

# **Integrated Constructed Wetland Tolka Valley Park Dublin**



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## **A Constructed Wetland for the Removal of Urban Pollution in the Finglaswood Stream, Tolka Valley Park, Dublin**

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*Abstract: Wetlands exist throughout Ireland in lowland, upland and coastal areas in various forms ( marshes, fens, bogs). They are the transitional zones between aquatic and land ecosystems and it is widely recognised that they all provide a varying degree of treatment of waters discharged into them ( e.g. sedimentation, nutrient uptake). They are ideally suited for the containment and treatment of polluted urban storm water runoff and are a holistic example of Sustainable Drainage Systems (SuDS). Unfortunately in Ireland because of pressure on land space in urban areas due to economic growth they are disappearing rapidly as they are drained and built on. In this paper a typically polluted storm water system (stream) discharging to a well stocked fishing river via an ornamental pond in a public park is presented. Because of the polluted condition of the stream the Local Authority had lost the amenity value of the pond and decided to install an Integrated Constructed Wetland (to treat the polluted stream) to improve the water quality discharging from the pond and thus achieve compliance with the thrust of the Water Framework Directive, the Phosphorus Regulations and the Nitrates Directive. The integrating nature of the wetland is discussed. The project has been an outstanding success and the pond has now achieved acceptable water quality.*

**Key words:** *Integrated Constructed Wetland (ICW), Water Framework Directive, Sustainable Drainage Systems(SuDS)*

### **1. Introduction**

Dublin City Council is the largest Local Authority in Ireland with a staff of 6,000 people and providing in excess of 700 services. These include the provision of Water, Public Lighting, Roads, Housing, Museums, Swimming Pools, Fire Services, Parks and Drainage. Drainage Services are provided by the Drainage Division which is based in the Civic Offices in Dublin City Centre. It is comprised of four sections -Maintenance, Reconstruction, Planning and Pollution Control. Dublin City Council, through its Pollution Control section, has a statutory obligation to implement the various sections of The Local Government (Water Pollution) Acts, 1977 & 1990. Dublin City Council must also ensure that all waters within its functional area comply with a range of legislation such as

- 1) Water Quality Standards for Phosphorus Regulations 1998
- 2) S.I. No.12 of 2001 Water Quality (Dangerous Substances) Regulations 2001
- 3) Environmental Protection Agency Acts of 1992-2003
- 4) Urban Wastewater Directive
- 5) S.I. No. 293 of 1998 European Communities (Quality of Salmonid Waters) Regulations – this is a Regulation that is only applicable to specific named waters in Ireland but the City Council strives to have all waters within its functional area comply with it.

In carrying out its functions/duties Dublin City Council is both reactive and proactive. It is reactive when for example it cleans up contamination after an oil /chemical spillage. It is proactive when it ensures that industry installs pollution preventative measures such as bunding of tanks containing polluting matter, when it investigates domestic dwellings for misconnections (it has been found that

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an average of 8 % of domestic dwellings in those areas drained on the separate system in Dublin area have a misconnection), when it issues trade effluent licences (968 issued to date), when it consents to Environmental Protection Agency (E.P.A.) requests for licences (68 to date) and as detailed in this paper when it is responsible for the construction of a wetland.

## **2. Wetlands**

Wetlands exist in their natural form throughout Ireland in such features as marshes, fens and bogs. They are the transitional zones between aquatic and land ecosystems and it is widely recognised that they all provide a varying degree of treatment of waters discharged into them (e.g. sedimentation, nutrient uptake). They are ideally suited for the containment and treatment of polluted urban storm water runoff and are a holistic form of Sustainable Drainage Systems (SuDS) where waters undergo attenuation, biological, physical and chemical treatment. SuDS in one form or another are now compulsory on all new schemes in Dublin City. While the above mentioned are all natural systems man has constructed his own artificial wetlands to mimic natural ones. The most common and well known of these is the reed bed where one species of plant – usually the common reed (phragmites) is cultivated. Often the flow to reed beds is pumped and as they require a relatively small area they can be located with relative ease almost anywhere. They provide for reasonable removal of B.O.D. and C.O.D. but no great removal of faecal coliforms, Nitrogen and Phosphorus . A more recent development in wetlands in Ireland is the use of the Integrated Constructed Wetland (I.C.W.). The I.C.W. concept was developed in the Dunhill-Annestown stream catchment in Co. Waterford in the south of Ireland and has been promoted by the National Parks and Wildlife Service. A typical I.C.W. is an artificially planted wetland composed of a number of shallow cells ranging from 300mm to 500mm in depth and having a low velocity throughout thus allowing solids to settle or be filtered as the water moves through the wetland and allowing long contact times between the water and the surfaces within the wetland. It mimics natural wetlands and creates systems that integrate the following three principals

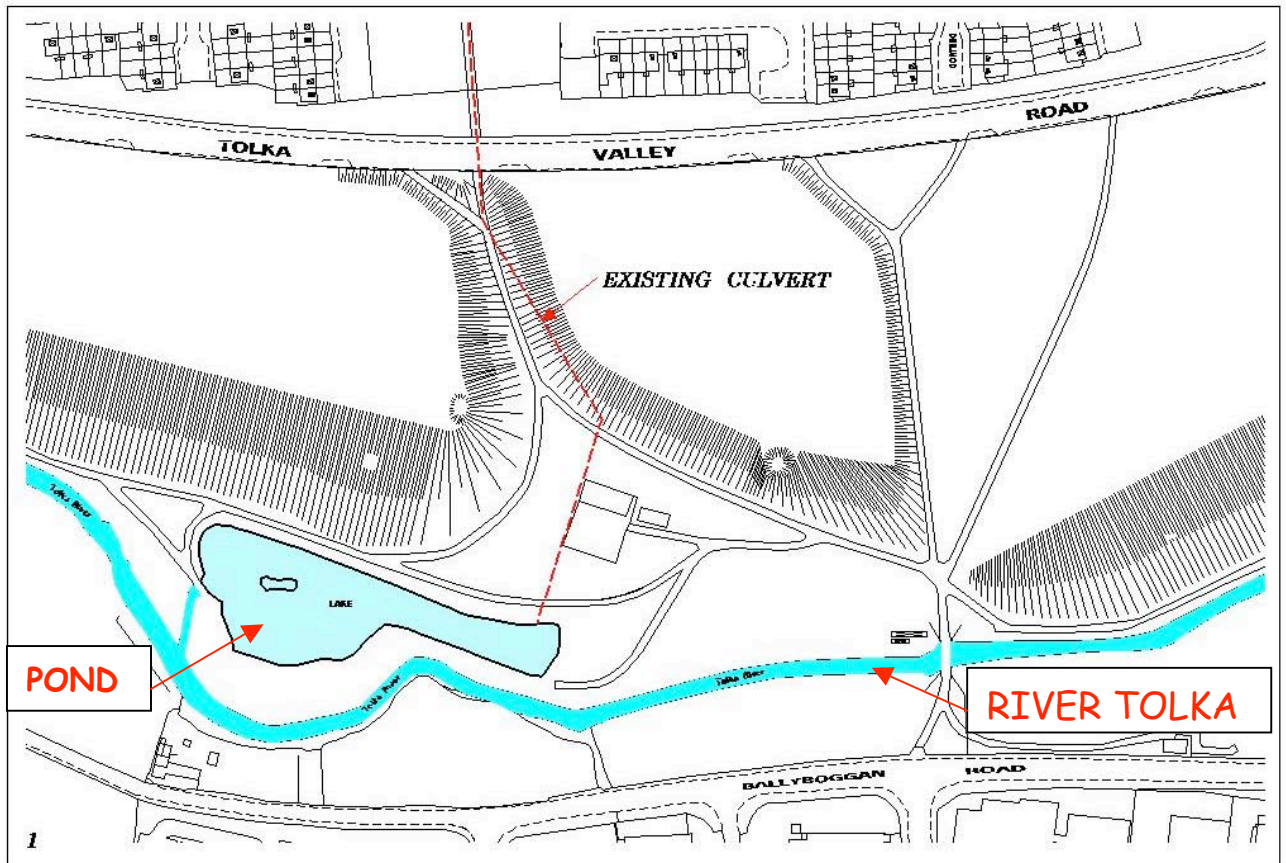
- ❑ Containment and treatment of effluent in a series of emergent vegetated areas
- ❑ Aesthetically fitting the wetland into the local area
- ❑ Enhancing habitat and encouraging biodiversity

These three objectives are achieved by incorporating a variety of local emergent plants (vegetation that is rooted in the sediment but with leaves at or above the water surface) and blending these in with the landscape. In I.C.W.s because of their long retention times and robust nature there is good removal of Nitrogen, Phosphorus, Suspended Solids, Coliforms, B.O.D and C.O.D.

## **3. Finglaswood Stream - Tolka Valley Park**

The Finglaswood stream is a small stream that originates in the village of Finglas on the northern outskirts of Dublin City. It flows in a southerly direction for 5 kms and outfalls to the river Tolka some 200 metres west of and upstream of Finglaswood Bridge in the Tolka Valley Park (see Fig 1). The River Tolka is a very well stocked fishing river supporting a large trout population and the members of several angling clubs use it on a daily basis. The largest of these clubs is The Tolka Anglers with a membership of 400. It flows into Dublin Bay at Fairview just to the west of the historic wooden bridge (built by Captain Blithe of Mutiny on the Bounty fame) which forms the western boundary of the blue flag beach at Dollymount. In Dublin City it passes through two public parks and the National Botanic Gardens. Under the Phosphorus regulations the E.P.A. have stipulated a target value of 0.05 mg/l for phosphorus in the River Tolka so all discharges to it need to be carefully controlled and monitored and improved where necessary. The Finglaswood Stream was once an open stream but it is now completely culverted and drains such areas as the large housing estates of Gortmore, Barnmore, Wellmount and Kippure all of which have been designed on the completely separate drainage system.

In the early 1980's Dublin City Council constructed a pond in the Tolka Valley Park (see Fig 1) and used the existing Finglaswood stream (now in culvert form) as its sole feedwater. The pond was designed to discharge directly into the Tolka river and was to be a central feature of the park where it was hoped families would congregate.



**FIGURE 1**

From investigative work in housing estates similar to Gortmore, Barnmore, Wellmount and Kippure in other parts of the city it is known that 8% of the houses in these estates have misconnections of foul drainage to the surface water drainage system. A recent survey of 2602 domestic premises in an area similar to this catchment gave the following breakdown of the different sources of misconnections:

Washing machines	Sinks	Dishwashers	Showers	Baths	Toilets
100	63	22	18	4	3
48%	30%	10%	8%	2%	2%

This is a total of 210 misconnections and represents a total misconnection rate of 8%. What is most striking about this table is the low number of toilets connected to the surface water system and that

washing machines, sinks and dishwashers contribute 88% of the pollutants. It shows that householders are aware of the polluting effect of toilet waste but not of other household appliances. Some typical appliances were sampled and analysed and gave the following characteristics:-

Appliance	B.O.D. (mg/l)	PH	Solids (mg/l)	Phosphate	Population Equivalent
Washing Machine	1,534 (58.5 Litres)	10	366	0.53	1.5
Dishwasher	313 (25 litres)	9.2	19	0.32	0.13
Car Wash	3,160 (7 litres)	-	-	0.36	

While these are only one sample of each appliance and taken as a spot sample at a point in time they show the polluting potential of these everyday effluents. **These misconnections are typical of the type of on-going pollution that was entering and polluting the stream and pond on a daily basis from domestic dwellings but in addition to these pollutants there was**

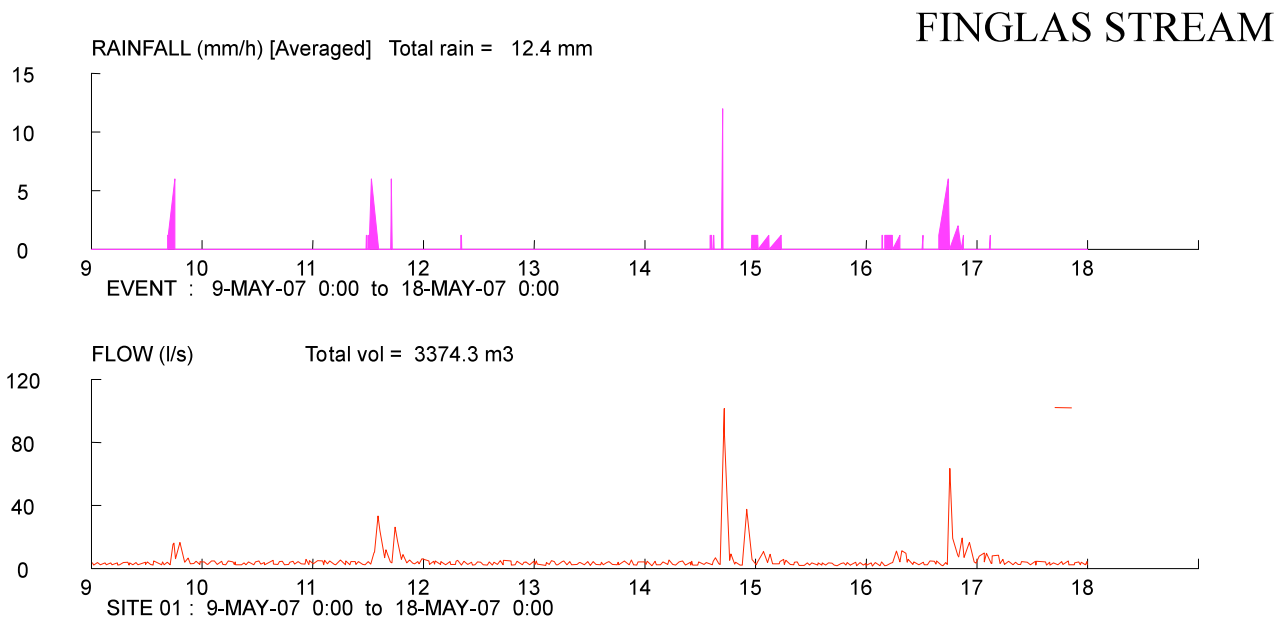
- Disposal of household chemicals, paints and solvents
- Diffuse pollution from intermittent road run-off with all the usual pollutants that are carried from trafficked roads
- Car wash run off with detergent, oils and solids
- Disposal of used engine oil into road gullies – this is most prevalent in summertime
- Disposal of old petrol from lawn mowers
- Disposal of material used in construction such as plaster slurry, cement, lime and readymix concrete container washings
- Fouling by dog and cat litter

The combined effect of these pollutants was that the amenity value of the pond was completely lost. There were large algal growths, grease, milky scum, vegetable matter, hydrocarbons from road run-off and illegal disposal ensuring that, particularly in summer time malodours were the norm in the pond making it a most unpleasant waterbody. It was unusual to see birdlife in the pond or to see members of the public spending any time in its environs.

Dublin City Council (Parks Department) was in a situation whereby the central feature of the park was rendered unusable because of the pollution of the stream feeding it and there was also pollution of one of the biggest rivers in the city from the same stream. In 1999 a meeting was held between the Drainage Division and the Parks Department of the Council and a proposal was put forward that would entail diverting the polluted stream directly to the River Tolka and bringing a new feed of cleaner water to the pond from a different source i.e. the river Tolka upstream of the pond. Concern was expressed about this proposal as the polluted streamwater would then discharge directly to the River Tolka with all the above mentioned problems being transferred to that river i.e. there would be uptake of N, P and the discharge would have S.S. and Faecal Coliforms. In the end it was decided that the installation of a wetland on the Finglaswood Stream upstream of the pond would provide the best solution by ensuring treatment of the stream (by settlement of suspended solids, uptake of nitrogen and phosphorus, removal of hydrocarbons and faecal coliforms) thus enhancing the amenity of the park by providing clean feedwater for the pond and a wetland with its own biodiversity. This would also comply with the thrust of the Water Framework Directive, the Phosphorus Regulations and the Nitrates Directive. It was envisaged that capturing all the base flow and most of the first flush would provide best results for minimum expenditure and disruption to the park.

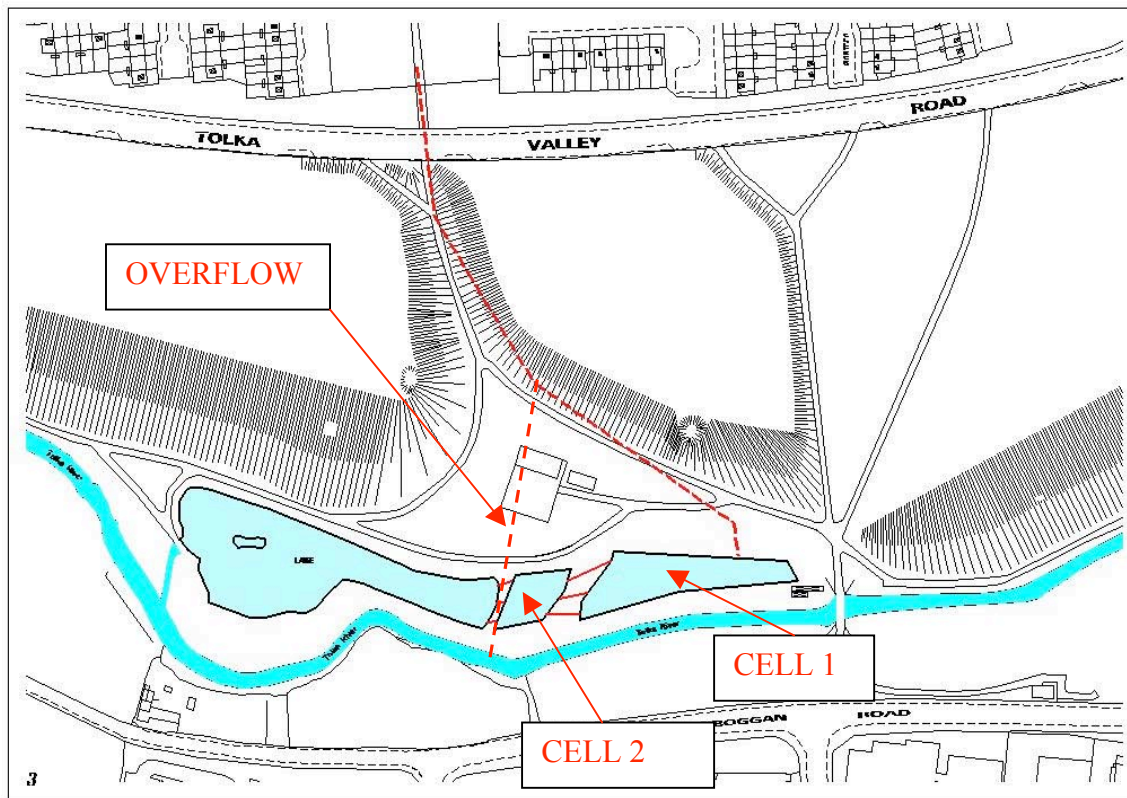
#### 4. Design of the wetland

The wetland in the Tolka Valley Park is a surface flow wetland and was a joint design by Dr. Rory Harrington of National Parks and Wildlife Service in co-operation with Dublin City Council. It was agreed at an early stage that the wetland could not cope with large storm events and flows in the catchment so it was decided to treat all the base flow and the first flush of major events – large flows were to be diverted at a weir and bypass the wetland by flowing directly into the River Tolka. This ensures that all day to day pollutants are treated. The design aimed to provide a wetland that would capture, contain and treat flow in emergent vegetated areas, blend in with its surroundings and enhance habitat diversity and most importantly provide a clean water to the pond. As was stated earlier these are the three objectives of I.C.W. Because the wetland was to be installed in a public park the landscape fit was given great attention. The soils in the wetland after being compacted quite quickly become hydric i.e. wet and devoid of oxygen and they tend to seal themselves because of the compaction at construction, deposition and the presence of lignin. The size of wetland that could be constructed was governed by the amount of available land . Looking at the site there was the River Tolka to the south, the bridge to the east, the walkway to the north and the existing pond to the west. Integrated Constructed Wetlands by their very nature require fairly large land areas and typical retention times are in the order of several days but as space was limited in the park a decision was made to send an absolute maximum flow of some 35 litres per second through the wetland and flows in excess of this would overflow at an overflow weir to the Tolka in wet weather/high flows. **This would ensure that all the day to day pollutants as described above were always treated in the wetland.** This maximum flow gives a retention time of 13 hours. A recent flow measuring exercise over a dry period of six weeks using the velocity area method gave an absolute dry weather base flow of 9 litres per second equating to a retention period of 49.5 hours.



The wetland was composed of two cells - a single primary cell and a secondary cell with a length/width ratio of 4:1 (Fig 2). Of major importance was the flow regime through the cells. It is vital that the flow is distributed evenly throughout the cells to avoid dry areas and to get maximum

benefit from the available area. To prevent canalisation and ensure even flow throughout the cells three outlet pipes were installed at the outlet from each cell. This allowed equal flow from cell to cell through the wetland and into the pond. A unique feature of this wetland is its orientation whereby the flow through it is contrary to the direction of flow of the Tolka. This means that in times of flood in the Tolka the wetland plants are not flushed away and water can be stored in the wetland and released after the flood. In November 2002 the whole of the wetland was covered with floodwater to a depth of 1.5 metres. After the flood waters receded there was practically no damage to the plant life.



**FIGURE 2**

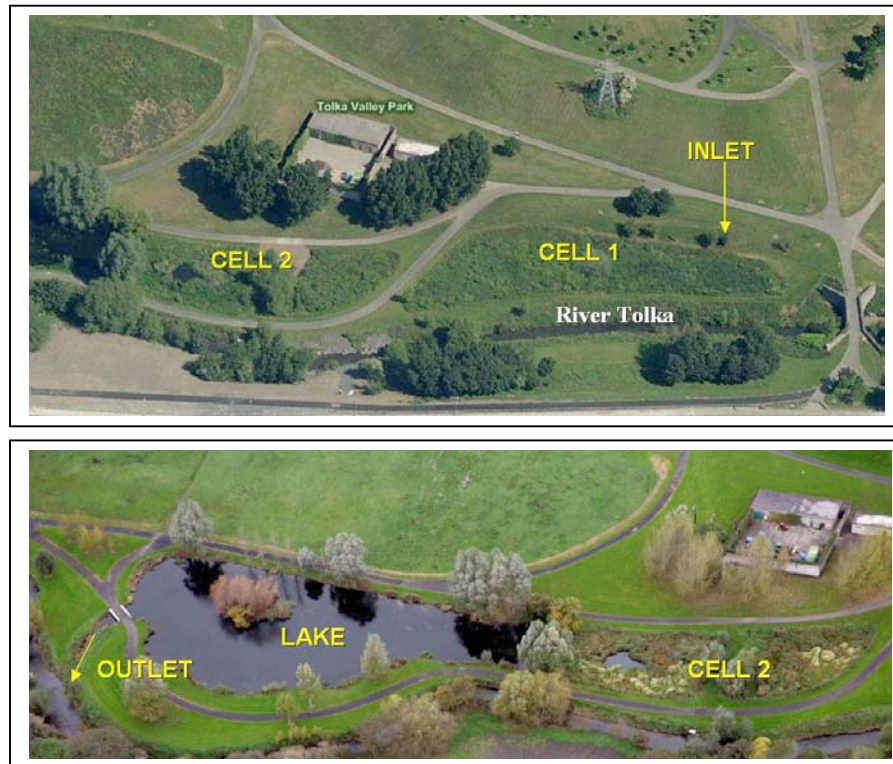
**Littering/Vandalism**

Other considerations at design stage included the need to manage the twin problems of littering/vandalism. This is a persistent problem in all public parks and includes the dumping of white goods, prams, bottles, cans and vehicles. It was decided to provide a walkway around the wetland and monitor the litter situation. As things turned out there has never been a problem with littering.

**Safety**

As the wetland was to be constructed in a public park there was the concern about safety and discussions centred around the installation of fencing or planting a briar barrier. In the end it was decided not to go for either of these options as (a) they could be presented as a challenge for youths who like to climb obstacles and (b) a safety concern for children who might get cut by the briars and thus neither proposal would achieve their objective. Instead a shallow area or shelf of 150mm - 200mm depth of water was installed for the first metre from the perimeter of the pond. It has been found that when wetlands are hydrated there is a reluctance for people to enter them. The wetland is probably the only project in the park that has not been vandalised.

Installation of the wetland began in November 2000 and consisted of the installation of a primary and secondary cell, planting of various plants and the diversion of the Finglaswood Stream into the wetland with major storm events by-passing the wetland. The plants in the wetland needed to be pollution tolerant and able to establish themselves quickly. Planting consisted of a wide variety of plants both native and introduced - known invasive species were avoided. As mentioned earlier one of the major differences between an I.C.W. and the more conventional reed bed is the diversity of plants in the I.C.W. making it much more robust. In the Tolka Valley Park wetland the planting includes the Common Reed (Phragmites), Bullrush (Typha Latifolia), Yellow Iris, Marsh Marigold and various Sedges.



**Aerial Views of Integrated Constructed Wetland & Lake**



**Planted Wetland**



**Marsh Marigold**

The Common Reed or Phragmites Australis spreads by Rhizomes (underground stems) and frequently forms large stands reaching 3 metres in height. They are very successful in spreading

(usually in the shallow areas near the edge of the wetland) and in some quarters are regarded as an invasive species. Historically they have been used for thatching and basket weaving. The Bullrush or Typha Latifolia is a well known wetland plant and excellent at removing Phosphorus. They tend to grow best in the deepest waters of a wetland and can reach heights of 2 metres with their familiar fur like tops. They and the Yellow Iris have become the dominant plants in the wetland. The Yellow Iris or Yellow Flag can establish themselves very quickly. They can grow to a height of 1 metre and can absorb large amounts of nitrogen and their roots give off anti-pathogenic-bacterial exudes which will help destroy coliforms. They are also deemed by some to be an invasive species.

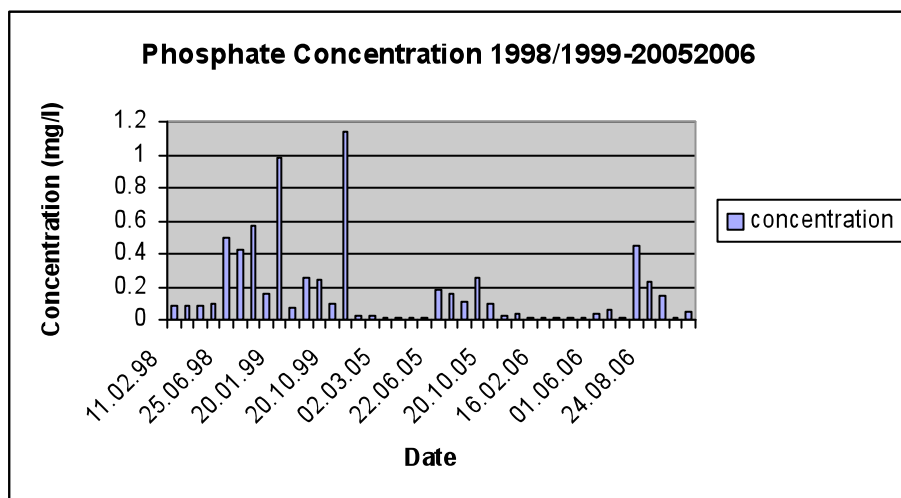
## 5. Performance

An I.C.W. removes pollutants from water by physical, biological and chemical processes. Sedimentation and filtration are responsible for the removal of suspended solids, particulate nitrogen and heavy metals. This happens as the flow is greatly reduced as it proceeds through the wetland. Some pollutants (hydrocarbons) are removed through absorption on to the plant surfaces so the greater the size of the wetland and the denser the planting the better the removal. Biological processes ensure that nutrients are absorbed and microbial activity is responsible for Nitrogen removal by nitrification and denitrification. Faecal coliforms are destroyed because they die off with time due to natural causes. No hydrocarbons have ever been observed in the outfall from the wetland.

Up to now Dublin City Council has not had extensive testing carried out on the wetland but it intends to have this type of testing carried out in 2007/2008. Of particular relevance will be sampling and testing during wet conditions. It will also have a biodiversity report prepared – at this stage the visual results in the pond are very positive and considered acceptable. Spot samples have been taken of the outfall from the pond before and after construction of the wetland and Phosphate and Ammonia reduction are as follows:

Parameter (mg/l)	1999	2005	% Reduction
Phosphate	0.296 (n=6)	0.014 (n=13)	95
Ammonia	1.080 (n=6)	0.503 (n=12)	51

Below is a graph showing the phosphate levels in the outlet from the pond for the period 1998 to 1999 before the wetland was installed and the period 2005 to 2006 after it was installed.



Suspended Solids levels in the discharge as would be expected are now all less than 10 mg/l. Coliform levels in the outfall tend to fluctuate but it is felt that this is as a result of the success of the pond in attracting a large bird population which introduce coliforms to the pond.

Some issues have become apparent with time. The three outlets from cell 1 to cell 2 need to be redesigned as they are prone to blocking with vegetation and the result is non uniform flow. The pipework has also blocked at the diversion with the result that at one stage all the flow was going down the diversion and not into the wetland. The wetland did not dry out and this gives support to the theory that there is no or very little exfiltration. The diversion weir is constructed in a manhole so inspection here is a little difficult. As the wetland is in a public park it is not practical (for security reasons) to leave automatic monitoring equipment such as flowmeters and samplers unattended so for the moment sampling can only be manual grab samples.



**Inlet to Wetland from Finglaswood Stream**



**Discharge from Pond to River Tolka**

## **6. Summary**

There are many advantages associated with this wetland and these include

- ❖ Low running costs - no electricity
- ❖ Can accommodate shock loading
- ❖ Non intrusive appearance
- ❖ No noise due to pumps
- ❖ Cheap installation
- ❖ Attracts birdlife
- ❖ Feature restoration
- ❖ Environmentally and ecologically sustainable

The Tolka Valley wetland has been a complete success and with the enormous improvement in water quality in the pond it now supports a large bird population (mallards, water hens, coots and swans – even a kingfisher), insect life (dragon flies), and diverse plant life. Families now visit what has become a feature that the City Council is proud of. One of the most important features of a public park is obviously to have families enjoying its facilities and families are now regularly seen enjoying the environs of the pond. Staff from other Local Authorities in Ireland and other interested bodies visit the wetland on a regular basis and all are impressed with its efficiency and appearance. None of the dumping of rubbish or littering of the area has occurred. We are not sure why this is but we are delighted none the less with this very positive outcome. There is a slight odour at the inlet to the wetland but this dissipates very quickly downstream of the inlet There is almost no on-going maintenance in the wetland and the expected life of the system is 20 years before desludging has to occur. The capital cost of such a project (some €30,000) is insignificant compared to hard

engineering solutions and after construction there has been almost no maintenance. There are no pumps associated with it as the feed is by gravity and it operates all day everyday for free without the need for electricity. Because it is a wetland there is no noise associated with the scheme. Dublin City Council is now engaged in the design of 5 other wetlands around the city.

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