8 HYDROLOGY AND HYDROMORPHOLOGY

8.1 Introduction

This chapter of the EIAR presents the hydrological and hydromorphological assessment of the proposed River Poddle Flood Alleviation Scheme. The existing hydrological environment within the study area is described and the impacts of the proposed scheme on the water environment are addressed in this chapter. Impacts relating to the construction and operational phases of the proposed scheme are assessed and mitigation measures proposed to reduce significant environmental impacts on the receiving environment. Finally, residual impacts are identified. The waterbodies within the study area are shown in **Figure 8-1.** Readers are also referred to **Chapter 7 Biodiversity** in relation to interactions with the water environment.

8.2 Statement of Authority

This chapter has been prepared by Barry Dunphy from Nicholas O'Dwyer Ltd. Barry holds a Bachelor's Degree in Civil Engineering and a Master's Degree in Engineering Water, Wastewater and Hydrology with over 20 years' experience in the flood relief and water supply industry in Ireland and internationally. Barry is the consultant Project Manager for the Poddle Flood Alleviation Scheme.

8.3 The Proposed Development

A detailed description of the proposed works is contained in **EIAR Chapter 5**. **The Proposed Development** In summary, the proposed River Poddle Flood Alleviation Scheme will consist of:

- **Raised earthen flood embankments** along the upper reach of the River in Tymon North and Tymon Park to provide flood protection. The embankment at Tymon Lake in Tymon Park will be constructed to provide the main flood storage in the Scheme, and a replacement **flow control structure** at Tymon Lake will control flows downstream in a flood event.

- An **integrated constructed wetland (ICW)** in Tymon Park to improve water quality.

- New, replacement or reinforced **flood walls** to provide flood protection in residential areas in the middle reach of the River at Whitehall, Kimmage; at Wainsfort Manor Crescent, Terenure; to the rear of properties on Fortfield Road south of Kimmage Crossroads, Kimmage; at the end of St. Martin's Drive in Kimmage; and at Mount Argus Close in Harold's Cross.

- **Channel realignment and regrading** in Whitehall Park to provide clearance between the river and adjacent properties for flood protection.

- **Ancillary works and associated development** includes drainage channel clearance and removal of trees where required for the works; rehabilitating or installing culvert screens in locations as required; installing flap valves in all culverts draining to the River; rehabilitating or replacing manholes; biodiversity enhancements including installation of floating nesting platforms in Tymon Lake,

Tymon Park, Tallaght; and landscape mitigation and restoration at Tymon Park, Tallaght, Whitehall Park, Terenure, and Ravensdale Park and St. Martin's Drive, Kimmage including public realm improvements, replacement footbridges, biodiversity enhancements and tree planting and landscaping.

- **Temporary works** include establishing a main construction compound in Tymon Park with access off Limekiln Road, Tallaght which will be in operation for the entire duration of the works; and temporary works / set down areas at Wainsfort Manor Crescent, Terenure and Ravensdale Park and St. Martin's Drive, Kimmage which will be in use for the duration of the works to be carried out in these locations. Other temporary works include stockpiling of excavated earth in designated areas of Tymon Park, Tallaght; temporary channel crossings at Tymon North and Tymon Park, Tallaght; and channel diversions at Tymon Park, Tallaght and Whitehall Park, Terenure to enable the works along the River channel to be carried out.

The proposed works which have the potential to impact on the hydrology and hydro morphology of the River Poddle consist of:

- Site preparation works including contractor's compound the construction of temporary roads, and the ICW in Tymon Park;
- Temporary river crossings at Tymon North and Tymon Park;
- The construction of earthen flood storage embankments in Tymon Park;
- The construction of a flow control structure on the River Poddle at the outlet of the Tymon Lake;
- Channel re-alignment and reprofiling at Whitehall Park; and
- The construction of flood defence walls along the banks of the River Poddle at Ravensdale Park and at St. Martin's Drive.

8.4 The Existing Environment

The extensive modification of the River Poddle in the past has significantly reduced its ecological value. It is understood that the River has no populations of salmonids and the culvert in the lower section of the River is likely to be impassable to any migratory species (*e.g*. Atlantic salmon or sea trout).

The study area where works are to be carried out within the Poddle catchment area and particular in proximity to the River itself are:

- Tymon North embankment works adjacent to the River channel;
- Tymon Park embankment, flow control structure and footpath grading works adjacent to existing Tymon Lakes;
- Tymon Park ICW works in and adjacent to the River channel;
- Whitehall Park river channel re-alignment works;

- Wainsfort Crescent defence wall works along River channel;
- Fortfield Road defence wall at rear of gardens along River channel;
- Ravensdale Park defence wall and pedestrian bridge along River channel;
- St. Martin's drive defence wall along River channel;
- Mount Argus defence wall along River channel.

8.4.1 Catchment Extent

The River Poddle is a highly urbanised catchment. The majority of the flows into the River Poddle originate from the surface water network.

The River extends from the Cookstown area north of Tallaght to the north east where it joins with the River Liffey between Grattan Bridge and the Millennium Bridge and has a catchment area of 16.4km^2. The Poddle is an ungauged catchment so no historic flow data or rating curves are available. Following the flood events of October 2011, level alarms and CCTV were installed at the Lakelands overflow weir, at the Wainsfort Manor culvert, and at Gandon Close. These are used to notify SDCC/DCC drainage maintenance when water levels rise to a certain point which might indicate a blockage of obstruction at the culvert inlet screen. The recorded level data for these culverts provide verification of flows in the River for a given rainfall event which was used in the modelling of the River.

The extent of the catchment is shown in **Figure 8-2** along with details on Hydrological Estimation Points (HEP) which are provided in **Table 8-1.** The River Poddle lies within the Liffey and Dublin Bay WFD Catchment (Catchment ID: 09), Hydrometric Area (HA: 09).

A thorough review of the latest available drainage network maps confirmed that there has not been a significant change to the drainage network since the 2014 CFRAM study. The catchment area does not necessarily follow the topographic catchment due to cross connections *via* the drainage network.

Table 8-1: Sub-catchments in the Study Area

HEP Point	Location	Catchment Area (Ha)	Channel Gradient
09_1029_U	Institute of Technology Tallaght	74.7	1:100
09_1874_2	Tymon Park	247.46	1:100
09_1874_5	Lakelands Overflow	378.54	1:250
09_1874_10	Mount Argus Park	481.09	1:167
09_1874_17	Confluence with the River Liffey	644.79	1:250

8.4.2 Surface Water Quality River Poddle

In December 2000 one of the most significant pieces of water-related EU legislation was introduced, the EU Water Framework Directive 2000/60/EC (WFD) which fully embraces certain key environmental management principles. Firstly, it adopts a holistic approach covering all waters - rivers, lakes, transitional waters/estuaries, coastal waters and groundwater as well as their dependant wetlands. Secondly, it recognises that water systems do not stop at administrative boundaries, such as county boundaries, requiring waters to be managed at a catchment or River Basin District (RBD) level. The WFD is an umbrella directive that incorporates the requirements of some other earlier pieces of European legislation. The targets set in the WFD are ambitious, which envisaged that the majority of water bodies would achieve good status by 2015 (unless classified as heavily modified in which case they should have achieved '*good ecological potential'* by 2015) and deterioration in existing water quality status is not acceptable (*'good ecological status'* in respect of macro-invertebrates is considered to be equivalent to a Q4 or above rating under the Irish water quality monitoring system. Other biological, physio-chemical and hydro-morphological elements also need to be taken into account in fully classifying river water bodies).

Ireland completed the first step in implementing the WFD in December 2003 by formulating the European Commission (Water Policy) Regulations (S.I. No. 722 of 2003) and transposing the WFD into Irish Law.

The EPA monitors the water quality of the River Poddle. River water quality is graded by the EPA from Q1 (seriously polluted) through to Q5 (unpolluted) based on the presence or absence of macro invertebrate communities. The Greater Dublin Strategic Drainage Study (GDSDS) outlined that, although the reference conditions had yet to be established for each water body within the GDSDS area at the time of its publication in 2005, the WFD is likely to require the achievement of both the molybdate-reactive phosphate levels (MRP) and biological Q value targets set out in the Phosphorus Regulations. However, derogations may be given for example where the waterbody has been heavily modified or for reasons such as technical unfeasibility, or disproportionate expense. Within the GDSDS area the River Poddle is likely to fall into this category as it has been heavily culverted and modified.

The EPA compiled a *National Implementation Report* in 2005 to provide information on the implementation of the Water Quality (Dangerous Substances) Regulations, 2001 (S.I. No. 12 of 2001). The report ("Dangerous Substances Regulations National Implementation Report, 2005") found the River Poddle to be Non-Compliant due to the presence of Atrazine. South Dublin County Council reported that the elevated level of Atrazine recorded in the Poddle River was due to a one-off sample and that this may have resulted from its use in domestic gardens or in parks in the area. Dublin City Council also reported slight Atrazine exceedances in the Poddle, as well as the Camac and Dodder Rivers.

The EPA *"Interim Report on the Biological Survey of River Quality: Results of the 2007 Investigations"*[1] found the River Poddle to be moderately polluted at Kimmage (Station No. 0400) and assigned it a rating of Q3. The lack of sensitive macroinvertebrate species and the abundance of tolerant species indicated severe ecological disruption. Excessive siltation and the presence of *Cladophora sp.,* a filamentous algae indicative of enrichment, were noted. Recent excavation works on the bank were also noted.

The report included the channel length surveyed (km) and the estimated channel length for the rivers in hydrometric area no. 9 in four biological quality classes: A - Unpolluted, B - Slightly polluted/eutrophic, C - Moderately polluted and D - Seriously polluted. Two kilometres of the River Poddle was surveyed and designated as Class C (moderately polluted) with a WFD Quality Class of "Poor" (**Figure 8-3**).

8.4.3 Estuarial/Transitional Waters within the study area

As can be seen in **Figure 8-1**, the River Poddle discharges to the Liffey Estuary Lower transitional waters. The Liffey Estuary Lower and the Tolka Estuary transitional waters are classified as "At Risk" of deteriorating or being at less than Good status in the future (**Figure 8-4**). The Transitional Waterbody WFD Status 2010-2015 mapping designated the Liffey Estuary Lower and Tolka Estuary as having "Moderate" quality status.

8.4.4 Catchment Description

The majority of the Poddle catchment is classified as low and very low near surface nitrate susceptibility, with a limited area of moderate and high susceptibility between Ravensdale Park and Mount Argus Park. The majority of the catchment is classified as high near surface phosphate susceptibility. Tymon Park and the reach of the River upstream of the M50 has a low near surface phosphate susceptibility, with a limited area in the vicinity of Wainsfort being classified as moderately susceptible.

The Poddle catchment is highly urbanised and heavily modified channel with no natural tributaries. This is noted in the changes in the River's course over time including the canalisation and culverting of the River as well as the introduction of in line lakes at Tymon North and in Tymon Park. Notable modifications to the River include:

- Lakes at Tymon North
- Lakes at Tymon Park
- Diversion of flows from Balrothery weir (Dodder) to Poddle just upstream of Lakelands weir – now removed

[1] (https://www.epa.ie/pubs/reports/water/rivers/Interim%20Report_2007_web.pdf)

- Penstock (broken) and overflow weir at Lakelands to divert flows to Terenure College Lakes
- Culvert and screen from exit of Wainsfort Manor to rear of Fortfield Avenue where River used to run *via* Kimmage Lodge and St Anne's flour mills
- Canalisation of River through Ravensdale Park – existing course ran to east of Park *via* Ravensdale Mills with a weir and canal running to a Mill pond before re-joining the main River at Poddle Park (current course)
- Culverted channel at Larkfield Mills – now SuperValu Sundrive to Stone Boat weir
- Culverting of River from Gandon Close, Harold's Cross to run under ground as far as the Grand Canal
- Grand Canal siphon and overflow into Grand Canal Sewer
- Poddle course continues underground from the Canal (except at White Swan Business Park) to outfall at Wellington Quay

8.4.5 Hydromorphology of the River Poddle

This section provides an overview of the existing hydromorphological condition of the River Poddle along with the impacts associated with the construction of the proposed Flood Alleviation Scheme.

Hydromorphology can be described as the hydraulic interaction between channel form and channel flows to define physical habitat. This also demonstrates the important link between hydromorphological forms and processes, and ecological condition and habitat. A hydromorphological response to a physical modification within a watercourse needs to be understood to determine not only the impacts on hydromorphological condition but also the impacts to habitats at a local scale. Please refer to **EIAR Chapter 7 Biodiversity** for information regarding the impacts of the proposal on habitats and species and proposed mitigation.

The WFD defines the flow, shape and physical characteristics of a watercourse as its hydromorphology. Any in-channel works can impact upon the shape of a watercourse and the natural processes that occur within it, including:

- flow patterns
- width and depth of a channel
- features such as pools, riffles, bars and bank slopes
- sediment availability/transport
- interaction between a channel and its floodplain
- ecology and biology (*i.e*. habitats which support plants and animals)

The River was part of the original settlement of Dublin city in the 9th century, forming the Dubh Linn (dark lake) after which it is named. However, as the City expanded the River

was extensively modified, including culverting under roads and residential areas, and realignment along property boundaries. The most significant change was the enclosure of the lower section of the River under Dublin City centre, comprising approximately 2 to 2.5km of culvert between Harold's Cross and Wellington Quay. Five other sections of the River have been culverted under residential developments, each between 100 and 500m length. The most extensive re-alignments are at the source of the River in Tallaght, where it has been aligned along boundaries in an industrial estate, and in Tymon Park, where it has been widened to form a series of ponds. The Poddle is significantly modified compared to natural conditions associated with a river of this type as a result of urbanisation leading to disconnection of the floodplain, channel realignment, and in-channel structures impacting sediment transport and channel widening/narrowing.

8.5 Methodology

This chapter presents the findings of a desktop study of available hydrological and water quality data from published sources from the EPA and OPW. It discusses the surveys, modelling and analysis carried out by NOD and specialist subconsultants Black & Veatch to design the Flood Alleviation Scheme. The analysis carried out incorporates river flow and level data, water quality sampling results, flood study reports, topographical site and riverbed survey information, along with geological and Ordnance Survey mapping.

8.5.1 Modelling the catchment

During the Eastern CFRAM Study in 2011 a Hydrology Report and Hydraulic Modelling Report were prepared. The hydraulic model for the River Poddle catchment was developed using InfoWorks ICM software which modelled the existing river channel (river cross sections, hydraulic structures and culverted sections) from Cookstown to the outfall to the River Liffey and included the contributing surface water network drainage.

The Hydrology Report for the River Poddle Scheme was compiled by Black & Veatch in 2019. This report contains a review of the previous hydrology assessment undertaken as part of the CFRAM study and provides recommendations for the proposed hydrology methodology to be used for the current River Poddle Flood Alleviation Scheme. This information was used to update and develop the hydraulic model to assess the extent of flood risk for the existing catchment and to determine the proposed flood alleviation measures to be adopted as part of the Scheme.

The hydrological study includes the analysis of existing hydrometric and meteorological data available throughout the catchment. This analysis determined the recent extreme events which could influence hydrological parameters used in previous studies.

Following the completion of the Hydrology Report a detailed assessment and update of the hydraulic model for the River Poddle was carried out by Black & Veatch using the updated hydrological information together with:

- a review of the River Poddle Catchment extents
- a review of GIS surface water networks for south Dublin and Dublin city areas within the Poddle Catchment to include for any changes to surface water network draining into the Poddle

- review of planning permissions in the catchment pertaining to changes in permeability and drainage into the Poddle as well as any modifications to the channel itself in terms of river crossing, weirs, bridges, culverts *etc*.

- a review of the CFRAM hydraulic model completed in 2014 to determine model stability.

- assessment of level monitors at Lakelands, Wainsfort Manor and Gandon Close and rain gauges within the catchment to verify flows.

- CCTV (closed circuit) survey of Lakelands overflow culvert to Terenure College Lakes, 24" drainage culvert on Priory Road, Kimmage and National Stadium culvert and siphon clean out.

- assessment of flow and rainfall survey data carried out at point locations along the River channel to verify the model.

- inclusion of topographic survey along the extents of the channel to provide updated levels.

- reservoir analysis to determine the storage requirement at Tymon lake, level of embankment works required and the most appropriate method to allow safe spill of the embankment should an event greater than the 1% Annual Exceedance Probability (AEP) or 100 year event occur.

The results of the hydraulic analysis were mapped to show the flood extents and depths for the 2yr, 5yr, 10yr, 20yr, 50yr, 75yr, 100yr, 1000yr flood events for the as well as the 100yr with 20% and 30% increase in peak flows attributable to climate change. **EIAR Volume 3**, contains the flood map outputs for the 100yr or 1% AEP event.

Inclusion of threshold survey levels for properties within the catchment to determine the level of damage for flood events ranging from 50%, 20%,10%, 5%, 2%, and 1% AEP flows as determined in the Hydrology Report. This determined the level of economic damage that would occur within the catchment from fluvial and pluvial flooding for the range of flooding events. These damage levels in monetary terms were then compared to the levels of damage that remained following the completion of the fluvial and pluvial proposed works to demonstrate the economic cost benefit to the flood alleviation scheme.

The design flood event for which the Flood Alleviation Scheme is proposed to protect was agreed by the Project Steering Committee to be the 1% AEP with the additional allowance of 60% blockage at the 12 significant culverts along the River.

8.5.2 Catchment Hydrology

The Poddle catchment is highly urbanised and heavily modified channel with no natural tributaries. This is noted in the changes in the River's course over time including the canalisation and culverting of the River as well as the introduction of in line lakes at Tymon North and in Tymon Park.

The modified urban nature of the watercourse means that standard methods for calculating the design flows such as Flood Studies Update (FSU) or Institute of Hydrology Report No. 124 (IH124) are not appropriate. From the FSU Web Portal, the catchment of the River

Poddle has an Urban Extent (URBEXT) factor of 0.8942, which accounts for high levels of urbanisation with very little rural contribution to the flow in the River.

As with other heavily urbanised watercourses, inflows to the River Poddle originate mainly from the surface water drainage network, although the base flow would be from groundwater. Therefore, the most suitable method for calculating flows in the system is an integrated modelling approach. This approach applies a rainfall hydrograph profile to a catchment with user defined permeability characteristics (*e.g*. percentage grassed, paved, roofed, *etc*.) to generate a flow in the surface water network which feeds the main watercourse.

Rainfall hydrograph profile

The initial step for generating the rainfall hydrograph profile was to use the FSU Work Package 1.2 *'Estimation of Point Rainfall Frequencies'*. This package estimates design rainfall events and their associated Depth, Duration, and Frequency (DDF). The output of the package is 2km x 2km gridded rainfall data for a range of return periods (or AEPs) and storm durations. The gridded rainfall is then converted to a rainfall hydrograph profile using storm profiles developed through the Flood Studies Report (FSR) and subsequent Flood Studies Supplementary Report No. 16.

The profiles selected for consideration were the 50% summer and the 75% winter profiles. During the model runs undertaken in this study it was found that the 50% summer profile provided the more extreme flood flow conditions within the River Poddle. As such the 50% summer profile was used for all design rainfall AEP events and rainfall depths were calculated for a range of durations from 15 minutes to 25 days and for AEPs from 50% to 0.1%.

Storm durations

In addition, a range of durations was analysed to determine the critical storm duration at various reaches along the catchment. For the upstream area around Tymon Park the critical duration was between 1 and 2 hours, while downstream of Tymon the critical duration was found to be 9 hours. This is unusually long for an urban catchment but can be explained due to the upstream attenuation at Tymon Park. Moving further downstream to the area around Mount Argus Park, the critical duration reduces again to approximately 2 hours. The worst-case critical duration was investigated to ensure that the worst-case storms are used in assessing flood risk at various locations along the watercourse with critical durations varying from 2 to 9 hours.

Historic flood events

Prior to the CFRAM study there were a number of historic events which caused flooding on the River Poddle. These are discussed in more detail in the following sections. The return period for these events was derived using the FSU web portal data.

Since the CFRAM was published there has been no reported flooding from the River Poddle. The 2011 flood event has been simulated using the hydraulic model to confirm that this recent event has been represented accurately.

24-25/10/2011 event

Up to 90mm of rain (as recorded by the Casement rain gauge) was reported to have fallen within a 6 hour period on the evening of 24th October, 2011. This resulted in major flooding

along the River Poddle. It was reported that the rainfall depth exceeded the 2% AEP (1 in 50 year event) at a number of rain gauging locations throughout Dublin and in some locations the 1% AEP (1 in 100 year event) was exceeded.

Post flood surveys were carried out to record flood extents and flood levels wherever possible. The resulting level information, photographs and anecdotal evidence were used to calibrate the hydraulic model.

05/09/2008 event

There was 47.88mm of rainfall recorded at Casement rain gauge and 57.9mm recorded in the Kimmage area over an 11 hour period which is approximately a 20% AEP (1 in 5 year event).

06/11/2000 event

The Poddle overflowed its banks in the Kimmage area when 103mm of rain fell over a 48-hour period in the Dublin area with estimated return periods of 4% to 3% AEP (1 in 25-33-year event).

11/06/1993 event

The Poddle River was reported to have overtopped its banks. Rainfall depth reported to be in the order of 1% to 0.4% AEP (1 in 100 - 250 year event). This was a long duration event in excess of 24 hours and the flooding was relatively minor.

25/08/1986 event

Hurricane Charlie caused significant flooding throughout Dublin. Along the River Poddle, a total of 80 households and 5 commercial properties were seriously affected by the flooding. Affected area stretched from Kimmage Cross Roads to the Grand Canal. No specific data on flood extents or locations was available for model verification.

Hydrological Estimation Points

Five Hydrological Estimation Points (HEP), similar to those used for the CFRAM Report were chosen to calculate intermediate flow value along the River Poddle as part of the hydrological study for the Poddle FAS. These locations are shown on **Figure 8-2** indicated by the red, yellow and green dots.

There are no tributaries along the River Poddle. Itwas decided during the preparation of Hydrology Report for this Scheme to match the four HEP used in the CFRAM study so that they can also be used to compare output with previous studies. The locations are as follows:

1. at the upstream end of the open watercourse close to the Institute of Technology Tallaght
2. at Lakelands Overflow Sluice
3. at the upstream end of Mount Argus Park
4. at the confluence with the River Liffey

A fifth point was selected for this project at Tymon Park as it is critical for the proposed online storage option.

8.5.3 Estimation and Validation of Design Flood Parameters

Design flood flows were calculated as part of the previous CFRAM study by using the FSU methodology and were compared to the flows generated by the CFRAM ICM model. Design flood flows for the Hydraulics Report for this study were then generated by the hydraulic simulations from the updated ICM model for the purposes of the development of the Flood Alleviation Scheme.

The FSU web portal (specifically 'Work Package 1.2, Flood Studies Update, Estimation of Point Rainfall Frequencies') was utilised to estimate the return periods for the storm events listed in **Section 8.5.2** using the rainfall data record available at these gauges. The Poddle catchment according to the FSU web portal can be seen in **Figure 8-5**.

The design flows were compared for the 10%, 1% and 0.1% AEP. **Table 8-2** below shows the comparison of the flows calculated with FSU, in the original CFRAM study and using the updated flood alleviation scheme (FAS) ICM model.

Table 8-2: Comparison of FSU flows to ICM model flows (CFRAM and FAS current study)

HEP	10% AEP			1%AEP			0.1% AEP		
	FSU	CFRAM	FAS	FSU	CFRAM	FAS	FSU	CFRAM	FAS
09_1029_U Inst. of Techn. Tallaght	0.68	2.0	1.12	1.25	3.0	2.09	2.23	3.8	2.98
09_1874_5 Lakelands Overflow	3.36	4.1	2.16	6.21	6.3	6.57	11.06	8.4	10.49
09_1874_10 Mount Argus Park	5.47	2.3	1.49	10.10	2.8	5.00	18.01	5.2	5.93
09_1874_17 Confluence with the River Liffey	8.10	4.2	1.19	14.98	5.0	2.05	26.71	6.2	3.55

8.5.4 Assessment of Potential Future Scenarios

Review / Validation of Design Storms

The hydrological analysis was applied in the hydraulic model to determine the critical storm durations for each area of the catchment, allowing the worst-case scenario to be designed for. Data provided in the model included rainfall depths for a range of events from the 50% AEP to the 0.1% AEP inclusive for the 9-hour duration event only.

As the catchment is highly urbanised the critical storm duration would be expected to be short. However, from the results from the modelling that was carried out for the Flood Alleviation Scheme this did not appear to be the case. The likely reason for this is the

existing attenuation which occurs at Tymon Park and other storage areas which are close to the upstream end of the watercourse.

From the analysis undertaken the critical duration for the upstream catchment as far as Castletymon Road Bridge is 2 hours, this then increases to 3 hours across Tymon Park and then becomes 9 hours from Tymon Park to the downstream boundary. The reason for this increase in the critical duration is due to the attenuation at Tymon Park which slows the flows down within the model and means that the peak response from the impermeable areas is similar to the response from permeable areas. The respective critical durations along the particular reaches of the River Poddle are illustrated in **Figure 8-6**.

Summer storms were more critical and gave the highest peak water levels along the entire length of the watercourse. This is to be expected given the urban nature of the catchment which is at greater risk of flooding from a flashier higher peaked rainfall in the summer than flatter longer duration winter rainfalls.

All design storms were simulated for the three critical durations (2, 3 and 9 hours) and with the summer profile. Generated flood extents map the worst-case scenario with the outputs of three rainfall durations combined together.

Climate Change Scenarios

When determining design flood levels for the defences, due consideration must be given to the long term affects attributable to climate change. The effects of future climate change have been assessed based on guidelines issued by the OPW. These guidelines recommended that two future scenarios should be assessed as follows:

Mid-range future scenario (MRFS) whereby;

- Rainfall depths +20%
- Flood flow +20%
- Sea level +0.5m
- Decrease in time to peak by 1/3 (Tp) due to afforestation [sic] future scenario allowances for the effects of forestation are not applicable due to the urban nature of the catchment

High end future scenario (HEFS) whereby:

- Rainfall depths +30%
- Flood flow +30%
- Sea level +1.0m
- Decrease in time to peak (Tp) by 1/3 and add 10% to Standard Percentage Runoff (SPR) rate due to afforestation [sic] future scenario allowances for the effects of forestation are not applicable due to the urban nature of the catchment

8.6 Potential Impacts During Construction

The impacts of the proposed scheme in the absence of mitigation measures on the water environment within the Study Area as described in **Section 8.2** are described in the following sections.

8.6.1 Site Preparation Works for the Access Tracks and Contractor's Compound at Tymon Park

Site preparation works for the access tracks and contractor's compound at Tymon Park will include the stripping of topsoil and the placement of mobile offices and toilets. The contractor's compound at Ravensdale will be a setting down area and will not require excavation of topsoil to establish it. The contractor will agree the location of the compounds with South Dublin County Council and Dublin City Council prior to the commencement of works in the respective areas.

The stripping of topsoil to create the base for the access tracks and the contractor's compound has the potential for silt laden runoff to enter the River during heavy rainfall events, with the potential for moderate short term for negative impacts on water quality and species that inhabit the River.

The spillage of diesel, hydraulic oil or lubricants from the contractor's compound to the watercourse may have a significant medium-term negative impact on the water quality and species that inhabit the River. Any spillage of diesel/hydraulic oil may also have a significant medium-term impact on groundwater in the area. The Outline CEMP details the construction methodology for the elements of the Scheme including prevention and control of spillages and pollution of water courses.

8.6.2 Site Preparation Works for the Tymon North Embankments, Tymon Park Flood Storage Embankment, Flow Control Structure and ICW

The construction of the flood storage embankments in Tymon Park will require the removal of the topsoil and excavating to subsoil in the footprint of the embankments on both sides of the River and at the Lake. Excavation to bed level of the River is required for the development of the ICW which is estimated at approximately 5,000 m^3.

Excavated material will be held on-site temporarily at designated locations and screened for use in the construction of the embankments. It is estimated that 50% of this material will be required for the embankments and landscaping and the remainder will be taken off site for disposal at a licensed facility. Any material that is imported for construction of the embankments will need to be screened to test its suitability before being brought to the site. All earth material for the embankments will be brought on to the site will be for immediate use.

The excavation of the soil and the removal of the subsoil to create the embankments and ICW has the potential to increase the vulnerability of groundwater to pollutants. In the event of any spillages of diesel or rupturing of the hydraulic pipes on the excavators this may cause a significant medium-term negative impact on groundwater because of the immiscible nature of the material.

Silt laden runoff from the temporary stockpiles may have the potential to discharge to the River resulting in a moderate negative short-term impact on water quality and species. The presence of suspended soils in the runoff has the potential to settle out in the riverbed depending on their size and the velocity of flow in the River.

There is potential for pollutants to enter the stream during construction of the wing walls and the flow control structure. The temporary crossing at Tymon North and the temporary crossing and channel diversion of the River around the site of the wing walls in Tymon Park may potentially have a moderate short-term negative impact on water quality in the River. The release of the sediments into the water column will have a potential significant

negative impact on water quality. Re-suspension of nutrients and trace heavy metals may cause an additional impact. In addition, the diversion of the River may have a significant negative impact on fish that live in the River but if correctly designed should not affect the movement of fish. The reduction in the overburden over the bedrock will leave the groundwater more susceptible to pollutants.

The excavation of the foundations for the wing walls is another potential source of pollutants to the water and groundwater in the area. Diesel/hydraulic oil from the bucket of the excavator are significant sources of pollutants to the River and groundwater. Any spillage of diesel or hydraulic oil to the River would cause a significant medium-term negative impact on water quality with the possibility of fish kills particularly during the summer months when river levels are low. Any spillage of diesel or hydraulic oil to the River would cause a significant medium-term negative impact on groundwater quality.

The pumping of concrete into the formwork is a potential pollutant. The spillage of uncured concrete into a water body will cause a rise in the pH of the water (an increase in hydroxyl ions). This would cause a moderate short-term negative impact on water quality. A concrete spill would also increase the suspended solids levels in the River which would have a significant negative impact on fish and macroinvertebrates.

8.6.3 Construction of Channel Re-alignment at Whitehall Park

Construction of the channel re-alignment at Whitehall Park will entail topsoil stripping and excavation to create a new channel course for the River, excavation of new riverbank and side slopes on the right bank side and build-up of riverbank for flood protection on the left bank side. The existing river channel at this location will be filled in. Excavated material will be screened for use in the construction of the embankments and grading of the slopes and infilling the existing river channel course but remainder will be taken off site for disposal at an agreed licensed area.

The excavation of the soil and the removal of the subsoil to create the new channel and embankments has the potential to increase the vulnerability of groundwater to pollutants. In the event of any spillages of diesel or rupturing of the hydraulic pipes on the excavators this may cause a significant medium-term negative impact on groundwater because of the immiscible nature of the material.

There is potential for pollutants to enter the stream during construction of the defence walls at the approach to Lakelands overflow.

The excavation of the foundations for the walls is another potential source of pollutants to the water and groundwater in the area. Diesel/hydraulic oil from the bucket of the excavator are significant potential sources of pollutants to the river and groundwater. Any spillage of diesel or hydraulic oil to the river would cause a significant medium-term negative impact on water quality with the possibility of fish kills particularly during the summer months when river levels are low. Any spillage of diesel or hydraulic oil to the river would cause a significant medium-term negative impact on groundwater quality.

The pumping of concrete into the formwork is a potential pollutant. The spillage of uncured concrete into a water body will cause a rise in the pH of the water (an increase in hydroxyl ions). This would cause a moderate short-term negative impact on water quality. A concrete spill would also increase the suspended solids levels in the river which would have a significant negative impact on fish and macroinvertebrates.

8.6.4 Construction of Fluvial Defence Walls Along the Banks of the River Poddle

Construction of new or replacement flood walls has the potential to cause significant impacts on water quality. The flood wall construction will include the excavation for foundations. It will involve placing a cofferdam around the area for excavation, removing the material to the required depth, and, unless precast units are used, formwork and pumping of concrete/grouting into the footings. The formwork will be put in place, and reinforced steel and concrete/grouting will be pumped into the formwork. The construction of these walls has the potential to have a moderate short-term negative impact on water quality in the River Poddle.

A number of operations in this process have the potential to pollute the surrounding water. The pollutants range from oil on the excavator, to diesel and lubricants on the formwork. These pollutants would have a significant short-term negative impact on the water quality in the River. The release of suspended solids and silt into the River would have a moderate short-term negative impact on aquatic species in the River. This impact would be exacerbated in summer when river flows are expected to be lower.

8.6.5 Impact of Scheme on Hydromorphology of the River Poddle

A baseline geomorphological survey was carried out as part of the design process. The information gathered was used to assess the impact of the proposed scheme on the geomorphological processes within the catchment. The key aspects considered in the assessment are the likely impact of the Scheme on the erosion and deposition of sediment in the catchment and how the functioning of the Scheme may be adversely impacted by it. It is noted that as the works are being constructed in urban areas, it is considered that the impact of the Scheme on the overall catchment geomorphology, or any high-quality physical river habitat, will be limited.

The key consideration of the Scheme is that it should not alter the morphological typology (*i.e*. the 'type of river morphology') of the River Poddle.

8.7 Potential Impacts of the Proposed Scheme during Operation

8.7.1 Impacts of the Operation of the Tymon Park Embankments and Flow Control on Water Quality

The short-term storage of the flood water in the reservoir will cause it to accumulate nutrients (nitrogen and phosphorus) from the soil. The flood water will also accumulate suspended solids and silt from the land. This will have the effect of increasing the loading of these chemicals and pollutants to the River. After a flood event the River water will be naturally turbid and will contain suspend solids and silt from the surrounding land in the catchment. However, the discharge from the storage reservoir will extend that loading and will add additional suspended solids and silts to the River. This will have a moderate short-term negative impact on the water quality in the River.

The maximum discharge rate through the flow control structure will be 748 l/s during events greater than the 50% AEP up to the 1% AEP. The outflow from the lake through the flow control structure has the potential to impact locally on bed and bank erosion. The potential scouring could result in the re-suspension of sediments and silts into the water that will be carried downstream. The rate of deposition of this material will be dependent upon its size and the velocity in the River, but it is expected that the majority of the material will settle out within the riverine system. It will have a localised moderate

negative impact on the water quality in the River. However, the design of the flow control structure will be such as to minimise any hydraulic transience and bed and bank stabilisation will be utilised if appropriate to prevent scouring. The ICW is located downstream of the flow control structure and will provide an improvement in water quality in the river as it exits Tymon Park.

8.7.2 Impacts of the Operation of the ICW on Water Quality

The ICW concept is tailored towards the treatment of a wide range of common parameters, particularly nutrients (Ammonia-N, Phosphorus, Nitrate, *etc*.) as well as additional parameters such as Suspended Solids, Biochemical Oxygen Demand and a variety of metals. The removal mechanisms for these are primarily absorption, adsorption, precipitation, sedimentation and sequestration. The inclusion of the ICW in the proposed Scheme demonstrates a commitment on behalf of SDCC to improve water quality within the River Poddle to work towards achieving 'Good' water quality status under the WFD.

8.7.3 Impacts of the Operation of the Fluvial Defence Walls and Embankments Along the Riverbanks on Water Quality

When construction is complete it is anticipated that the impact of the fluvial defence walls on water quality will be minimal. There may be some localised changes in the flow patterns around or close by to them, but it is anticipated to only be noticeable when the flows are high and the walls are holding water levels. This will be a localised minimal impact. In most cases the walls constructed are replacing existing in-channel walls and embankments are located adjacent to the riverbank so there are minimal effects. As flows increase and when the defences are "*acting"* (*i.e.* containing significant flood events) then the flow patterns will change from the existing scenario as they will be largely contained within the channel rather than flowing out into urban areas. This act of containment would not adversely affect quality as compared with flowing onto paths and roads and returning to the channel.

8.8 Mitigation Measures

The following measures are recommended to mitigate against the potential impacts during the construction and operation phase as outlined in **Section 8.6** and **8.7** above.

In general, all works on the riverbank will be subject to a specific method statement agreed in advance with the statutory authorities. The method statement will incorporate the following points:

- To avoid excessive silt runoff, site clearance is not to be undertaken during wet conditions, when rainfall of more than 0.5 mm/hour is forecast within the next 24 hours.
- To avoid contamination of the River water during an extreme flood event, no works likely to generate soiled water are to be carried out when rainfall of more than 3mm/hour is forecast within the next five days in the River Poddle catchment.
- At the riverbank works locations, eroded sediments are to be retained with silt fences.
- Soil cleared from the site and all materials associated with the building process are to be stored outside the flood zone in designated storage areas.

- Works adjacent to the riverbank will have catch-nets and silt traps to prevent debris from falling into the River.
- Raw or uncured waste concrete is not to be disposed of within 30m of the River.
- Fuels, lubricants and hydraulic fluids for equipment used on the construction site, as well as any solvents and oils *etc.*are to be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment.
- Fuelling and lubrication of equipment is not to be carried out close to the riverbank or lake shore.
- Any spillage of fuels, lubricants of hydraulic oils is to be immediately contained and the contaminated soil removed from the site and properly disposed of.
- Waste oils and hydraulic fluids is to be collected in leak-proof containers and removed from the site for disposal or re-cycling.
- Hydrocarbon/grit interceptors of suitable size are to be placed on the runoff discharge from the car park at the abstraction point and must be maintained by a person or persons designated to carry out this maintenance.

8.8.1 Mitigation Measures during Construction - An Overview

Mitigation measures relate to the protection of the aquatic environment from significant impacts that have been identified during the construction works. In addition to mitigating significant impacts for water quality these mitigation measures will also protect the aquatic species in the river.

Best practice mitigation measures will be employed for this Scheme as contained in the following guidance documents and best practice UK CIRIA guidance which includes but not limited to the following:

- C532 Control of water pollution from construction sites: guidance for consultants and contractors;
- C648 Control of water pollution from linear construction projects;
- SP156 Control of water pollution from construction sites – guide to good practice
- NRA's 'Guidelines for the Crossing of Watercourses during Construction of National Road Schemes (NRA, 2005);
- the Eastern Regional Fisheries Board guidance document 'Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites' (Murphy, 2004); and
- the Southern Regional Fisheries Board guidance document 'Maintenance and protection of the inland fisheries resource during road construction and improvement works' (Kilfeather, 2007).

At the start of the project it is recommended that the main contractor holds a series of toolbox talks with the sub-contractors and supervisors to make them aware of the various environmental commitments made in relation to the scheme. It is recommended that responsible personnel and communication lines are agreed in advance of the work starting. These named responsible people should be documented in an Environmental Operating Plan for the scheme.

It is recommended that measures contained in the scheme specific Construction and Environmental Management Plan (CEMP) are instituted prior to the work commencing. The Plan shall follow the guidelines and headings of the ISO 14001:2006 Environmental Management Systems Standard. The Plan should also incorporate waste management, separation, disposal and documentation for wastes generated on-site, and in the contractor's compound. All contractors working on site should be made aware of the CEMP, its requirements and reporting procedures. A nominated person shall be tasked with maintaining the CEMP, ensuring that training is given to all workers and that all records regarding waste handling and disposal, environmental incidents and emergency procedures are kept in the main site office. It is recommended that an independent audit of the CEMP is carried out before the work commences. Similarly, a review of the CEMP shall be carried out during the construction programme.

For in-river works the following mitigation measures are recommended:

- Measures to minimise the suspension and mobilisation of sediment downstream of the working area should consider silt barriers and cofferdamming to create dry working areas.
- Works should allow the river to recover for at least 14 hours on a daily basis meaning that the period of in river work should be about 10 hours maximum.
- A dry working area should be created for pouring of concrete.
- In areas of the river where there are alien species, all plant and machinery should be thoroughly washed before moving to another section of the River.
- All vehicles should be regularly checked for oil leaks, and ruptured hose pipes.

Control of Suspended Solids

The potential for the release of suspended solids to the River during the construction of the storage embankments will be significantly increased during wet weather. It is recommended that temporary fencing is erected around working areas adjacent to the river to prevent earth-moving equipment from encroaching too close to the River or Lake at Tymon when constructing the walls and embankments.

The risk of erosion will be minimised where possible by planning the construction and construction routes. It is recommended that the topsoil under the footprint of the embankment is removed on a phased basis to help reduce the likelihood of soil erosion at the site. Where the topsoil is stripped and the subsoil removed, a drainage system should be installed to collect water from the excavated/denuded areas. The water should drain to a temporary settlement pond. The overflows for the settlement ponds should be to land rather than the River or the Lake. Sandbags should be used in denuded areas to attenuate runoff and reduce soil erosion. Stockpiles of soil should be situated a distance away for the edge of the river. Sandbags should be placed around the stockpiles to prevent sediment laden runoff to the river.

Only certified soil should be used for the construction of the embankments.

Wash down areas for vehicles and site equipment should be located away from the riparian zone. The wash water should be directed to the settlement pond.

The pouring of the concrete for the wing walls of the flow control structure should be undertaken in dry weather and the concrete should be allowed to cure for 48 hours

minimum. Wash water from the concrete pumps or surplus concrete left in the truck must not be discharged to the river.

Control of Other Pollutants

Best practice methods should be employed at all stages during the construction. Fuel, lubricants, hydraulic oil, repair equipment used on the construction site should be carefully handled to avoid spillage. All tanks, barrels or containers containing hazardous materials (oils, lubricants, sealants *etc.*) must be stored in a sufficiently sized bunded area. Spill kits will be made available in site compound and in site machinery. In the event that a spillage does occur, adsorbent material should be placed on the material to adsorb it. The contaminated adsorbent should be correctly disposed of as a hazardous waste and brought to a licenced waste handing site by a licenced waste contractor. The Site Manager must retain a copy of any waste transport and disposal documentation. In the event of a larger spillage of oil/hydraulic oil then South Dublin County Council and/or Dublin City Council Environment Sections should be contacted immediately. The Emergency Procedures for the site should have a procedure for dealing with large spillages.

All empty diesel/oil/hydraulic oil containers should be drained to a single labelled container. The empty oil containers should be stored in a dedicated labelled totally sealed skip. Waste skips should be collected by a licenced waste carrier and brought to a licenced facility for disposal. All disposal records must be retained at the site offices.

The waste from the chemical toilets should be collected by a licenced waste carrier and brought to a licenced treatment facility.

A supply of oil booms and soak pads must be maintained within the contractor's area.

8.8.2 Timing of In-River Works

As this is a non-salmonid river, there is no seasonal restriction on timing of in-river works, and no requirement for prior approval of in-river works by IFI or NPWS, except that, as described above, it may be preferable to carry out certain works in low flow periods. Best practice measures will be adhered to and any diversions of the river during construction should follow the NRA's 'Guidelines for the Crossing of Watercourses during Construction of National Road Schemes (NRA, 2005).

8.9 Monitoring

A robust programme of maintenance will ensure that culvert screens and channels are kept clear of debris to ensure the Flood Alleviation Scheme functions correctly during a storm event. This includes carrying out repair works on existing walls and instituting a robust maintenance programme to ensure that debris that has accumulated in the channel is removed and vegetation cleared in order to prevent blockages in the future. These measures will be undertaken by each Council (South Dublin County Council and Dublin City Council) as part of a regular maintenance programme. The existing culverts and screens at Wainsfort Manor, Lakelands and Gandon Close have CCTV cameras and level alarms and are currently checked and cleared by the responsible local authority in advance of forecast rainfalls.

In addition to the above maintenance an asset register of the flood defences for the River Poddle will be prepared for SDCC/DCC to be incorporated into the development plans for both authorities to ensure that defences that are erected will not be removed as part of any future development either by a local resident or as part of a planning submission.

The embankment structures will be kept clear of tree planting to maintain structural integrity and the flow control structure and embankment at Tymon Lake will undergo periodic checks by an All Panel Reservoir Engineer to ensure that the structural condition of the embankment is in order and there is no change or obstruction to the operation of the emergency overflow spillway that would inhibit the secure overflow of the embankment for events greater than 1% AEP.

8.9.1 Residual Impacts

The construction of the scheme will require in river works along the length of the River Poddle as well as works adjacent to and within the drainage area of the River. There is a potential for increased silt and suspended solids in the River during the construction work but with strict adherence to the Standard Operating Procedures for working in the River these impacts should be mitigated. In summary, in respect of the water environment, the impacts of the construction and operation of the Scheme will be localised and short term.

There will remain some areas within the catchment that will not directly benefit from the flood defence works and where there will still remain residual flooding. Residual flooding will occur in these areas as a result of localised pluvial flooding where the existing surface water network does not have the capacity to cope with a 1% AEP storm event. The residual flooding does not relate to fluvial flood flows directly from the River Poddle but rather the inability of the local surface water system to effectively drain high intensity rainfall events. This pluvial flooding has been identified particularly at Whitehall (SDCC), Mount Argus Road (DCC) and The Coombe (DCC). The surface water drainage issues identified during the hydraulic modelling in these locations have been discussed with both local authorities and SDCC and DCC have made commitments to develop solutions for these areas. These works are outside the scope of the proposed Scheme.

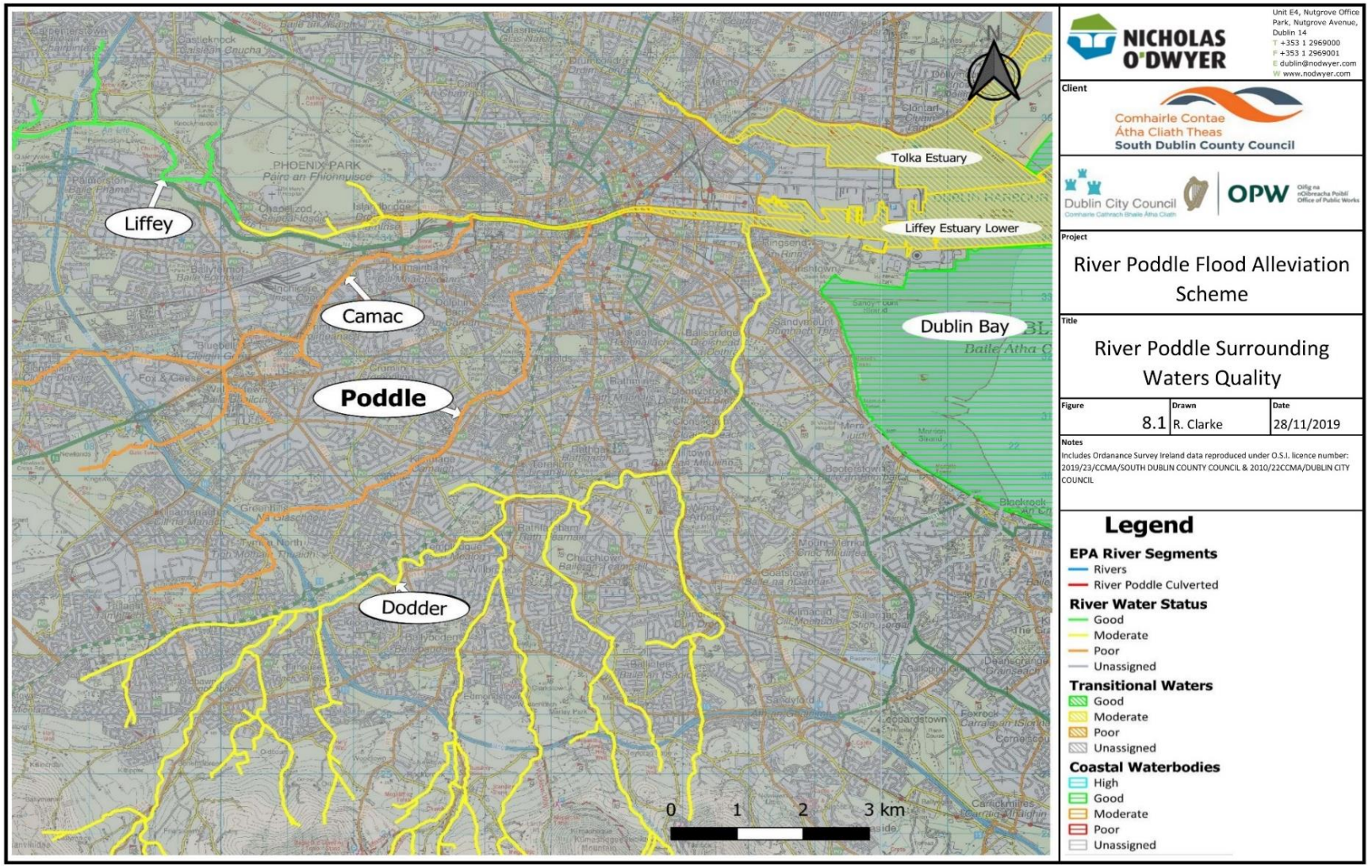
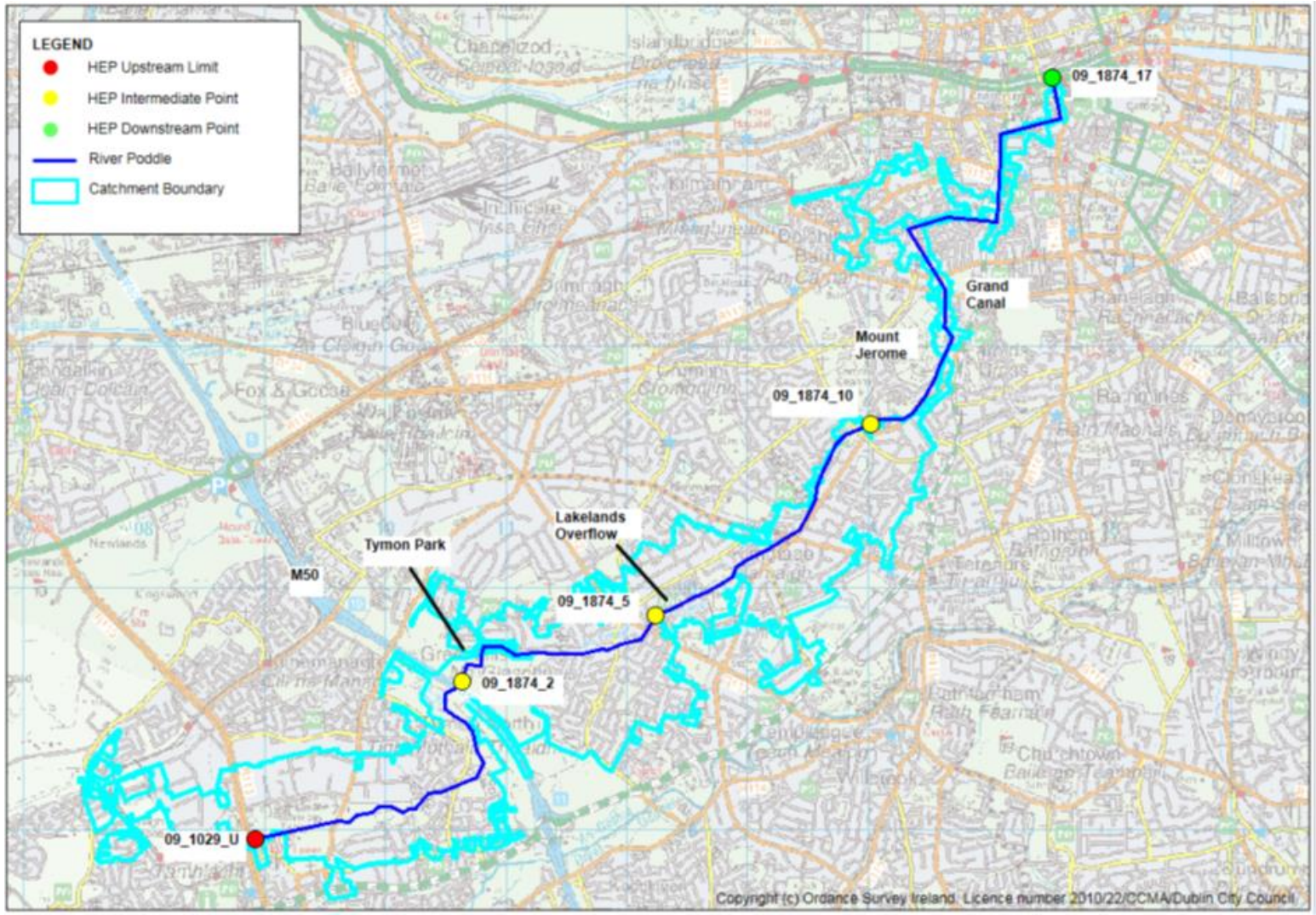


Figure 8-1: River Poddle surrounding waters quality



Source: Black & Veatch, Final Hydrology Report, 22 January 2019

Figure 8-2: Hydrological Estimation Points

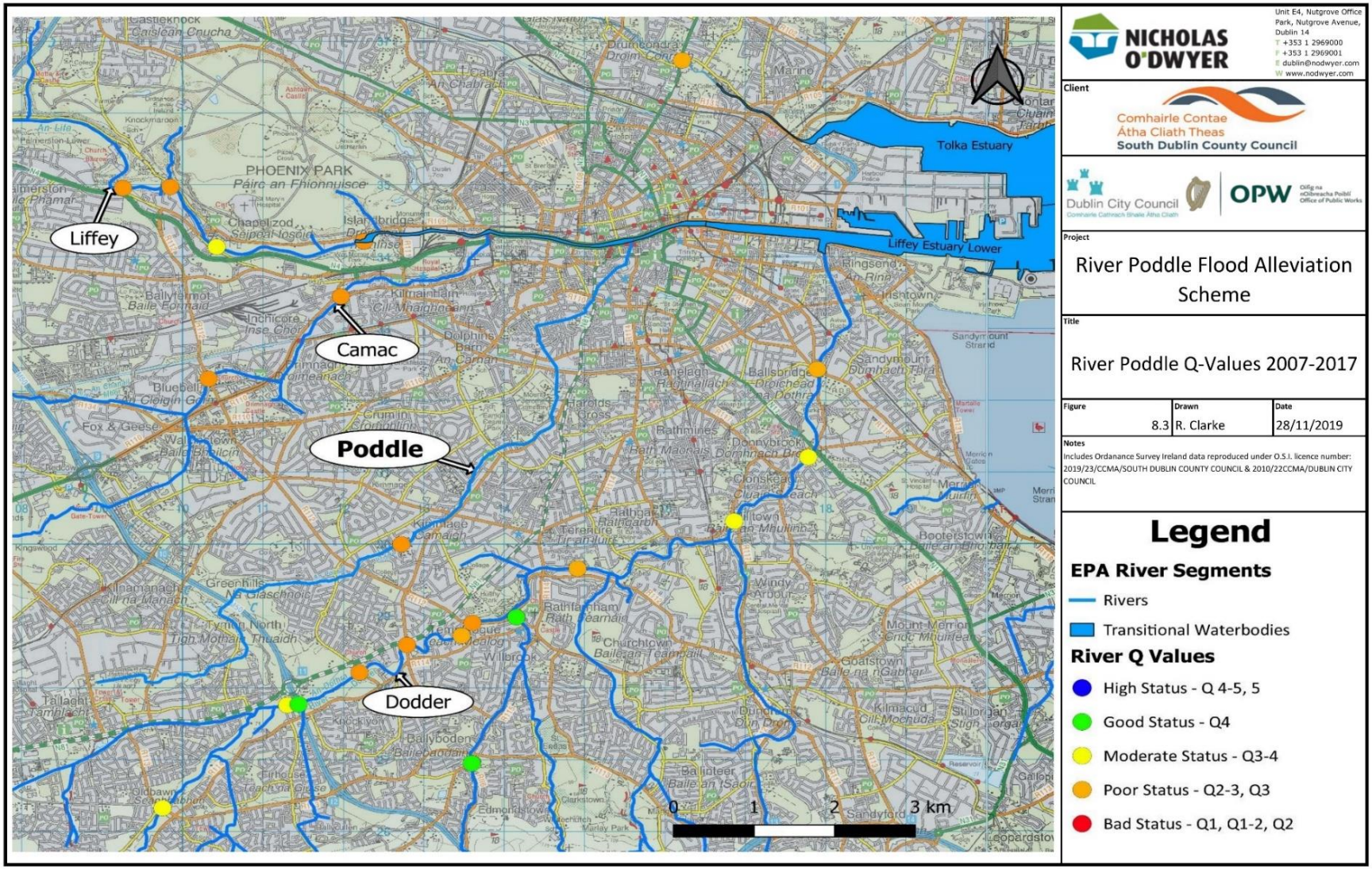


Figure 8-3: Q-Values of the River Poddle and other surrounding rivers 2007-2017.

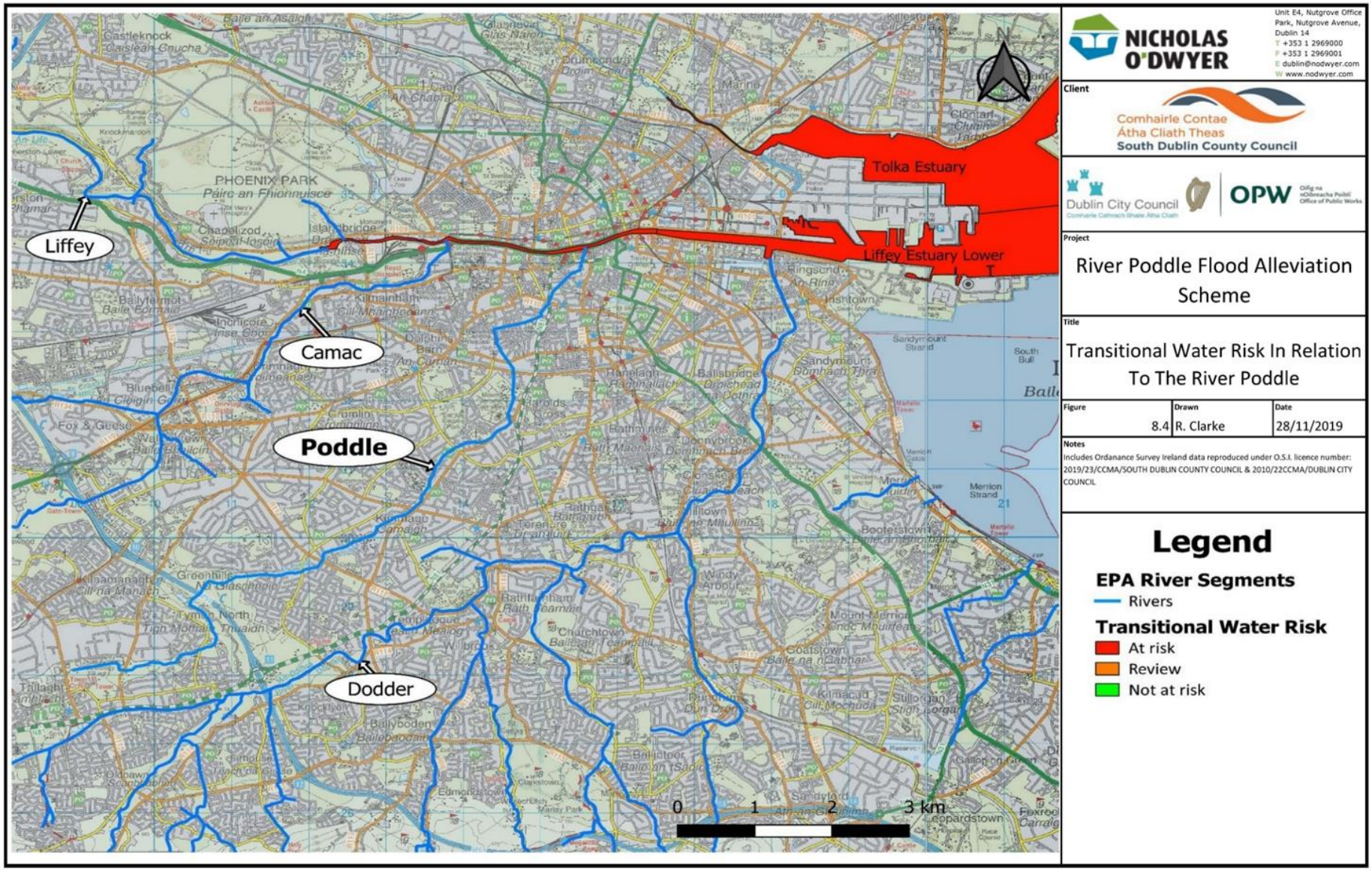


Figure 8-4: Transitional water risk in relation to the River Poddle.

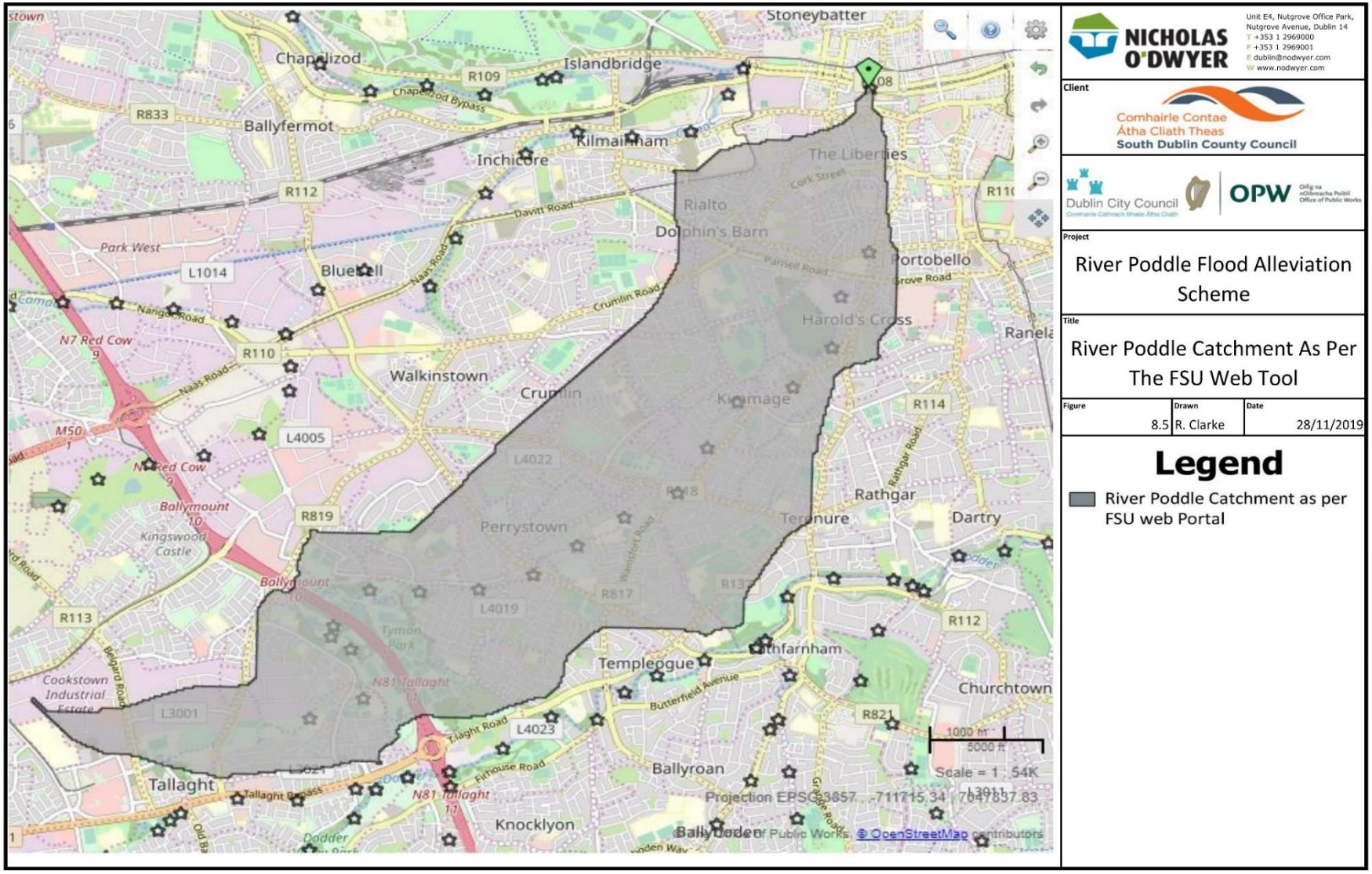
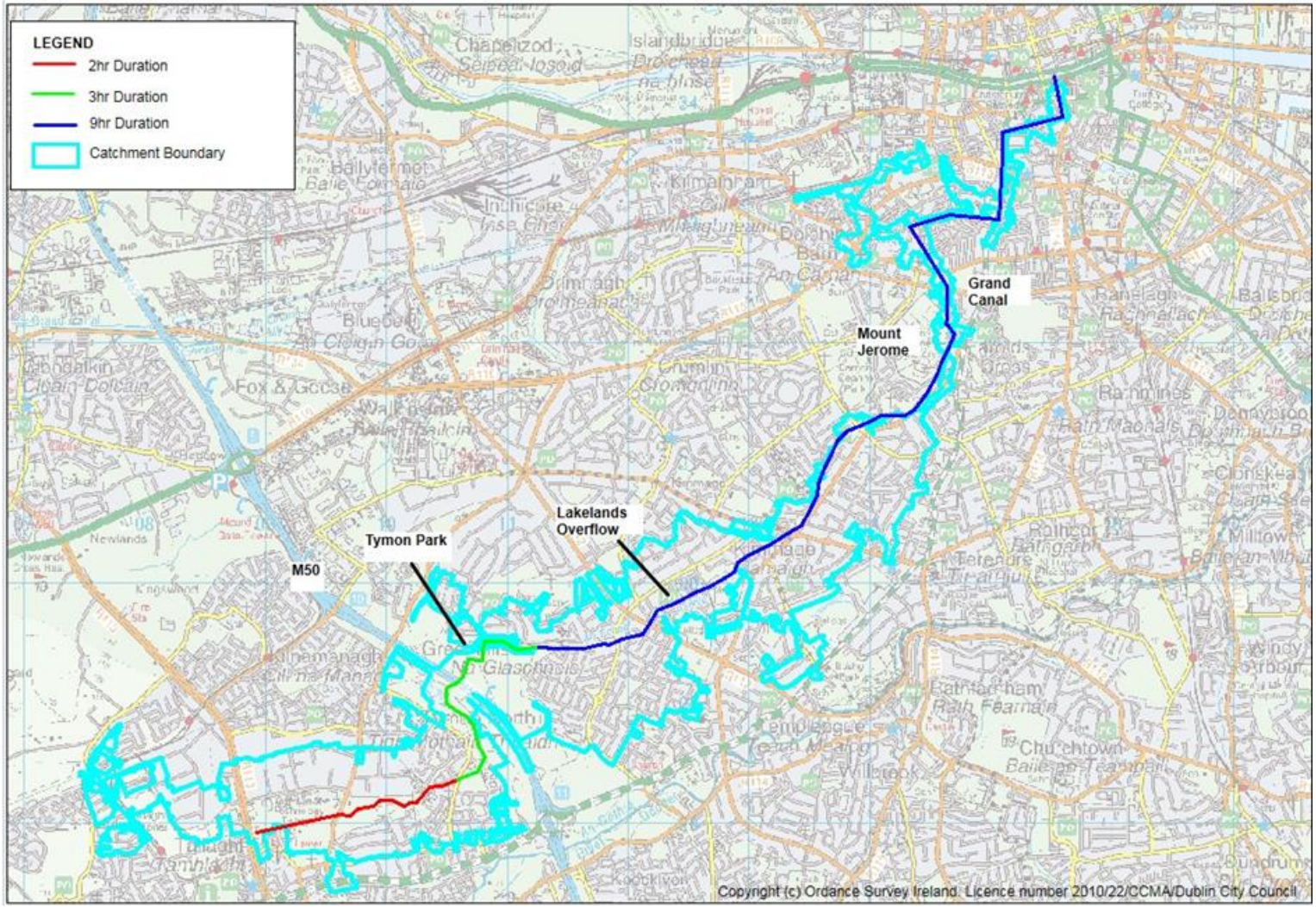


Figure 8-5: River Poddle catchment as per the FSU web tool.



Source: Black & Veatch, Final Hydrology Report, 22 January 2019

Figure 8-6: Critical Storm duration by reach of the River Poddle.