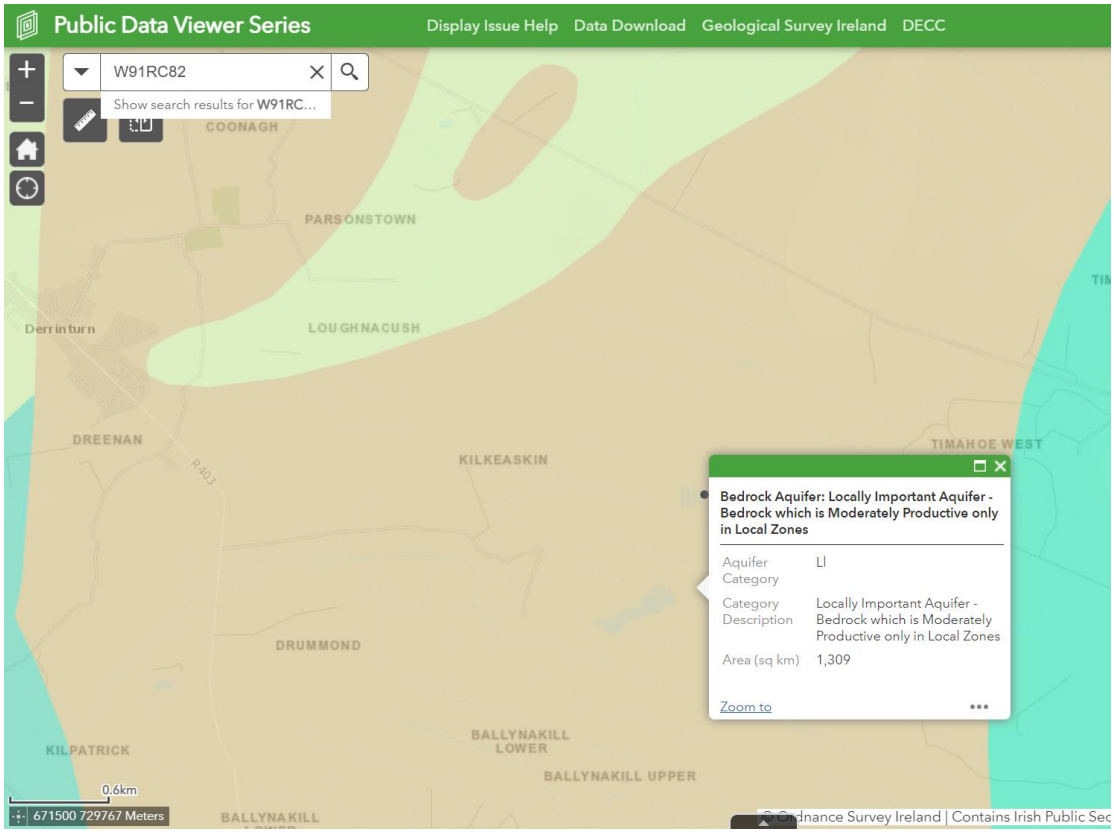


Figure 6: Groundwater Aquifier

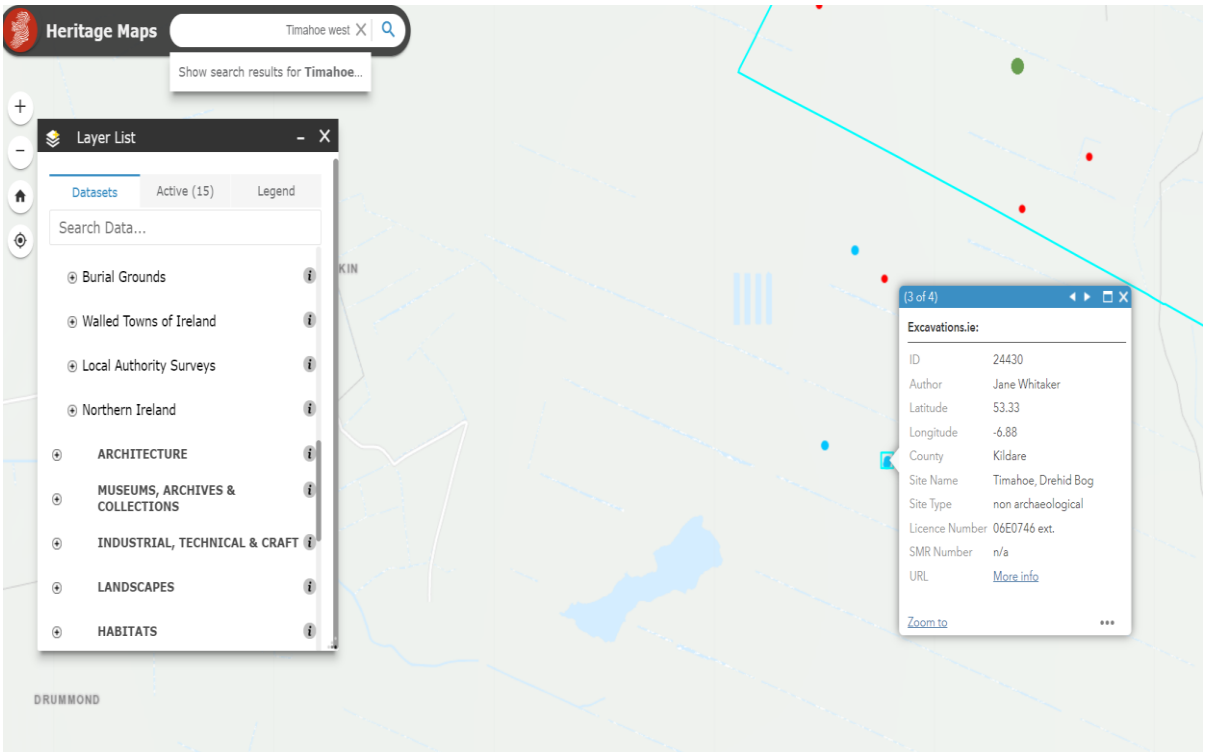


Figure 7: nearest heritage

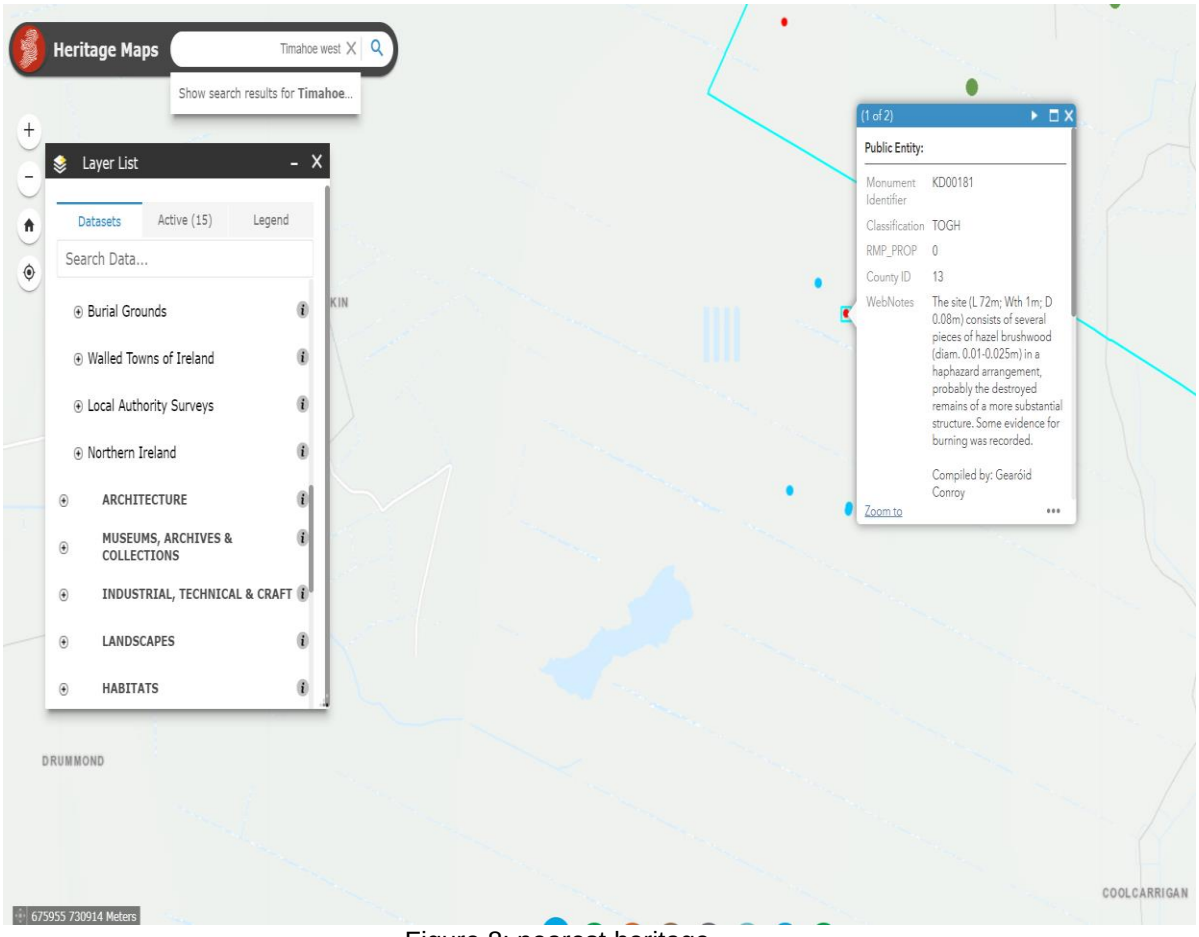


Figure 8: nearest heritage

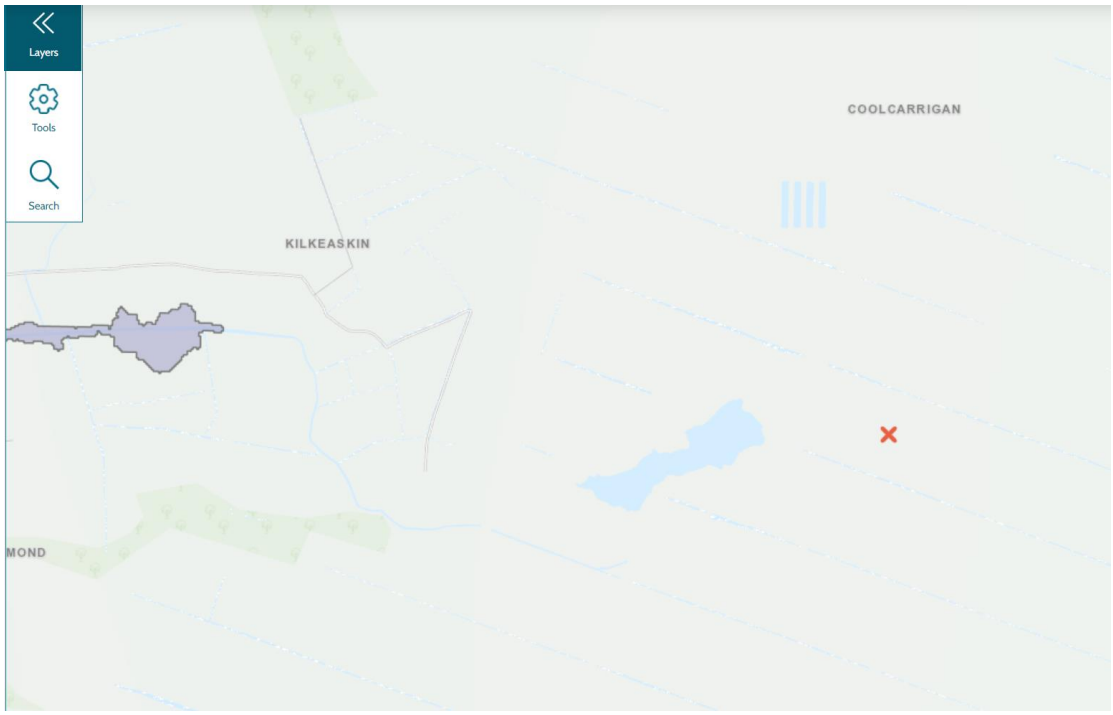
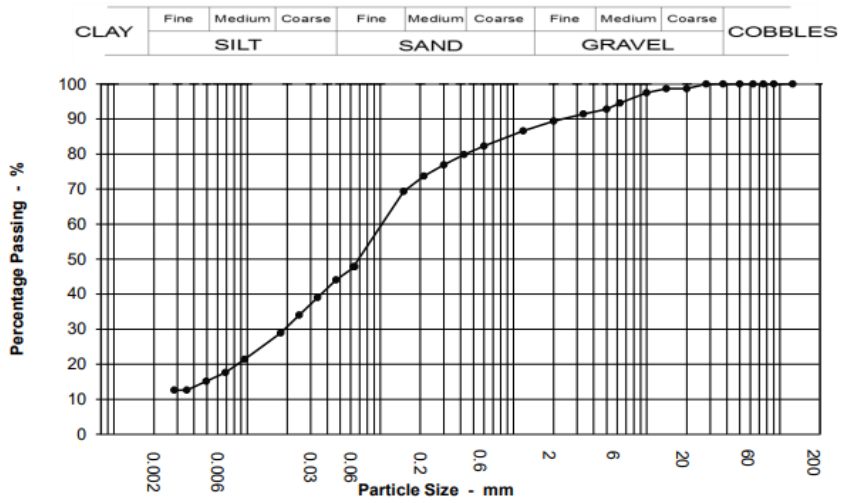


Figure 9: Flood maps

LAB RESULTS

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22110**
		Borehole / Pit No	TP01
Location	**Drehid**	Sample No	B
		Depth	2.10 m
Soil Description	Slightly gravelly sandy SILT	Sample type	B



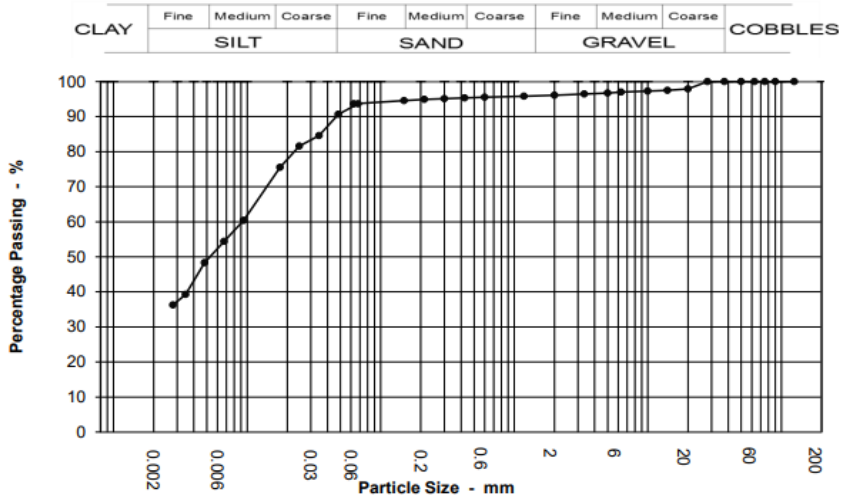
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.064	48
90	100	0.047	44
75	100	0.034	39
63	100	0.025	34
50	100	0.018	29
37.5	100	0.010	21
28	100	0.007	18
20	99	0.005	15
14	99	0.004	13
10	97	0.003	13
6.3	95	0.002	10
5	93		
3.35	91		
2	89		
1.18	87		
0.6	82		
0.425	80		
0.3	77		
0.212	74		
0.15	69		
0.063	48		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	11.0
Sand	42.0
Silt	37.0
Clay	11.0

Grading Analysis	
D100	28.00
D60	0.10
D10	
Uniformity Coefficient	

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22110**
		Borehole / Pit No	TP02
Location	**Drehid**	Sample No	B
		Depth	2.00 m
Soil Description	Slightly gravelly slightly sandy SILT	Sample type	B



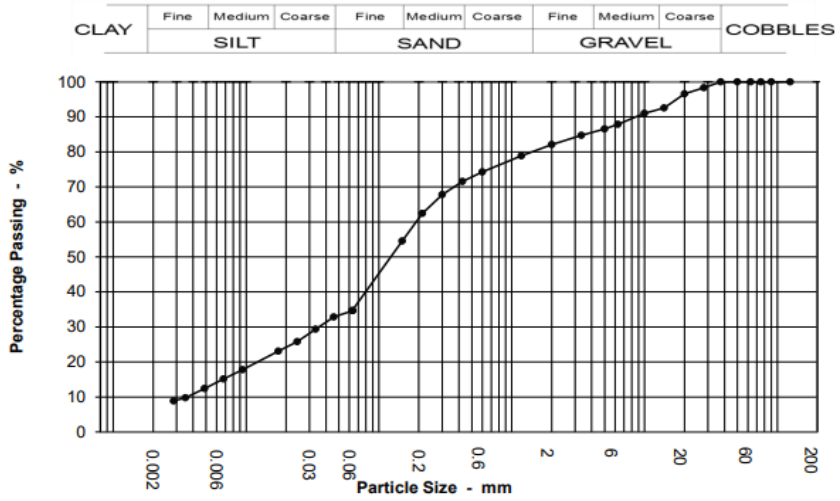
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.068	94
90	100	0.048	91
75	100	0.035	85
63	100	0.025	82
50	100	0.018	76
37.5	100	0.009	60
28	100	0.007	54
20	98	0.005	48
14	98	0.003	39
10	97	0.003	36
6.3	97	0.001	24
5	97		
3.35	96		
2	96		
1.18	96		
0.6	96		
0.425	95		
0.3	95		
0.212	95		
0.15	95		
0.063	94		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	4.0
Sand	2.0
Silt	61.0
Clay	33.0

Grading Analysis	
D100	28.00
D60	0.01
D10	
Uniformity Coefficient	

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22110**
		Borehole / Pit No	TP03
Location	**Drehid**	Sample No	B
		Depth	1.80 m
Soil Description	Slightly gravelly sandy SILT	Sample type	B



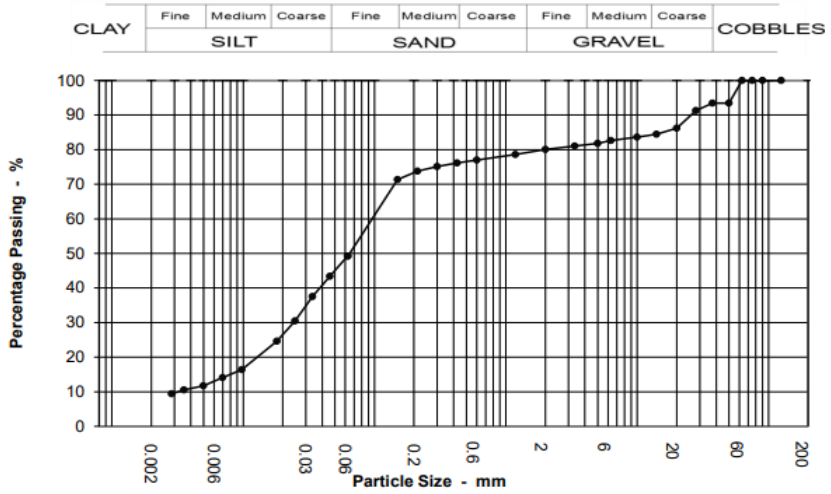
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.064	35
90	100	0.046	33
75	100	0.033	29
63	100	0.024	26
50	100	0.018	23
37.5	100	0.009	18
28	98	0.007	15
20	97	0.005	12
14	93	0.004	10
10	91	0.003	9
6.3	88	0.002	7
5	87		
3.35	85		
2	82		
1.18	79		
0.6	74		
0.425	72		
0.3	68		
0.212	62		
0.15	55		
0.063	35		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	18.0
Sand	47.0
Silt	27.0
Clay	8.0

Grading Analysis	
D100	37.50
D60	0.19
D10	0.00
Uniformity Coefficient	53.00

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22110**
		Borehole / Pit No	TP04
Location	**Drehid**	Sample No	B
		Depth	1.80 m
Soil Description	Slightly gravelly slightly sandy SILT	Sample type	B



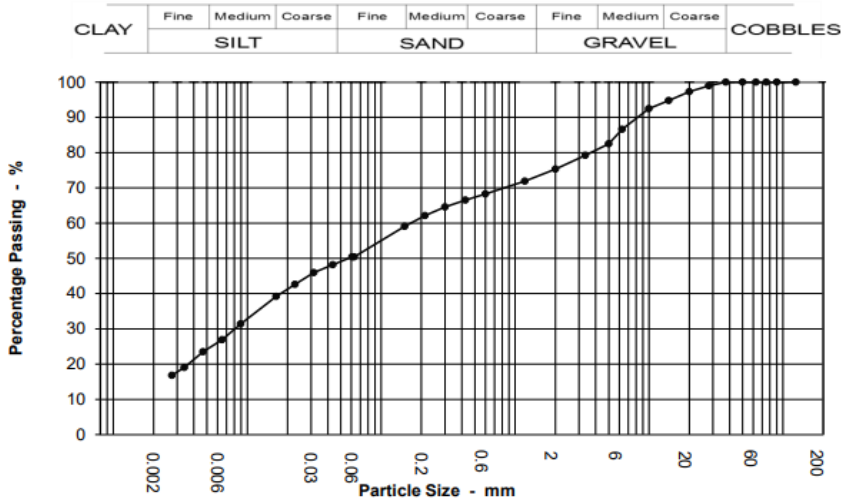
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.062	49
90	100	0.046	43
75	100	0.034	38
63	100	0.025	30
50	93	0.018	25
37.5	93	0.010	16
28	91	0.007	14
20	86	0.005	12
14	84	0.004	11
10	84	0.003	9
6.3	83	0.001	7
5	82		
3.35	81		
2	80		
1.18	79		
0.6	77		
0.425	76		
0.3	75		
0.212	74		
0.15	71		
0.063	49		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	20.0
Sand	31.0
Silt	41.0
Clay	9.0

Grading Analysis	
D100	63.00
D60	0.10
D10	0.00
Uniformity Coefficient	30.00

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22110**
		Borehole / Pit No	TP05
Location	**Drehid**	Sample No	B
		Depth	2.70 m
Soil Description	Slightly gravelly slightly sandy SILT	Sample type	C



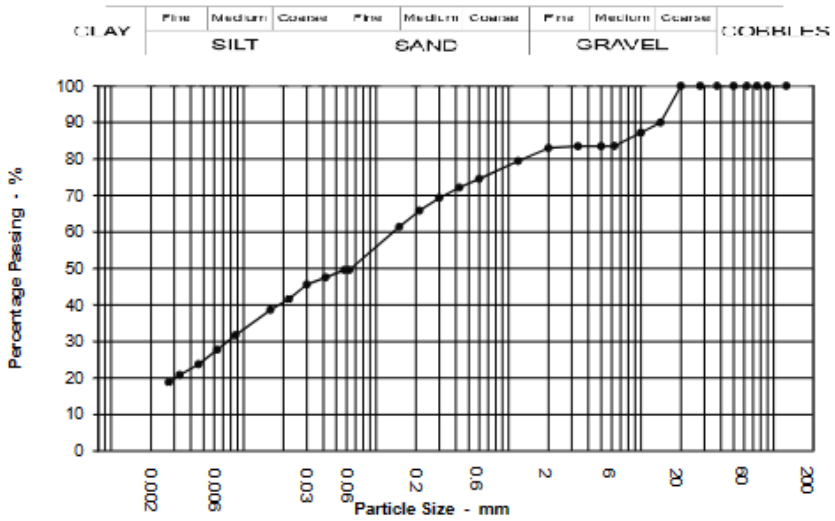
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.061	50
90	100	0.044	48
75	100	0.031	46
63	100	0.023	43
50	100	0.016	39
37.5	100	0.009	31
28	99	0.006	27
20	97	0.005	24
14	95	0.003	19
10	92	0.003	17
6.3	87	0.001	11
5	83		
3.35	79		
2	75		
1.18	72		
0.6	68		
0.425	67		
0.3	65		
0.212	62		
0.15	59		
0.063	50		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	25.0
Sand	25.0
Silt	35.0
Clay	15.0

Grading Analysis	
D100	37.50
D60	0.17
D10	
Uniformity Coefficient	

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** BS 1377 : Part 2 : 1990 : Clause 9	Job Ref	P22209
		Borehole / Pit No	TP06
Location	Drehid Landfill	Sample No	B
		Depth	2.60 m
Soil Description	Slightly gravelly sandy CLAY	Sample type	B



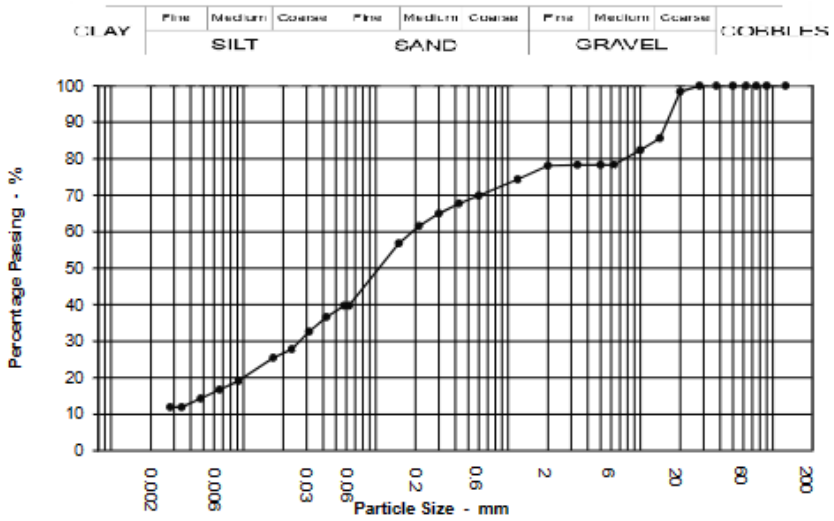
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.058	50
90	100	0.042	48
75	100	0.030	46
63	100	0.022	42
50	100	0.016	39
37.5	100	0.009	32
28	100	0.006	28
20	100	0.005	24
14	90	0.003	21
10	87	0.003	19
6.3	84	0.001	11
5	83		
3.35	83		
2	83		
1.18	79		
0.6	75		
0.425	72		
0.3	69		
0.212	66		
0.15	61		
0.063	50		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	17.0
Sand	33.0
Silt	33.0
Clay	17.0

Grading Analysis	
D100	20.00
D60	0.14
D10	
Uniformity Coefficient	

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** BS 1377 : Part 2 : 1990 : Clause 9	Job Ref	P22209
		Borehole / Pit No	TP07
Location	Drehid Landfill	Sample No	B
		Depth	2.30 m
Soil Description	Slightly gravelly sandy CLAY	Sample type	B



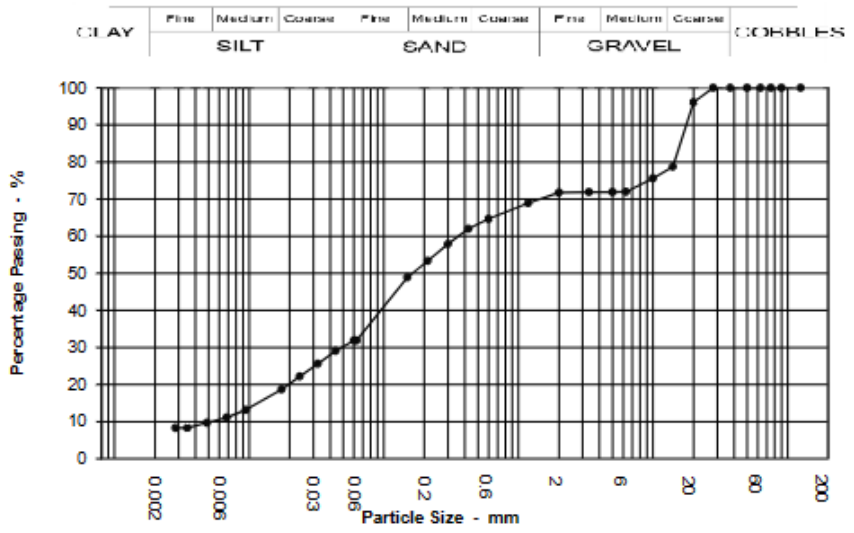
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.058	40
90	100	0.042	37
75	100	0.031	33
63	100	0.023	28
50	100	0.017	25
37.5	100	0.009	19
28	100	0.007	17
20	98	0.005	14
14	86	0.003	12
10	82	0.003	12
6.3	78	0.001	7
5	78		
3.35	78		
2	78		
1.18	74		
0.6	70		
0.425	68		
0.3	65		
0.212	62		
0.15	57		
0.063	40		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	22.0
Sand	38.0
Silt	29.0
Clay	11.0

Grading Analysis	
D100	28.00
D60	0.19
D10	0.00
Uniformity Coefficient	110.00

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** **BS 1377 : Part 2 : 1990 : Clause 9**	**Job Ref**	**P22209**
		Borehole / Pit No	TP08
Location	**Drehid Landfill**	Sample No	B
		Depth	2.40 m
Soil Description	Slightly gravelly sandy CLAY	Sample type	B



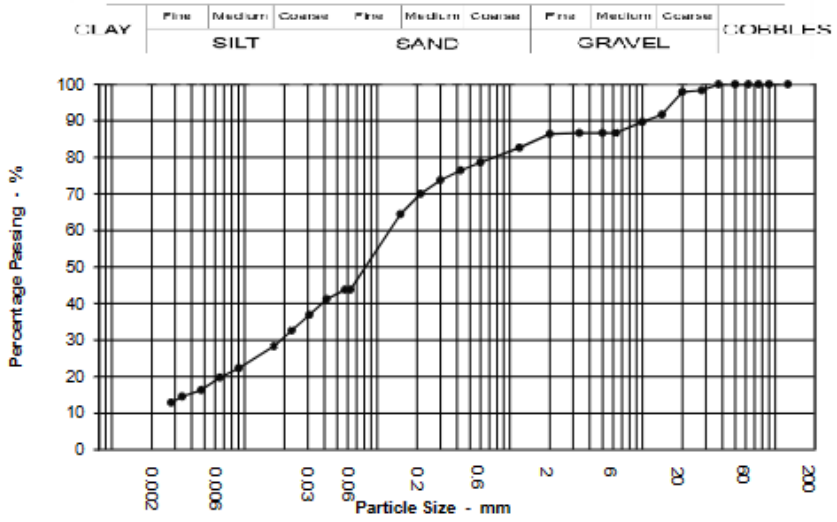
Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.060	32
90	100	0.044	29
75	100	0.032	26
63	100	0.024	22
50	100	0.017	19
37.5	100	0.009	13
28	100	0.007	11
20	96	0.005	10
14	79	0.003	8
10	76	0.003	8
6.3	72	0.001	6
5	72		
3.35	72		
2	72		
1.18	69		
0.6	65		
0.425	62		
0.3	58		
0.212	53		
0.15	49		
0.063	32		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	28.0
Sand	40.0
Silt	24.0
Clay	7.0

Grading Analysis	
D100	28.00
D60	0.36
D10	0.01
Uniformity Coefficient	68.00

pgl priority geotechnical	**PARTICLE SIZE DISTRIBUTION** BS 1377 : Part 2 : 1990 : Clause 9	Job Ref	P22209
		Borehole / Pit No	TP09
Location	Drehid Landfill	Sample No	B
		Depth	2.30 m
Soil Description	Slightly gravelly sandy CLAY	Sample type	B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.057	44
90	100	0.042	41
75	100	0.031	37
63	100	0.023	33
50	100	0.017	28
37.5	100	0.009	22
28	98	0.007	20
20	98	0.005	16
14	92	0.003	15
10	90	0.003	13
6.3	87	0.001	9
5	87		
3.35	87		
2	86		
1.18	83		
0.6	79		
0.425	76		
0.3	74		
0.212	70		
0.15	64		
0.063	44		

Test Method	
BS 1377 : Part 2 : 1990	
Sieving	Clause 9.5
Sedimentation	Clause 9.5

Sample Proportions	
Cobbles	0.0
Gravel	14.0
Sand	43.0
Silt	32.0
Clay	12.0

Grading Analysis	
D100	37.50
D60	0.12
D10	0.00
Uniformity Coefficient	98.00

APPENDIX B – PRELIMINARY OPERATIONS & MAINTENANCE PLAN

VESI ENVIRONMENTAL
Integrating our water back into nature

Bord na Móna

Drehid Waste Management Facility
Preliminary Integrated Constructed Wetland

Operations & Maintenance Plan D2

May 2023

Table of Contents

List of Tables

1.0 INTRODUCTION

This preliminary Operation and Maintenance Plan (O&M Plan) has been drafted for Planning Stage to outline the procedures for the Integrated Constructed Wetland (ICW) system, which will be implemented on an ongoing basis. It is recommended that managers and operators responsible for the day-to-day operation of the ICW system be fully aware what the system was designed to treat, how ICW systems function, and the expected performance of these systems. Managers and operators should also be aware of the on-site aspects of the ICW system including the general hydraulics, ecological aspects, and all of the various components.

Training will be provided to operation and maintenance personnel.

1.1 General overview of the ICW system

The ICW system for the Drehid Waste Management Facility has been designed to treat collected stormwater run-off from the proposed Landfill extension. The ICW concept is based on the ability of wetlands to cleanse influent contaminated water; they are free water surface flow systems consisting of a series of densely vegetated shallow cells, across which influents flow.

Five cells, with an operational water depth of approximately 150mm, are densely vegetated and sequentially arranged to maximise the distance over which the influent must travel for maximum retention time and treatment. The treatment areas of each cell are provided in Table 1 below.

Table 1: Cell Treatment Areas	
Cell 1	9,571m^2
Cell 2	6,943m^2
Cell 3	5,703m^2
Cell 4	12,262m^2
Cell 5	8,567m^2
Total	43,046m^2

Collected stormwater run-off will flow via gravity from settlement lagoons located north of the ICW site. Outflow from these lagoons will flow by gravity through a 225mm diameter pipe into Cell 1.

The ICW is constructed using the on-site soil material. Each cell is densely planted with a selection of wetland emergent plant species. These plants assist in the many physical, chemical, and biological processes that occur within the wetland system to reduce the through flowing water of its various polluted contaminants. The vegetation also plays a very important role in reducing the volume of effluent discharging from the ICW to the receiving waters, especially through the process of evapotranspiration.

Effluent flows between the cells through 225mm diameter interconnecting pipework. Outlet pipes from the cells are fitted with elbows for the control of water levels. The discharge from the ICW will flow south to an existing drain and run eastward before connecting to the local receiving watercourse (Cushaling and on to Figile water courses).

2.0 DAILY MONITORING

Daily visual inspections of the ICW will be carried out by the responsible person to assess the items described as follows. Details of observations should be recorded and made available upon request.

2.1 Inspection of ICW inlet and outlet locations

Visual check of all exposed pipework will ensure flow is not blocked by any material. The general appearance of the final effluent should be noted, paying particular attention to water colour in the discharge. If the final discharge water appears to be heavily discoloured or polluted, then the outlet pipe should be isolated immediately by closing or turning up the adjustable pipe in Cell 5. The site manager should be informed of the situation to obtain advice on the next course of action, thereafter, contact to be made with VESI if outlet is closed.

The operator shall record the occurrence of any odours in the discharge or whether the discharge appears discoloured.

2.2 Flow monitoring

Daily flow rates to the ICW and discharge rates from the ICW will be noted and recorded including noting of flows between cells.

Rainfall data – daily rainfall data should be recorded for cross referencing purposes. All monitoring equipment shall undergo annual maintenance and calibration or as per manufacturers requirements.

2.3 Accidental spillage

Any incidences of spillages that may occur in the landfill that convey to the ICW shall be identified and recorded with the appropriate action taken to correct the problem should they occur.

The discharge pipe from the ICW will be checked at least weekly and should the water deem unsatisfactory for discharge, the outlet pipe will be isolated and the elbow within the outlet pipes turned as required to stop flow.

In the event of an accidental discharge to the ICW, the inlet pipe shall be closed. If deemed necessary, Cell 1 will be isolated by closing the outlet pipe of Cell 1 until the spillage has been cleaned and the affected material disposed of for treatment. Details are to be recorded and documented. Details of the accidental spill should be brought to the attention of the Site Manager as soon as practically possible.

3.0 WEEKLY MONITORING

3.1 Assess cell water levels

The operator will undertake a visual inspection of the water levels weekly to ensure that water depths are maintained between 150mm and 300mm. This can be checked at inlet and outlet locations where water level gauges are installed. Under normal operating conditions water levels should be maintained at 150mm to optimise treatment. Water depths in the cells will fluctuate depending on weather conditions and influent flows. Cell depths may increase during prolonged wet weather and decrease during dry periods.

3.2 Internal and external cell embankment inspection

The operator will undertake a visual inspection of the sloping embankments on either side of the cell (internal and external) to check for any sign of leakage, slippage, or distortion. Any notable defects should be recorded, and the necessary action required should be undertaken immediately. Any leakage, slippage or distortion will require a track machine or digger to be brought in on site to amend any defects. This is important during the initial months following construction as plants become established on the embankments.

3.3 Inspection of Inlet & Outlet Pipes

All pipes within the ICW system will be visually inspected for blockages, sediment accumulation, vegetation growth around the pipe, and debris. Blockages will influence the flows through the system and be checked weekly.

The operator will maintain access to all inlet and outlet pipes by keeping vegetation within the cells and on the embankments clear from pipes. Access to pipes shall also be maintained to facilitate maintenance and clearing of vegetation. Over-growth of vegetation will limit access to the inlet and outlet pipes for maintenance and monitoring.

Pipes will require jetting on an annual basis or as required.

4.0 MONTHLY MONITORING

4.1 Wetland Vegetation Assessment

The wetland cells will be densely planted using a selection of wetland plant species. The main species to be planted in the ICW are listed below in Table 2.

Table 2: Main species used in ICW

Botanical name	Common name	Flowering period	Max height	Max water depth	Summer	Winter
Glyceria maxima	Reed sweet grass	Jun – Aug	2.5m	0 – 60cm		
Typha angustafolia	Small reed mace	Jun - Jul	3.0m	0 – 15cm		

Table 2: Main species used in ICW						
Botanical name	Common name	Flowering period	Max height	Max water depth	Summer	Winter
Iris pseudacorus	Yellow flag iris	May – Jun	1m	0 – 20cm		Deciduous Not visible in winter
Typha angustafolia	Small reed mace	Jun - Jul	3m	0 – 15cm		

4.1.1 General plant behaviour

The main growing season is May to September. New growth begins in March, with species such as *Iris pseudacorus* being one of the first to emerge. The exact emergence of new growth in a given season will depend on the temperature. Milder springs are associated with earlier growth and cooler springs associated with later growth (April-May).

All plants begin to brown between September-October, with deciduous plants losing all foliage and foliage from some of the plant species falling below the water (such as *Iris*).
The foliage of some deciduous species will remain above water, such as *Typha*, until the spring.

Some species are semi-evergreen (such as *Glyceria maxima*) whereby the level of die back will depend on the winter conditions. Colder winters cause more die back than milder winters while evergreen plants such as *Carex riparia* will brown slightly and will reduce in height during the winter.

4.1.2 Monitoring

Any differences in the composition or cover of the plants should be noted and recorded. Any significant changes in the colour of the vegetation or die off should be monitored and reported. Any increased establishment of weeds/grass should also be noted.

4.2 Influent and effluent water quality monitoring

4.2.1 Influent and discharge monitoring

A sample of the influent into Cell 1 and the final discharge from Cell 5 of the ICW shall be taken monthly and analysed for at least the following parameters:

- pH;
- Biological Oxygen Demand (BOD);
- Suspended solids;
- Total Ammonia as N;
- Ammonia;
- Chemical Oxygen Demand (COD);
- Temperature

Records of all monitoring are to be maintained for external and internal checking.

5.0 QUARTERLY MONITORING

5.1 Review of maintenance and monitoring records

A review of the results from the maintenance and monitoring carried out on the wetland, and receiving watercourse of the site shall be undertaken quarterly. The review of monitoring results will assess:

- The general performance of the ICW;
- Maintenance record; and
- Whether or not there is any impact occurring on adjacent surface waters.

The O&M Manual must be updated should there be any changes in the number of samples taken or the frequency of sampling.

5.2 Surface water quality monitoring

A grab sample of the receiving surface waters both upstream and downstream of the final discharge point shall be taken quarterly and analysed for at least the following parameters:

- pH;
- Biological Oxygen Demand (BOD);
- Suspended solids;
- Total Ammonia as N;
- Ammonia;
- Chemical Oxygen Demand (COD);
- Temperature

Records of all monitoring are to be maintained for external and internal checking.

6.0 BI-ANNUAL MAINTENANCE (EVERY 6 MONTHS)

6.1 Sediment Assessment

Over time there will be an accumulation of sediments in the ICW, however this will be confined initially to the first cell. The surface water lagoons will be assessed regularly to ensure that these have the necessary maintenance carried out to reduce the sediment entering the ICW.

The sediment build-up in the ICW cells will be comprised of the settlement of solids from the influent and the accumulation of dead plant matter.

The depth of the sediment will be investigated in the initial cell on a biannual basis. The depth of the sediment should also be investigated prior to removal to ensure that the liner and upper section of topsoil beneath the sediment is not disturbed. Ideally the material that lies 0.2m above the liner should remain undisturbed.

Once the sediment is removed, the requirement of topsoil for the replanting and sealing of the cell should be assessed.

Outlet pipes shall be readjusted to provide the appropriate water level in each respective cell, as these will have been adjusted over time to accommodate increases in sediment accumulation.

7.0 ANNUAL REPORTING

A report on the operations and maintenance of the ICW is to be prepared annually. This document will review the ongoing performance of the ICW. Any modifications to the ICW and/or influent wastewater discharge type/volume is to be included in the report together with a record of any non-compliance incidents (if any). Results of quarterly monitoring will also be included in the Annual Report.

NOTE

This operation and maintenance plan will be updated prior to the commissioning of the ICW and will comply with any licencing requirements.