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21/12/2023

UÉ ref: LT0709

Dear Inspector,

Re: Unsolicited Information - Greater Dublin Area Agglomeration (Ringsend) - D0034-02

Uisce Éireann wishes to submit the following unsolicited information for the Agency's consideration.

Please find appended the ameded Marine Modeeling Report, this report should replace the previous one that was submitted on the 7th July 2023. The amendment was necessary following a recent audit of the model setup files. The audit identified an error in one input file for two of the modelled scenarios:

a) the Future Notionally Clean Summer scenario; and
b) the Future Mass Emissions scenario.

The audit confirmed that all other scenarios included in the report were correct. The errors have now been corrected, the model scenarios re-run, and the report has been updated with the revised plots. There are only small changes to these plots, and there is no material change to the conclusions drawn of the report.

The amended modelling report does not have any impact on the conclusions of the NIS and EIAR which were undertaken to support the WWDA application.

Furthermore, a memo on the modelling of Cooling Water Channel (CWC) at Ringsend has been prepared and appended to this letter. The memo should provide the Agency with additional information on how Uisce Éireann has considered the effect of the CWC in the water quality modelling studies carried out as part of both the planning application and WWDL review application.

The CWC was represented in a similar manner in the marine modelling surveys which were completed to support both the planning and the WWDL review application. The difference between the two surveys was that for the final simulations the planning modelled the weir in its existing state whereas the 2023 WWDL review Study modelled the weir in its repaired state. Uisce Éireann is satisfied that the repair of the CWC alone will have no material change on the designated bathing area nor in the achievement of WFD objectives for the receiving waterbodies.

Yours sincerely,

Sheelagh Flanagan

Sheelagh Flanagan
Wastewater Strategy

intertek
Total Quality. Assured.

UISCE EIREANN

Greater Dublin Area Agglomeration WWDL Review

Water Quality Modelling Assessment

P2612_R6177_Rev3 | 20 December 2023

Intertek Energy & Water Consultancy Services
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DOCUMENT RELEASE FORM

Uisce Eireann

P2612_R6177_Rev3

Greater Dublin Area Agglomeration WWDL Review

Water Quality Modelling Assessment

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Rev No	Date	Reason	Author	Checker	Authoriser
Rev 0	25/05/2023	Initial issue to client	JS	NB	PAT
Rev 1	05/07/2023	Client comments & additional modelling	JS	NB	PAT
Rev 2	07/07/2023	Addressing final client comments	DOW	PAT	PAT
Rev 3	20/12/2023	Updating plots	YW	PAT	PAT

Intertek Energy & Water Consultancy Services is the trading name of Metoc Ltd, a member of the Intertek group of companies.

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GLOSSARY

3D
3-dimensional

AD
Advection-Dispersion

BW
Bathing Water

CFRAMs
Catchment Flood Risk Assessment and Management

DHI
Danish Hydraulic Institute

DIN
Dissolved Inorganic Nitrogen

EC
Escherichia coli (E. coli)

ELV
Emission Limit Value

EQS
Environmental Quality Standard

EIAR
Environmental Impact Assessment Report

FFT
Flow to Full Treatment

FM
Flexible Mesh

GDD
Greater Dublin Drainage

IE
Intestinal Enterococci

MRP
Molybdate Reactive Phosphorus

NOD
Nicholas O'Dwyer

psu
Practical Salinity Units

TA
Total Ammonia

TSAS
Tropic Status Assessment Scheme

UÉ
Uisce Éireann

WB
Waterbody

WFD
Water Framework Directive

WtE
Waste to Energy

WWDL
The Wastewater Discharge Licence

WwTP
Wastewater Treatment Plant

1. INTRODUCTION

Intertek Energy and Water Consultancy Services (Intertek) and Nicholas O'Dwyer Ltd. (NOD) were appointed by Uisce Éireann (UÉ) to undertake a Water Quality (WQ) modelling study to assess future proposed discharges from Ringsend Wastewater Treatment Plant (WwTP). The purpose of this study is to support a Wastewater Discharge Licence (WWDL) review and to take advantage of newly available monitoring data across Dublin Bay as well as an update to the original 3D flexible mesh (FM) hydrodynamic (MIKE3) model of Dublin Bay used to support the previous consenting of Ringsend WwTP.

A series of future scenarios were modelled as part of this study, to examine the potential impacts of upgrades to the WwTP and the resulting change in the chemical and bacterial composition of effluent. A baseline case was also run for the period 2019-2021, to inform a validation exercise, comparing modelled output to monitoring data for the updated baseline period.

This report details the data collation process, model setup and model validation, and presents the results of the future scenarios and model validation exercise.

1.1 Overview

An original study, undertaken by the Danish Hydraulic Institute, (DHI), was conducted in 2018 (DHI, 2018), in support of the Ringsend WwTP Environmental Impact Assessment Report (EIAR) which was prepared in support of the planning permission submission for a significant upgrade to the WWTP both in terms of capacity and effluent quality. These works include the provision of adequate capacity for future growth in addition to ensuring compliance with the Urban Wastewater Treatment Directive.

A MIKE3 model developed as part of the DHI study was later updated and further refined by Intertek as part of the Dublin Bay Bathing Waters Forecasting System (BWFS) project in 2021. Improvements in the model's performance against field data was seen after the application of new boundary data, and refinements to the model mesh, focused on designated Bathing Waters (BWs).

In addition to the updated model, this study was also able to take advantage of the availability of additional monitoring data from the Environmental Protection Agency (EPA) and other sources.

1.2 Objective

The objective of this modelling study was to determine the fate of key chemical and bacterial substances within Dublin Bay, most specifically within the Lower Liffey Estuary, with reference to the relevant Environmental Quality Standards (EQSs), to determine if the proposed future discharges are compatible with the achievement of WFD Objectives of the receiving waters and Conservation Objectives of the Protected Areas.

The substances assessed in this study are as follows:

- BOD (biochemical oxygen demand);
- DIN (dissolved inorganic nitrogen);
- MRP (Molybdate reactive phosphorus);
- Ammonia;
- Bacteria (*Intestinal Enterococci* & *Escherichia coli (E. coli)*).

In the case of ammonia, Total Ammonia (TA) is modelled, while results are presented for Un-ionised Ammonia (UA) after post processing of model outputs. Further details on the post processing methodology can be found in Section 2.4.

Modelling was conducted for both average winter and average summer conditions across Baseline and Future scenarios. The planned improvement in effluent quality as a result of the upgrade works currently underway at the Ringsend WWTP are tested in future scenarios.

Full details of the modelled scenarios are presented in Section 2.3.

2. APPROACH

The initial phase of the study involved collating and processing data to update the model inputs for the new baseline period. Updated data was then used to define all river, UÉ asset and industrial discharge flows to the Hydrodynamic (HD) model, before updated concentrations were applied to all river, UÉ assets and industrial discharges in the Advection-Dispersion (AD) models used for WQ simulations.

This study has used 2019 – 2021 as a more up-to-date reference for the baseline. This is updated from the previous modelling conducted by DHI which used 2013 – 2015 as a reference baseline.

Seasonal average values from the baseline period were calculated and applied to the HD model. Winter values were defined as the average condition for November to February, while summer values were defined as the average condition for May to September.

2.1 Data Collation

2.1.1 River Discharges

A total of 11 fluvial discharges are represented in the Dublin Bay model. These are presented in Figure 2-1.

Winter and summer fluvial inputs, alongside a summary of their source are presented in Table 2-1.

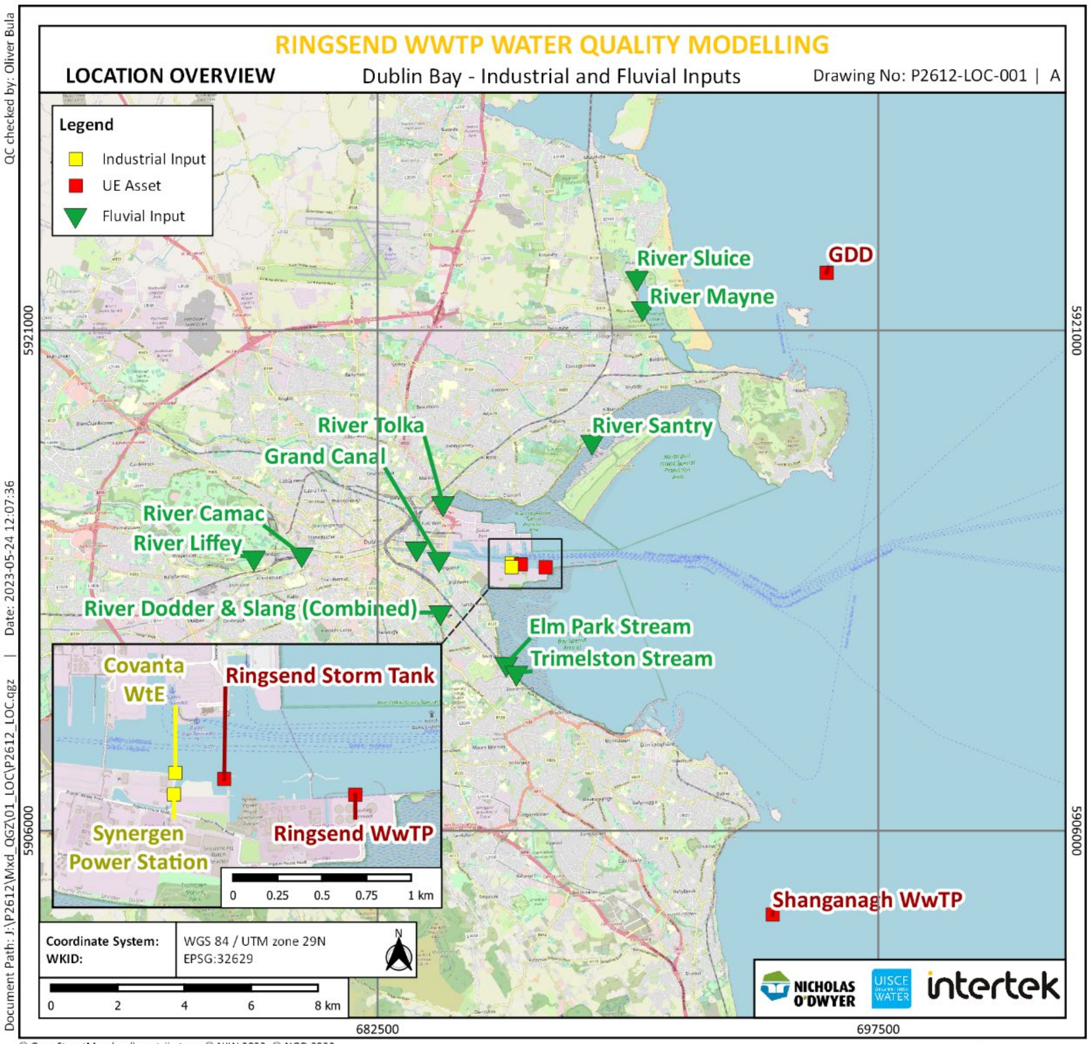
The River Liffey represents the largest freshwater input to Dublin Bay and is characterised in the model by a discharge located at the tidal limit at Islandbridge. Upstream of the tidal limit significant tributaries join the Liffey after the dam at Leixlip, notably the Ryewater and River Griffeen.

Numerous datasets were made available by UÉ for the Liffey, and a review undertaken to identify the most representative data source. Through comparisons of seasonal ratings curves, it was decided to progress with a dataset from Leixlip Dam, comprised of hourly flow for the period 2017-2021. An estimation of the discharge from the intervening catchment from the confluence of Ryewater at Leixlip to Islandbridge was estimated using information provided in the CFRAMS modelling reports (RPS, 2016) and flow estimates from HydroTool. This estimated the intervening catchment area as 96.3km^2. To account for this area, donor flow from the River Dodder was scaled and added to the seasonal average flows calculated at Leixlip Dam. Therefore, the total inputs for the River Liffey at Islandbridge comprise of seasonal averages for; data at Leixlip, Ryewater, Grifeen, and scaled data from the Dodder to represent the intermediate catchment.

For the majority of the remaining sites, river discharges were updated with the latest EPA river gauge data. For four sites, no additional data was available, and the discharges used in the previous study were adopted. These were for River Sluice, River Mayne, and both Grand & Royal Canals, all of which represent small catchments with respect to the other modelled inputs.

Newly available river monitoring data on the Trimleston Stream, provided by the INTERREG Acclimatize programme (Acclimatize, 2022) was used to derive seasonal average flow, which was then also scaled according to catchment area and used as a donor for Elm Park Stream. This represents an improvement on the estimated flows (of 0.05m^3/s) used in the previous study.

Figure 2-1 Location of Modelled (Fluvial, UÉ& Industrial) Inputs



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NOT TO BE USED FOR NAVIGATION

Table 2-1 River Inputs

Name	Winter Flow Rate (Q, m³/s)	Summer Flow Rate (Q, m³/s)	Source
River Liffey	27.2	9.1	Derived from hourly flow data at Leixlip Dam (2017-2021), provided by UÉ. Flows representative of model input at Islandbridge, through estimation of contribution of intervening catchment.
River Dodder & Slang (Combined)	3.1	1.4	Calculated from EPA Gauges (Waldron's Bridge & Frankfort)
River Tolka	3	0.9	Calculated from EPA Gauge (Botanic Gardens)
River Camac	0.8	0.3	Calculated from EPA Gauge (Killeen Road)
River Santry	0.2	0.1	Calculated from EPA Gauge (Cadbury's)
Royal Canal	0.1	0.1	No newly available data. Discharge retained from 2018 study

Name	Winter Flow Rate (Q, m³/s)	Summer Flow Rate (Q, m³/s)	Source
Grand Canal	0.1	0.1	No newly available data. Discharge retained from 2018 study
River Mayne	0.2	0.2	No newly available data. Discharge retained from 2018 study
River Sluice	0.4	0.4	No newly available data. Discharge retained from 2018 study
Elm Park Stream	0.08	0.03	Donor values based on catchment for Trimelston Stream
Trimelston Stream	0.03	0.01	Seasonal averages calculated from Acclimatize Dataset, collected 2018-2020

2.1.2 UÉ & Industrial Discharges

A total of six UÉ & industrial discharges are represented in the Dublin Bay model. These are presented in Figure 2-1 The majority of these inputs represent UÉ assets (Ringsend WwTP, Shanganagh WwTP Outfall & Ringsend Storm Tank), while the remainder are industrial discharges local to Ringsend WwTP (Synergen Power Station & Covanta Waste to Energy Plant). The Greater Dublin Discharge (GDD) is not yet operational and was only included in future run scenarios.

Table 2-2 details each discharge and the origin of the discharge rate and concentrations applied in the WQ models.

Full details of the values used for each model scenario is presented in the table of runs in Appendix A.

Table 2-2 Source of UÉ & Industrial Inputs

Name	Source	Type
Ringsend WwTP	Baseline flows calculated from monitoring data. Future data provided by UÉ	UÉ Asset
Ringsend Storm Tank	Data provided by UÉ	UÉ Asset
Greater Dublin Discharge (GDD)	Data provided by UÉ	Future UÉ Asset
Shanganagh WwTP Outfall	Data provided by UÉ	UÉ Asset
Synergen Power Station	Discharge data retained from 2018 study	Industrial discharge
Covanta Waste to Energy (WtE) Plant	Discharge data retained from 2018 study	Industrial discharge

2.1.3 Chemical & Bacterial Quality Data

The chemical and bacterial data used in the WQ models are principally drawn from EPA monitoring data, alongside data from the Acclimatize programme and data provided directly by UÉ as part of this study. Seasonal average values have been derived from these datasets, and pre-processing of the data has removed notable outliers in the raw sampling data, for a small number of datasets.

Where no suitable data was available to update inputs, values from the previous DHI study have been retained.

The majority of bacterial input values have been derived from the Acclimatize dataset, while the EPA dataset has provided the majority of water chemical values. Dissolved Inorganic Nitrogen (DIN) has been derived by totalling samples for Total Organic Nitrogen (TON) & Ammonia.

2.1.4 River Discharges

The EPA monitoring dataset provides the source for BOD, DIN, MRP & Ammonia for the vast majority of sites. Overall values from the EPA data are broadly consistent for individual parameters across the contributing sites.

Donor values are used for three sites where no suitable data exists. These are for the River Sluice discharging into the Baldoyle estuary, and the Elm Park & Trimleston Streams, which discharge into South Dublin Bay. No EPA monitoring station is available at these sites.

Data for the River Sluice uses data from the neighbouring River Maine as a donor. The Maine is the best donor candidate given that the total discharges of both rivers are comparable, and being neighbouring, largely urban catchments, they share the same catchment characteristics.

Donor data for the Elm Park & Trimleston Streams is taken from the River Santry. While the donor river is much large than the two streams, the catchments are comparable, i.e. predominantly urban, dominated by residential housing. Donor data is considered more appropriate for the baseline period than the DHI data used in the previous study.

No suitable data is available for Grand canal and Royal canal, as neither have a dedicated EPA monitoring station. As the characteristics of the canals are likely to be different to any of the monitored rivers, it was decided that it would be more appropriate to use the values from the original study, than to take values from a donor river.

2.1.5 UÉ & Industrial Discharges

Baseline values for all parameters at Ringsend WWTP are taken from the effluent monitoring dataset provided by UÉ, covering the baseline period (2019 - 2021).

Baseline values for Shanganagh WWTP are drawn from the DHI modelling report, with updated values provided for the future scenarios.

For WwTP baseline conditions, the standard concentration for secondary treated effluent is used in lieu of any modelling for Intestinal Enterococci in the previous study. This compliments the standard concentration for E. Coli, that was previously used.

Values from the original DHI study provide inputs for the two power station discharges (Synergen & Covanta), which contain no chemistry or bacterial inputs. These represent cooling water used for the power plant operation, and it is assumed that clean water is discharged.

2.1.6 Validation Dataset

Validation of the baseline model was undertaken for both the winter and spring setups for three water chemistry parameters. EPA monitoring data was compared against modelled BOD, DIN & MRP at a total of six sites, as detailed in Table 2-3 below.

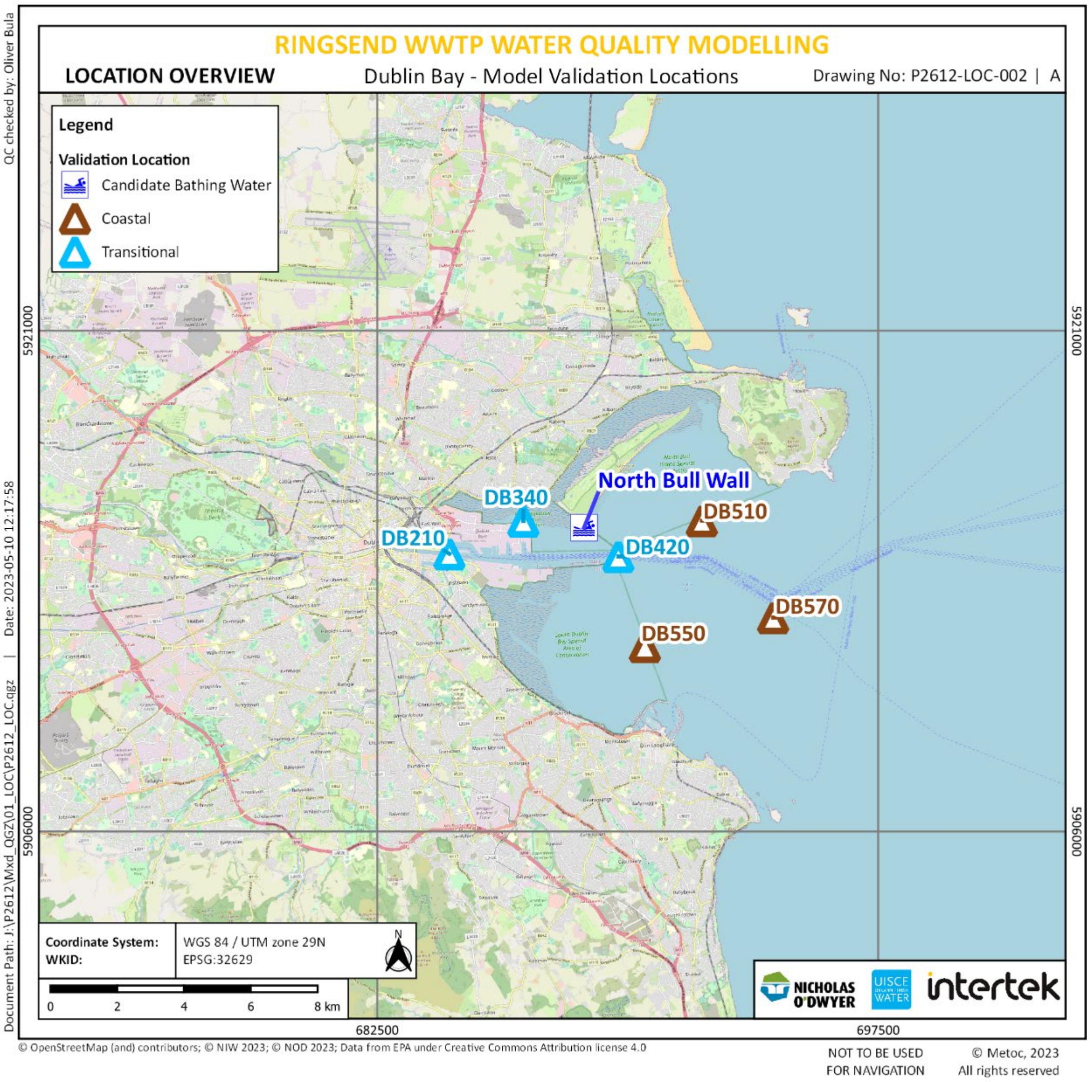
Bacteria in the summer baseline model was validated against BW monitoring data collected at the North Bull Wall.

Table 2-3 Validation Data

EPA Station	Parameter Validated	Waterbody
DB210	BOD & MRP	Transitional
DB340		
DB420		
DB510	DIN	Coastal
DB550		
DB570		

The location of all validation stations is depicted in Figure 2-2 below.

Figure 2-2 Location of Validation Datasets



2.2 Model Setup

2.2.1 Updated Dublin Bay Model

As noted in Section 1.1, the model used in this study is an updated model of Dublin Bay, developed during the Dublin Bay Bathing Waters Forecasting System (BWFS) project in 2021. A discussion of the improvements undertaken, and analysis of validation against field data is presented in Intertek (2021).

The key improvements include refinements to the model mesh, around BWs within Dublin Bay. In addition, the model was improved through the application of new boundary data, as well as changes to some model parameters, and the roughness scheme applied to the model.

The new boundary data were obtained from the FES2014 global tide model, which provides 34 tidal constituents at a 1/16° resolution. New boundary data was applied to the open boundaries in the form of water level time series.

It has been demonstrated (Intertek, 2021) that these enhancements to the model resulted in an overall improvement to the HD performance against field data.

2.2.2 Model Inputs

Other than the improvements noted above, the MIKE3 model used in this study is unchanged from that presented in DHI (2018). The model is 3D, comprised of 8 vertical layers, parameterised as equidistant sigma layers.

The boundary data are extracted for the year 2021, and winter and summer runs are conducted in January and July respectively. Model runs are set up to simulate an initial 14 day period for spin up (1 spring / neap cycle), and assessed on a subsequent 14 day period that is chosen to be representative of mean spring and neap conditions. An additional 7 days is modelled for the 'event based' 'Mass Emissions' and 'Storm Tank' scenarios to ensure antecedent background concentrations are reached during the simulation.

Within the HD model, initial conditions and boundary conditions of temperature and salinity are retained from the original study.

Structures from the original model are retained. These comprise a dyke structure to represent the eastern extent of the intermittently submerged North Bull Wall, and the weir structures used to represent the Poolbeg Power Station (Cooling Water) channel.

Outflows from the Ringsend WwTP discharge into the Poolbeg Power Station (Cooling Water) channel before meeting the River Liffey over a weir. In the original study two conditions of this weir were modelled as it was found that, due to damage to sections of sheet piling, water was entering the Liffey continuously at low water before meeting the weir structure. The two conditions presented a 'present day' (unrepaired) and future (repaired) configuration for the structure. On discussions with UÉ at the initiation of the project, it was decided to use the present day configuration for baseline scenarios, and the repaired condition for all future scenarios, as the works are scheduled to commence before proposed upgrades to Ringsend WwTP are operational.

WQ modelling is conducted within the AD module of MIKE3 where constant decay rates are applied for each substance. The decay rates applied are discussed in Section 2.2.3 below. For each WQ model run, initial concentrations and boundary conditions are used for each substance, the values of which are retained form the original study. Initial and boundary condition values used in this study are presented in Table 2-4.

Table 2-4 Modelled Initial Condition and Boundary Conditions for WQ Substances

WQ Substance	Winter		Summer	
	Initial Condition	Boundary Condition	Initial Condition	Boundary Condition
BOD (mg/l)	0.75	0.5	0.75	0.5
DIN (mg N/l)	0.2	0.1	0.05	0.01
MRP (mg P/l)	0.02	0.02	0.02	0.01
TA (mg N/l)	0.02	0	0.02	0
EC (per 100ml)	0	0	0	0
IE (per 100ml)	0	0	0	0

2.2.3 Model Decay Rates

Simple decay rates are applied in the WQ models for each modelled substance. In the majority of cases decay rates from the previous study were retained. Decay constants used in the study are presented in Table 2-5.

After a review of the performance of the previous modelling study, and discussions with UÉ on experience gained from other modelling studies, the decay rate for BOD was modified to improve model performance for BOD. The rate was reduced from 551.4 hours (T90) to 2763.1 hours (T90) and applied for both winter and summer conditions. Bacterial decay rates were also updated in accordance with Uisce Éireann's latest Technical Standard for Marine Modelling.

Table 2-5 Decay Constants Used in WQ Modelling

WQ Substance	Winter Decay Rate T90 (Hours)	Summer Decay Rate T90 (Hours)
BOD	2763.1	2763.1
DIN	3314.0	551.4
MRP	4737.8	789.6
TA	276.9	276.9
EC	43	24
IE	86	48

2.3 Model Scenarios

A total of nine HD scenarios were modelled to inform this study, which were used to drive a total of 38 WQ scenarios. The majority of models simulated constant discharges over the model duration. For the future operation of Ringsend WwTP, two future scenarios are modelled. A 'Future' scenario includes upgraded values for the Ringsend works, and includes all background asset and river sources. A 'Future - Notionally Clean' scenario retains the future discharge at Ringsend, but removes all other asset discharges, and inputs a calculated natural contributing concentration for all river discharges.

Two 'event based' time varying scenarios were modelled, simulating a 'Mass Emissions Scenario', where Flow to Full Treatment (FFT) conditions were simulated for a 24 hour period, and a 'Storm Tank Scenario', where the release of a 100,000m^3 discharge was made concurrently with FFT operation at the Ringsend WwTP. FFT flows for Ringsend WwTP were modelled as 13.8 m^3/s.

The HD scenarios modelled were as follows:

- Baseline (2019-2021) - Summer & Winter conditions: mean measured seasonal discharge flow and concentration,

- Future Scenario - Summer & Winter conditions: future average flow (DWF *1.25), ELV concentrations,
- Future Scenario: Notionally Clean - Summer & Winter conditions: future average flow (DWF *1.25), ELV concentrations,
- Future Mass Emissions Scenario – Summer & Winter conditions: future FFT flow for a 24 hour period, ELV concentrations,
- Future Storm Tank Scenario - Summer conditions: future FFT flow in combination with a 100,000m^3 storm tank discharge for a 5 hour period, future max ELV concentration.

The combination of HD and WQ model runs are summarised in Table 2-6. River discharge loads are constant for all runs; current observed loads are used except for 'notionally clean' scenarios where a constant concentration based on 20% of the High/Good Class threshold concentration is adopted. The six WQ substances were modelled for all scenarios with the following exceptions:

- For the 'Future Notionally Clean Scenarios' two substances were modelled, DIN and MRP, with river loads set at notionally clean (20% of the High/Good Class threshold).
- Bacterial substances (EC & IE) were modelled for the 'Future Storm Tank Scenario' in order to support assessment of impact of storm tank discharges on bathing waters.
- In the 'Future Mass Emissions Scenario', a 'notionally clean' approach is used for the DIN and MRP runs where only the Ringsend discharge is modelled. For the BOD & Total Ammonia Mass Emission runs in this scenario, all sources are modelled.

A full table of runs, combining the run setup and listed input loads (flow & concentration), are presented in Appendix A.

Table 2-6 List of HD & WQ Model Runs

Run Number	HD Scenario	Modelled WQ Parameters	Discharge
1	Baseline (Winter)	BOD, DIN, MRP, TA, EC, IE	Constant
2	Baseline (Summer)	BOD, DIN, MRP, TA, EC, IE	Constant
3	Future – Scenario (Winter)	BOD, DIN, MRP, TA, EC, IE	Constant
4	Future – Scenario (Summer)	BOD, DIN, MRP, TA, EC, IE	Constant
5	Future – Notionally Clean Scenario (Winter)	DIN, MRP	Constant
6	Future – Notionally Clean Scenario (Summer)	DIN, MRP	Constant
7	Future Mass Emissions Scenario (Winter)	BOD, DIN, MRP, TA (For DIN & MRP, the Ringsend discharge is modelled in isolation, with no background concentrations)	Constant, time varying at Ringsend WwTP & GDD
8	Future Mass Emissions Scenario (Summer)	BOD, DIN, MRP, TA (For DIN & MRP, the Ringsend discharge is modelled using a 'notionally clean' approach)	Constant, time varying at Ringsend WwTP & GDD
9	Future Storm Tank Scenario	EC, IE	Constant, time varying at Ringsend WwTP & Storm Tank

2.4 Assessment Criteria & Post Processing

Model impacts are assessed against Environmental Quality Standards (EQS) as prescribed by the Surface Water Regulations for Ireland (Amended) (IG, 2019) and the Bathing Water Regulations (IG, 2008). These regulations do not contain an EQS for Un-ionised Ammonia (UA), however, in line with previous studies, an target of 21µg/l[1] as an annual average was adopted for this study. EQS values are presented in Table 2-7.

WQ model output has been processed and presented statistically based on the assessment spring-neap cycle. Plots are then presented in accordance with the relevant EQS.

The assessed concentration for each of the modelled pollutant were as follows:

- BOD, the 95-percentile concentration over a spring-neap tidal cycle;
- DIN, the 50-percentile (i.e. median) concentration over a spring-neap tidal cycle;
- MRP, the 50-percentile (i.e. median) concentration over a spring-neap tidal cycle;
- Un-ionised Ammonia, the 50-percentile (i.e. median) concentration over a spring-neap tidal cycle;
- *E. coli*. the 95-percentile concentration over a spring-neap tidal cycle; and
- *Intestinal Enterococci* the 95-percentile concentration over a spring-neap tidal cycle.

The concentration of un-ionised ammonia was determined from the concentration of Total Ammonia and calculated by post processing the modelled concentrations for Total Ammonia. The conversion of Total Ammonia to Un-ionised Ammonia is dependent on pH, temperature, and salinity of the receiving waters. The reference pH, Temperature & Salinity used in the conversion to Un-ionised Ammonia were taken as the seasonal mean values from the Tropic Status Assessment Scheme (TSAS) assessment of the Lower Liffey Estuary during the baseline period (2019-2021). The seasonal fraction of Un-ionised Ammonia was calculated as 1.2% of Total Ammonia for winter, and 2.8% of Total Ammonia for Summer.

As the EQS for DIN & MRP are based on salinity, additional post processing has been undertaken to present the designated WQ class with respect to individual waterbodies and the associated seasonal salinity characteristics. Salinity is derived from the seasonal 2021 TSAS values for each waterbody. The EQS scores presented in Table 2-7 are illustrative of the Lower Liffey Estuary waterbody, into which Ringsend WwTP discharges. There are no TSAS data associated with the North Bull Island waterbody, and thus the seasonal salinities for Dublin Bay are applied to this area. This represents a conservative approach, given that there will be a small freshwater influence from the River Santry in this area.

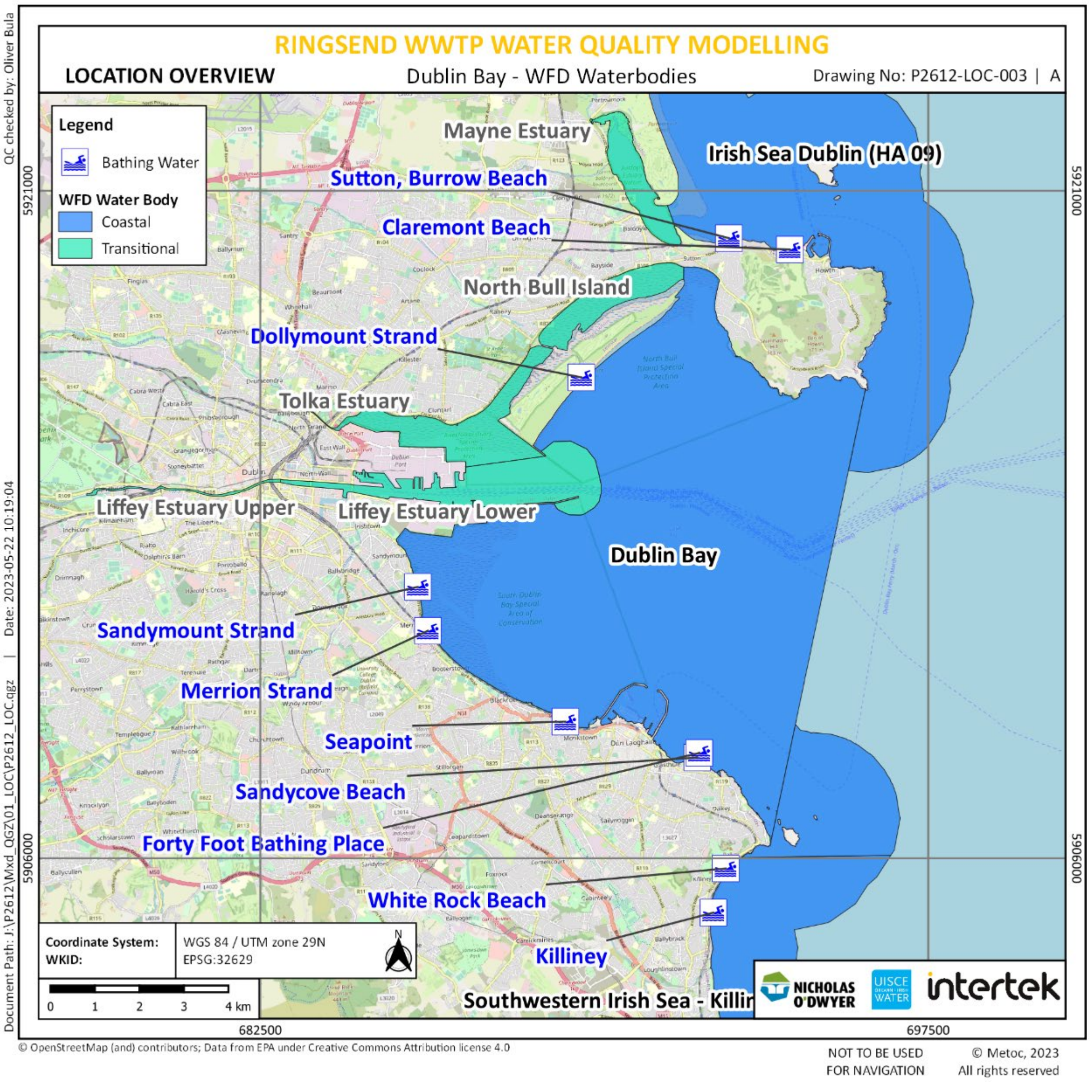
Figure 2-3 illustrates the local WFD waterbodies.

[1] This value originates from the EU Freshwater Fish Directive, which was revoked with the introduction of WFD. An ammonia standard has not been included for transitional or coastal waters in the WFD or Surface Water Regulations (Ireland). It is included as part of this study to provide an indication of potential for impacts on aquatic life.

Table 2-7 Applied Environmental Quality Standards

Substance	High	Good	WFD Applicable Waterbody
BOD	High status ≤ 3.0 (95%ile)	Good status ≤ 4.0 (95%ile)	Transitional
DIN	High status ≤ 0.26 (median)	Good status ≤ 0.506 (median)	Coastal (Applicable for PSU of 31)
MRP	High status ≤ 0.026 (median)	Good status ≤ 0.044 (median)	Transitional (Applicable for PSU of 31)
EC	Excellent Status ≤ 250 cfu/100ml (95%ile)	Good Status ≤ 500 cfu/100ml (95%ile)	At designated Bathing Waters, for all samples collected over four bathing seasons (discounting may apply)
IE	Excellent Status ≤ 100 cfu/100ml (95%ile)	Good Status ≤ 200 cfu/100ml (95%ile)	
Un-ionised Ammonia	No EQS for Un-ionised Ammonia for Ireland. Previous studies have used a criteria of 21µg/l for an annual average.		

Figure 2-3 Location of WFD Waterbodies



3. MODEL VALIDATION EXERCISE

Validation of the updated baseline WQ model was achieved by comparing modelled concentrations of BOD, MRP & DIN with observed data from the EPA, as well as concentrations of *Escherichia coli (E. coli)* & *Intestinal Enterococci* to data collected at North Bull Wall, a monitored (non-designated) swimming site.

The WQ model was run for both summer and winter conditions, with an initial cold start and two week 'spin up' period to achieve equilibrium, followed by a second two-week (Spring-Neap) period over which results were extracted.

As noted in section 2.1.6, comparisons were made at 6 sites with comparisons for BOD & MRP made at sites located in transitional waterbodies, and DIN compared in a coastal waterbody, as per the assessment criteria (see section 2.4).

Results for the validation of BOD, MRP and DIN are shared below in Figure 3-1, Figure 3-2 and Figure 3-3 respectively. The validation exercise takes modelled and measured data representative of the surface layer. Within the individual box and whisker plots, the horizontal orange line shows the median concentration, the box is indicative of the 25 – 75% quantile and whiskers indicative of the 5 – 95% quantile. The dashed green and blue lines demonstrate the relevant EQS standards for 'Good' and high respectively.

Results of the validation of bacteria parameters at North Bull Wall is presented in Figure 3-4. As before, samples and modelled results are representative of the surface layer.

Figure 3-1 Validation of observed and modelled concentrations for BOD (transitional waters)

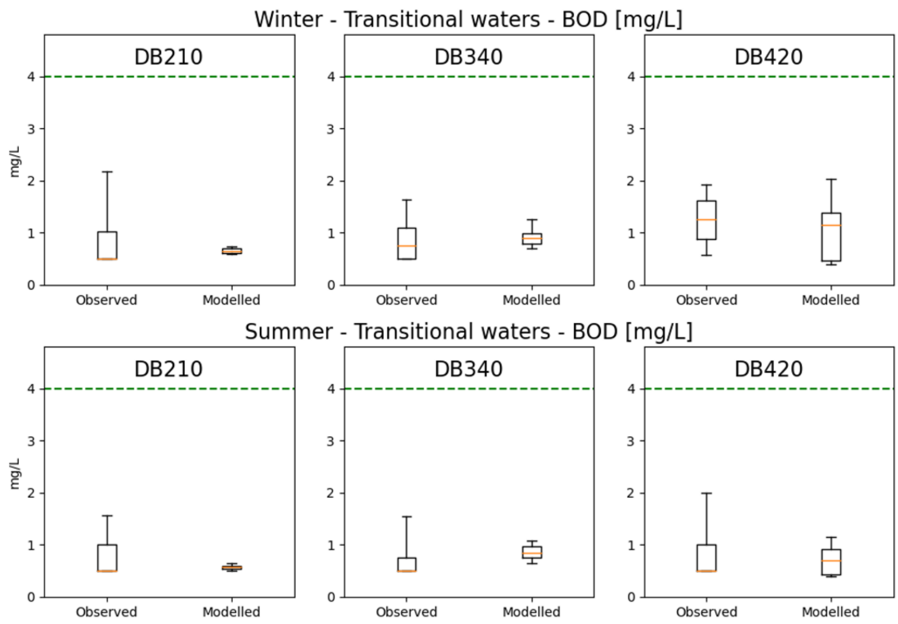


Figure 3-2 Validation of observed and modelled concentrations for MRP (transitional waters)

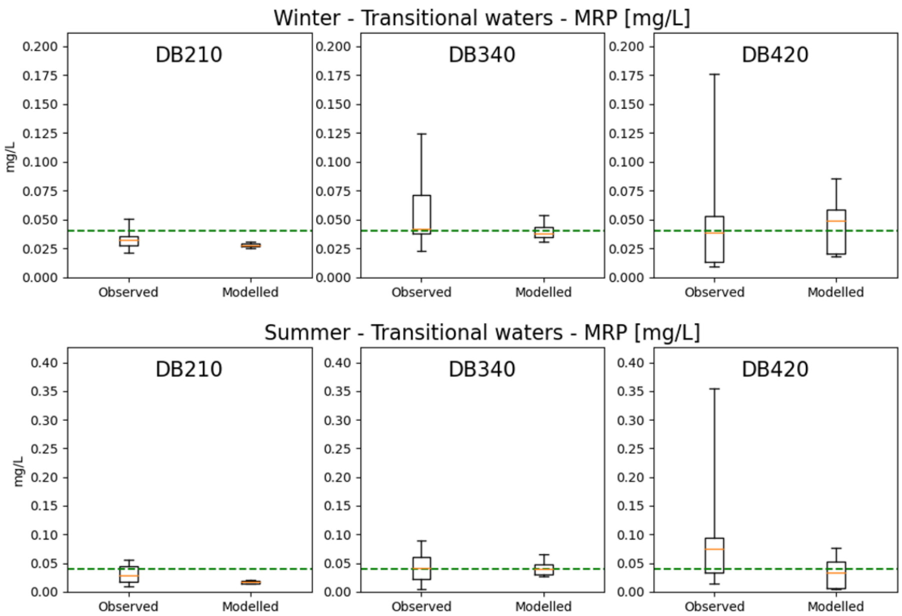


Figure 3-3 Validation of observed and modelled concentrations for DIN (transitional waters)

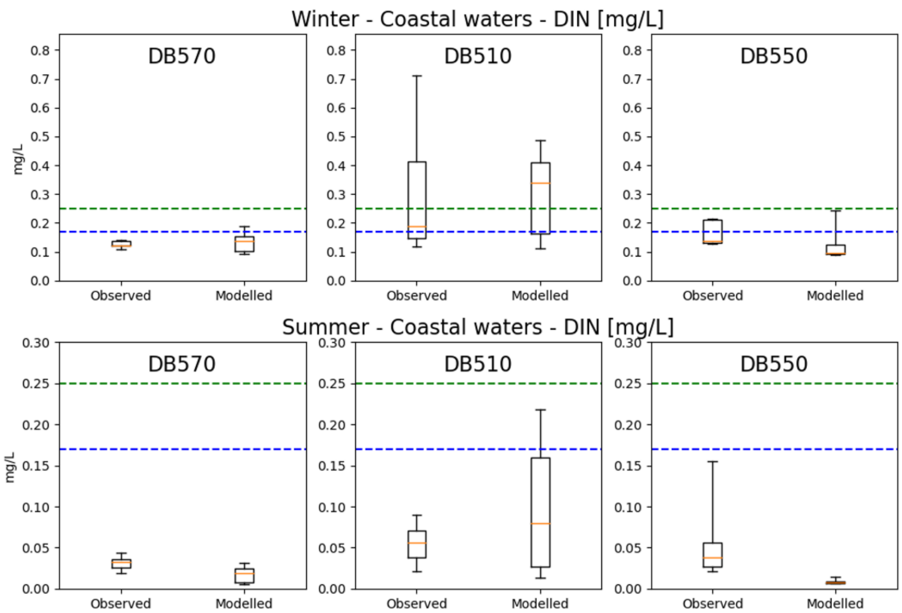
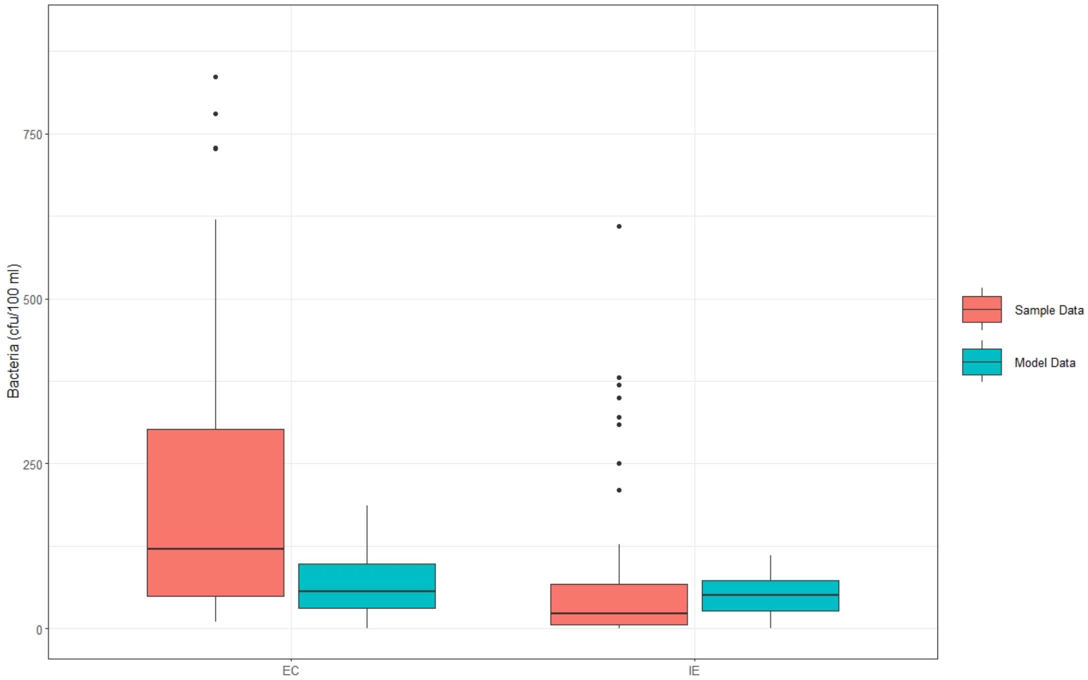


Figure 3-4 Validation of observed and modelled concentrations of bacteria at North Bull Wall



The validation plots demonstrate that the WQ model can replicate the key processes underpinning the dispersal and decay of pollutants within Dublin Bay. No one site is seen to consistently under or over predict, and results are comparable in both transitional and coastal waters.

In transitional waters (Figure 3-1 & Figure 3-2), the range of values for the model is lower in comparison to the measured data at site DB210 within the River Liffey. However, the median values compare well between measured data and modelled values. This is likely a result of seasonal means being used to derive the modelled inputs, a method which is likely to omit the effects of storm events (indicated by the high outliers for BOD at DB210 in the measured data). Conversely this method will also omit low flow values but ensures a lower range to the modelled values. Comparisons at other transitional water sites are favourable, with a good comparison for mean values.

For coastal water sites (Figure 3-3), there is less prevalence of outliers as a result of the higher dilution from sea water in comparison to transitional waterbody sites. As with the comparisons for BOD & MRP in the transitional waterbodies, the overall comparison of median values is favourable between the field data and the model. Modelled and measured medians are all below the EQS for 'High', with the exception of site DB510 for winter.

For bacteria, the median fit is good for EC & IE (Figure 3-4), while there is a marginal underestimation of EC, and an overestimation of IE. However, the variation is small, and acceptable for such a wide variation in input concentrations from multiple sources. The measured dataset does show significant outliers not captured by the model. Again, this is likely due to storm inputs that are not captured by inputs to the model.

This validation exercise has demonstrated that the model setup is suitable for future scenario modelling. In comparison with the previous 2018 model validation, this updated model demonstrated, in general, improved performance.

4. RESULTS

The results of the future WQ modelling scenarios, as outlined in Section 2.3 are presented in this section.

The model was run for two consecutive spring-neap cycles, with the first designated as a spin up period, and results generated from the second period. As outlined in Section 2.4 results are a statistical representation of the second two-week period. The exceptions are the 'event based' scenarios which were run for a longer duration, to ensure enough time for concentrations to return to background levels.

Results of the 'Future Scenario' are presented in Section 4.1. These comprise a series of static plots for the winter and summer scenario side-by-side. This format is the same for the results of the 'Future Scenario: Notionally Clean', which are presented in Section 4.2.

Results of the 'event based' scenarios are presented as animated dashboards, depicting the duration of the 'Mass Emissions' and 'Storm Tank' events, and the time over which concentrations within the receiving waterbody return to reference ambient conditions. Static snapshot plots of concentration through the simulation period are presented in Appendix B and Appendix C for the 'Mass Emissions Scenario' and 'Storm Tank Scenario' respectively. A brief narration of the results is provided in Section 4.3 and 4.4 respectively.

Terminology used in this section when referring to impacts from the discharge of the Ringsend WwTP will employ the term 'mixing zone' when referring to a plume discharging into an area where an EQS is applicable, and defines the zone within which the relevant EQS is exceeded. When an EQS is not applicable, the term 'mixing plume' will be used to describe the extent of the impact, noting that there would be no environmental standard to compare with in this case. For example, there is no EQS for MRP in coastal WBs. The Ringsend WwTP discharges to the Liffey Estuary WB, which is a transitional WB.

4.1 Future Scenario

4.1.1 BOD (Figure 4-1)

Results of BOD concentrations for the winter and summer are very similar. A mixing zone is observed in the location of the Ringsend outfall and limited to the northern side of the Great South Wall under both summer and winter conditions. The footprint of the mixing zone, where the EQS for BOD is exceeded, is approximately 1.2km by 200m for the winter scenario, which reduces to approximately 1km by 200m in the summer scenario. In both scenarios the mixing zone remains close to the south wall and does not migrate across the Estuary.

Beyond this area, WFD objectives of the receiving waterbody are met, with concentrations below the 'Good' threshold. River loads are contributing to the overall concentrations, and therefore, the extent of the mixing zone is representative of the cumulative impact of the Ringsend outfall, background concentrations, and contributions from sources that are not UÉ assets.

4.1.2 DIN (Figure 4-2 & Figure 4-3)

Concentrations for DIN are presented in Figure 4-2, while Figure 4-3 presents DIN as indicative water quality.

As there is no applicable DIN EQS for transitional waters (IG 2019) the coastal water EQS has been used to contextualise the mixing plume around the outfall.

The concentrations for DIN (Figure 4-2) do have a seasonal variation, with higher background and boundary condition inputs (as defined in Table 2-4) for the winter scenario dominating the winter plot.

Elevated concentrations are associated with the Ringsend outfall, and areas of the Tolka Estuary. In the summer plot, background concentrations are notably lower, reflecting the drop in boundary concentrations from 0.1 mg N/l to 0.01 mg N/l.

Concentrations are presented in Figure 4-2 throughout the model domain in the context of the threshold for 'Good' indicative quality in coastal waters, as calculated for the observed salinities from the Liffey Estuary Lower WB (into which the Ringsend outfall discharges). It should be noted that the actual 'Good' threshold would be slightly higher in the Tolka Estuary WB and slightly lower in the Dublin Bay WB.

However, the indicative water quality presented in Figure 4-3 is derived from the predicted DIN concentration and the relevant 'Good' threshold as calculated using the seasonal mean salinity in each waterbody (WB) as presented in the latest EPA TSAS data (2019 – 2021).

Modelled concentrations are compatible with WFD objectives, which are met for all scenarios in coastal waterbodies where the DIN EQS applies.

With regards to transitional waterbodies, there are areas of the Tolka Estuary WB and Liffey Estuary Lower WB where the concentration threshold for 'Good' in coastal waters is exceeded.

In the summer scenario this is only for an area associated with the mixing plume from the Ringsend WwTP, while in the winter scenario, this extends across the estuary into the Tolka Estuary WB. Although this is not relevant to the WFD classification of these transitional waters, this may affect the trophic status of these WBs.

The indicative quality for each constituent WB for DIN (Figure 4-3) is seen to have a large seasonal variation. For the winter scenario, 'High' and 'Good' indicative quality is associated with the Dublin Bay WB. A change from 'High' to 'Good' status is seen with the transition from Dublin Bay WB to the Liffey Estuary Lower WB. The Liffey Estuary WB is predominantly 'Good' indicative quality, with 'Moderate' indicative quality observed in the area of the Ringsend outfall, and the north side of the channel, bordering the Tolka Estuary WB. The lower salinities associated with the Tolka Estuary WB mean that 'Good' predominates at the boundary to the Lower Liffey Estuary, before becoming 'Moderate' again towards the mouth of the Tolka river. The modelled result for the 'North Bull Island' waterbody indicates a 'Moderate' indicative quality. 'High' indicative quality dominates the summer scenario, with small areas of 'Good' in the upper Tolka Estuary.

A key contributing factor for the seasonal differences are 'cumulative impacts' as contributions from rivers are included, which influence the modelled (total) concentrations. The result from a 'notionally clean' model run for this scenario is presented in Section 4.2.

4.1.3 MRP (Figure 4-4 & Figure 4-5)

Concentrations of MRP for the summer and winter scenarios are shown in Figure 4-4, while the indicative water quality classification is shown in Figure 4-5.

MRP concentrations (Figure 4-4) do have a seasonal variation, with higher background and boundary condition inputs (as defined in Table 2-4), and differences in the mixing zone associated with the Ringsend outfall.

Unlike DIN, there is no applicable MRP EQS for coastal waters (IG 2019), although there is an EQS for MRP for transitional waters.

In the winter scenario, a mixing zone of 2.5km by 200m is observed around the Ringsend outfall, which reduces to 1.5km by 200m in the summer scenario. In both scenarios the mixing zone remains close to the south wall and does not migrate across the Estuary. Outside of this mixing zone WFD objectives are met for the summer condition, with no other areas exceeding 0.044 mg P/l, which is equivalent to the 'Good' threshold, valid for the Liffey Estuary Lower WB, as determined by locally measured salinities. Therefore, the discharge is compatible with WFD under these conditions. For the winter scenario, areas of the Tolka Estuary WB are seen to exceed the previously defined concentration for ‘Good’, particularly behind North Bull Island. Approximately half of the Tolka Estuary WB is seen to exceed this threshold.

MRP is presented as an indicative water quality in Figure 4-5. In the summer scenario, ‘High’ WQ is indicated for all locations beyond the mixing zone associated with the Ringsend outfall. Further afield, ‘Moderate’ WQ is observed north of the Liffey, with areas of the Tolka Estuary and Liffey Estuary Lower WBs noted as not meeting the WFD objectives. Areas of ‘Good’ indicative quality are seen to extend across the north side of Dublin Bay, the River Liffey and up to Howth. These areas, as well as the rest of the areas classed as ‘High’ indicative quality do meet the WFD objectives.

A key contributing factor for the seasonal differences, and the presence of ‘Good’ & ‘Moderate’ WQ in the winter condition are ‘cumulative impacts’ as contributions from rivers are included and are contributing to the modelled concentrations. The result from a ‘notionally clean’ model run or this scenario is presented in Section 4.2.

4.1.4 Un-ionised Ammonia (UA) (Figure 4-6)

The impact footprint of UA is small and constrained to within the outfall channel and weir structure. The non-regulatory target of 21µg/l is exceeded in a very small mixing plume, for the winter scenario, but is not exceeded for the summer scenario (albeit for the limited footprint). The mixing plume for the winter scenario is approximately 300m by 75m. The higher water temperature and pH associated with the summer scenario gives rise to a higher ratio of UA from TA in comparison to the winter result.

In both scenarios the mixing plume remains close to the south wall and does not migrate across the Estuary.

4.1.5 EC and IE (Figure 4-7 to Figure 4-10)

Concentrations of EC & IE are presented in Figure 4-7 & Figure 4-8 respectively. The results show the bacterial plumes with concentrations exceeding 500 cfu/100ml for EC and 200 cfu/100ml for IE extending into Dublin Bay. Increases in bacteria concentrations can also be observed at locations where fluvial inputs are present in the model, representing the comparative contribution of local river catchments. This is illustrated by the discharge from the Elm Park & Trimleston streams, flowing into the Sandymount & Merrion Strand BWs, as well as Liffey and Tolka rivers which are contributing bacterial loads to Dublin Bay.

In the context of impacts on designated Bathing Waters the extent of the discharge plume associated with the Ringsend discharge is not seen to reach or interact with local designated BW sites at Dollymount Strand and Sandymount Strand.

Figure 4-9 & Figure 4-10 show the same model results, but with the plot contours changed to provide indicative BW classification. White areas indicate ‘Excellent’ BW status, green areas indicate ‘Good’ classification, while orange indicate areas failing to meet ‘Good’ classification.

These plots clearly demonstrate that the proposed discharge from Ringsend is compatible with the achievement of Bathing Water quality standards at designated Bathing Waters

Figure 4-1 Modelled concentration of BOD (mg/l, depth average, 95%ile). Colour contours are representative to the Liffey Estuary Lower EQS, where blue is high, green is good, and orange is less than good.

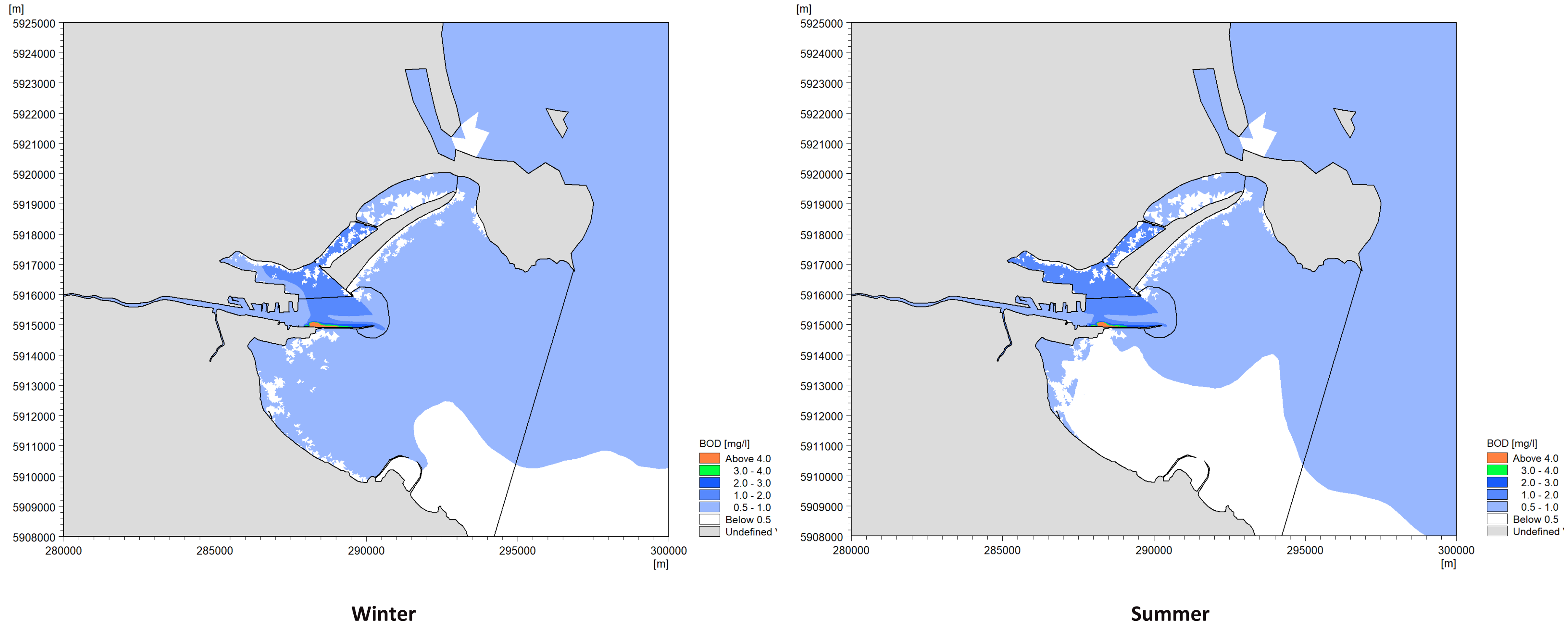
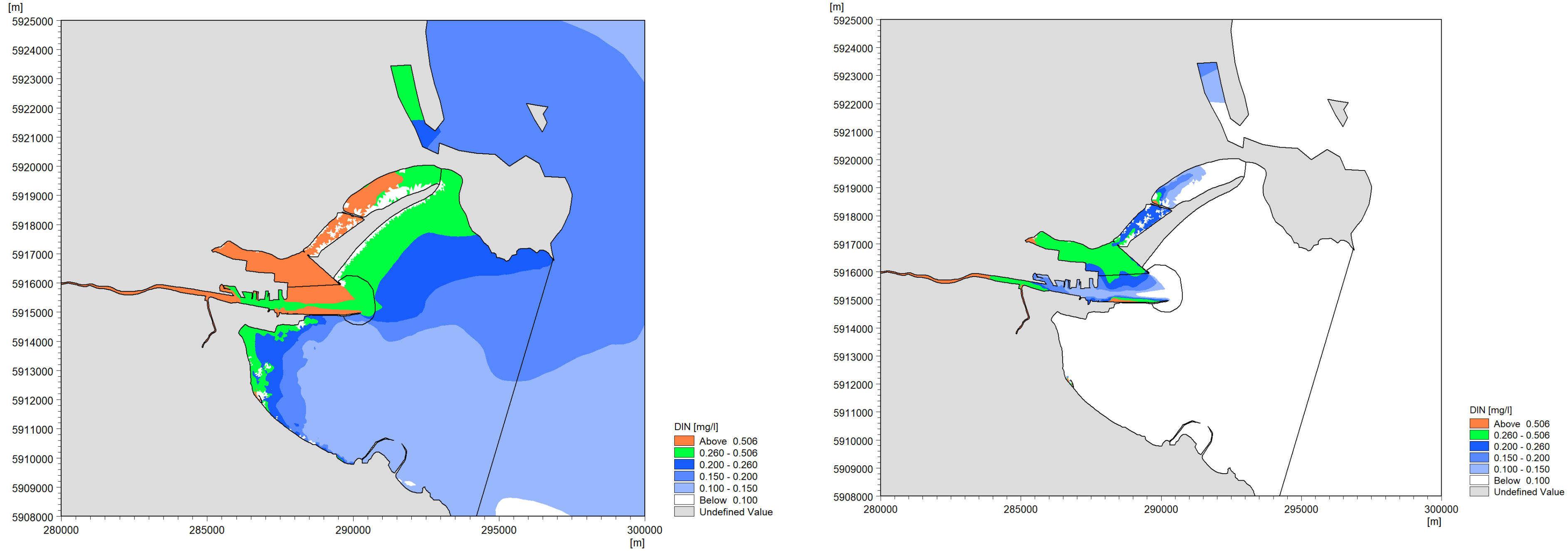
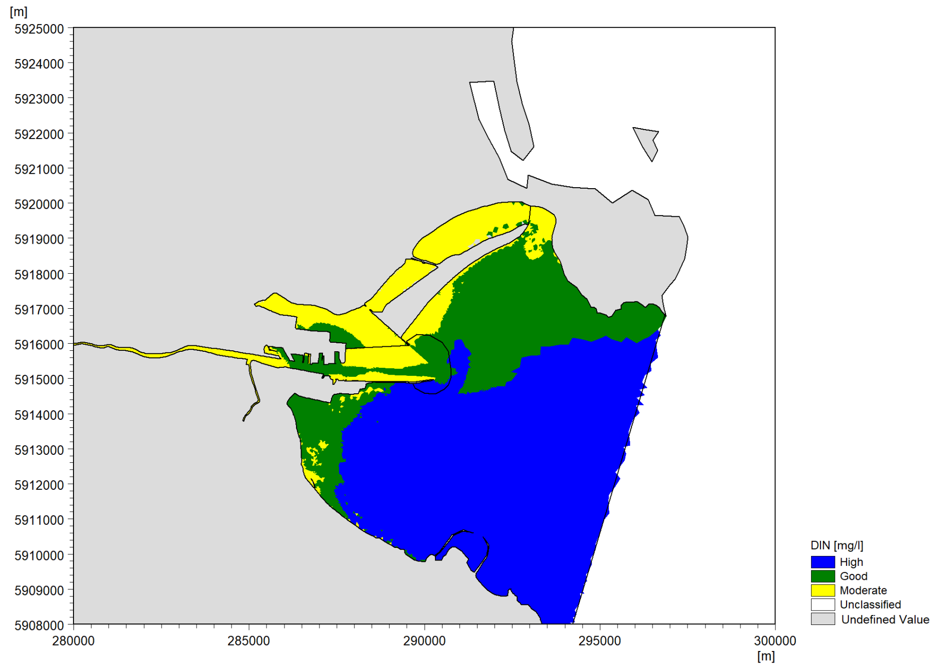


Figure 4-2 Modelled concentration of DIN (mg/l, depth average, 50%ile). Colour contours are representative to the Liffey Estuary Lower EQS in the receiving waterbody, where blue is high, green is good, and orange is less than good.

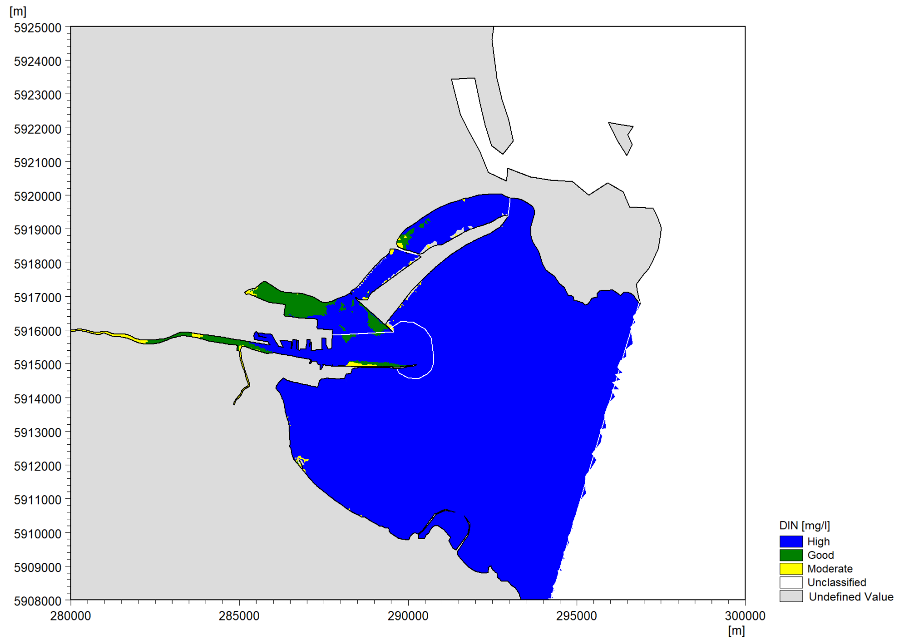


Winter **Summer**

Figure 4-3 Classification of modelled DIN concentrations (mg/l, depth average, 50%ile). Colour contours are representative to the EQS within the respective TSAS assessment waterbody areas.

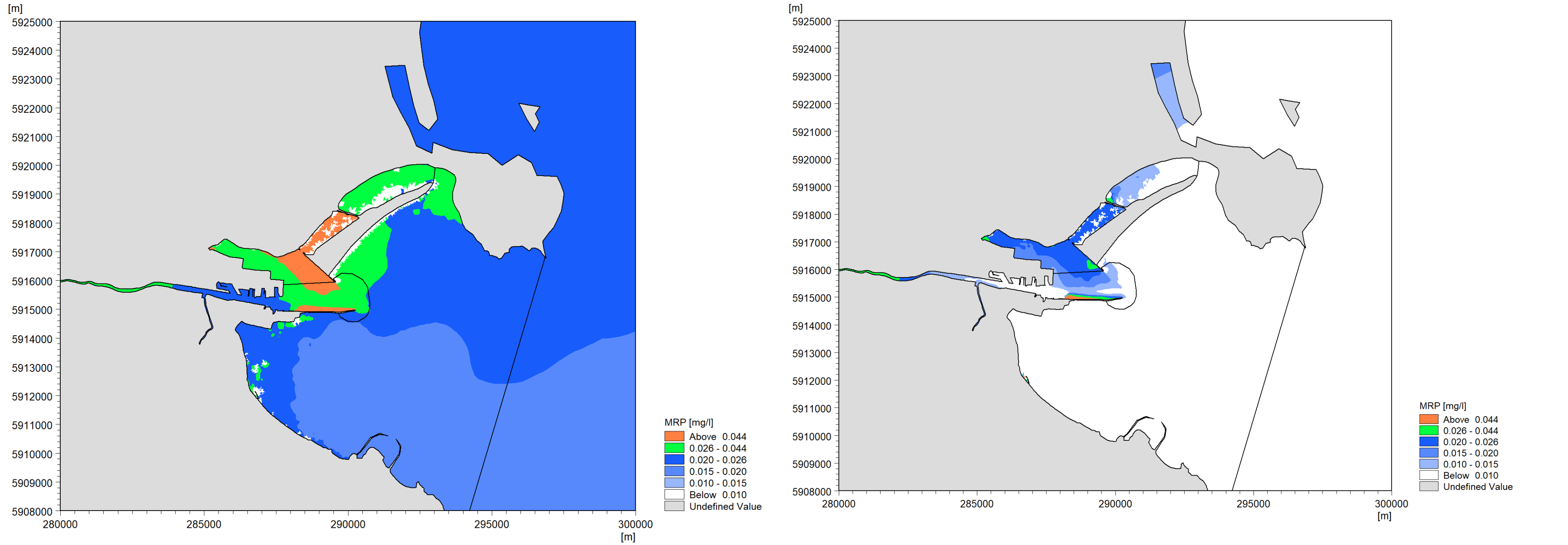


Winter



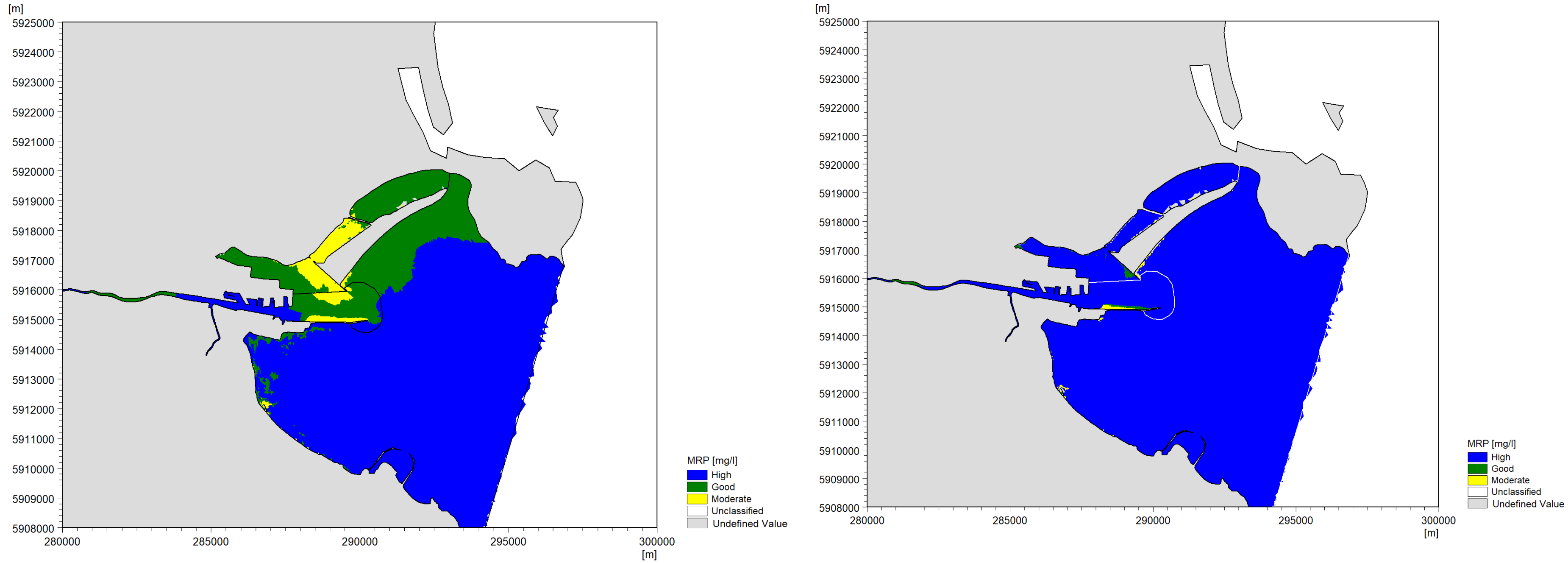
Summer

Figure 4-4 Modelled concentration of MRP (mg/l, depth average, 50%ile). Colour contours are representative to the Liffey Estuary Lower EQS in the receiving waterbody, where blue is high, green is good, and orange is less than good.



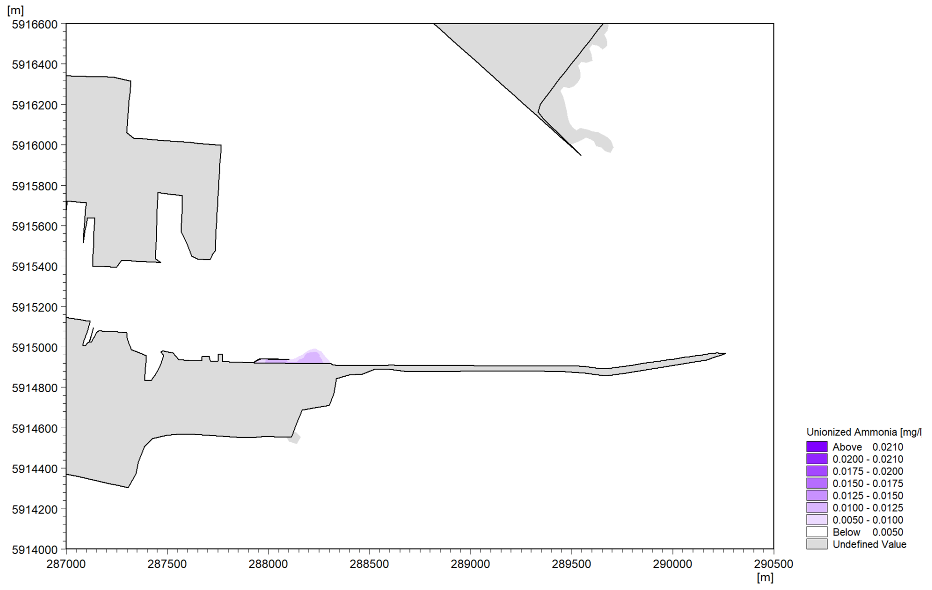
Winter **Summer**

Figure 4-5 Classification of modelled MRP concentrations (mg/l, depth average, 50%ile). Colour contours are representative to the EQS within the respective TSAS assessment waterbody areas.

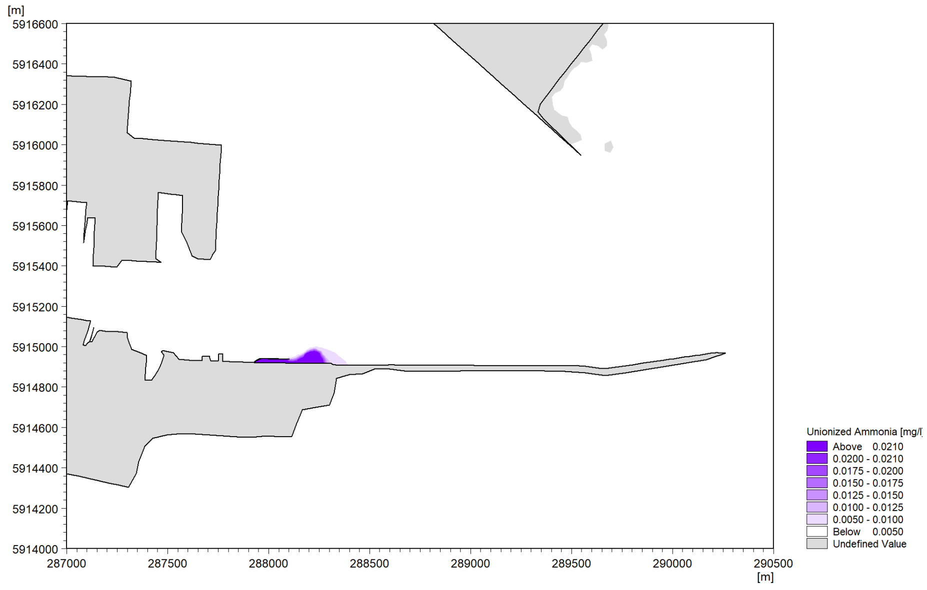


Winter **Summer**

Figure 4-6 Modelled concentration of Un-ionised Ammonia (mg/l, depth average, 50%ile).

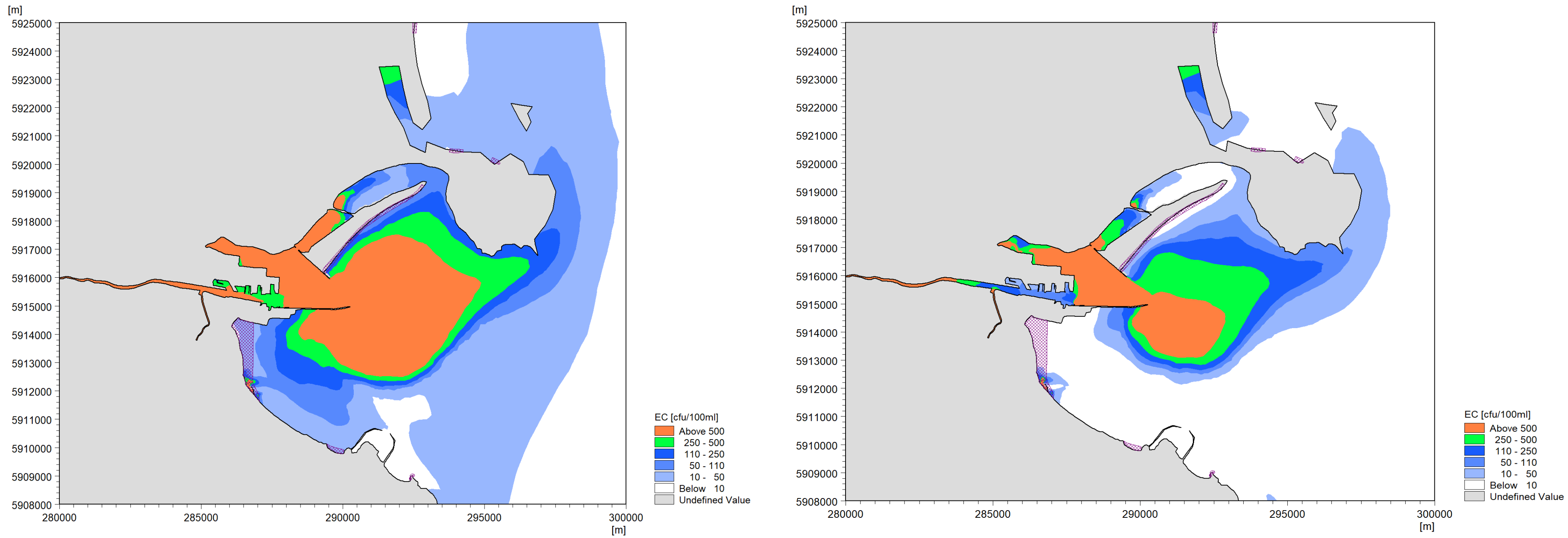


Winter



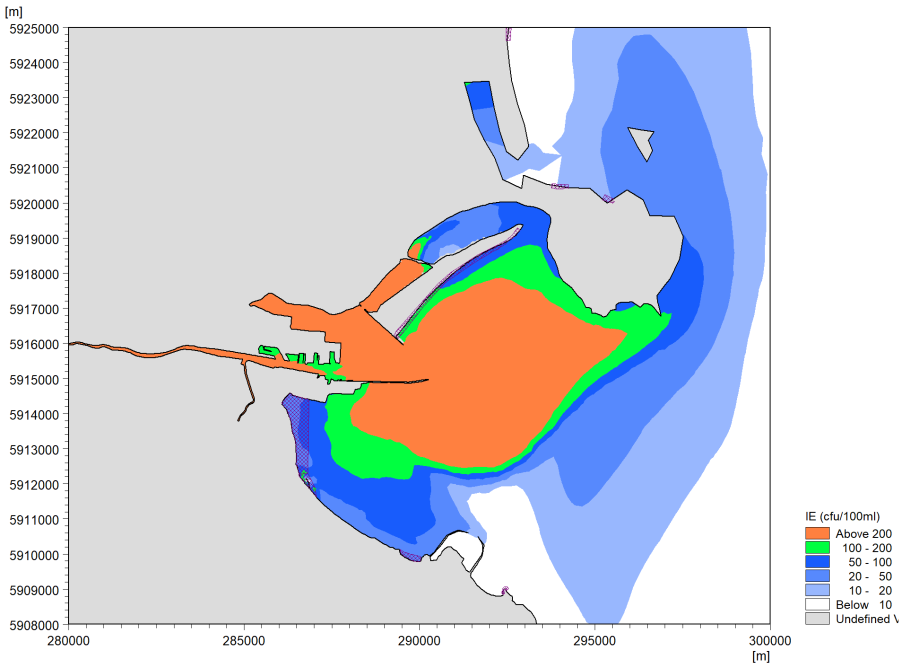
Summer

Figure 4-7 Modelled concentration of EC (mg/l, surface layer, 95%ile). Colour contours are representative of the EQS, where blue is 'Excellent', green is 'Good', and orange is less than good. Purple shading represents designated BW polygons.

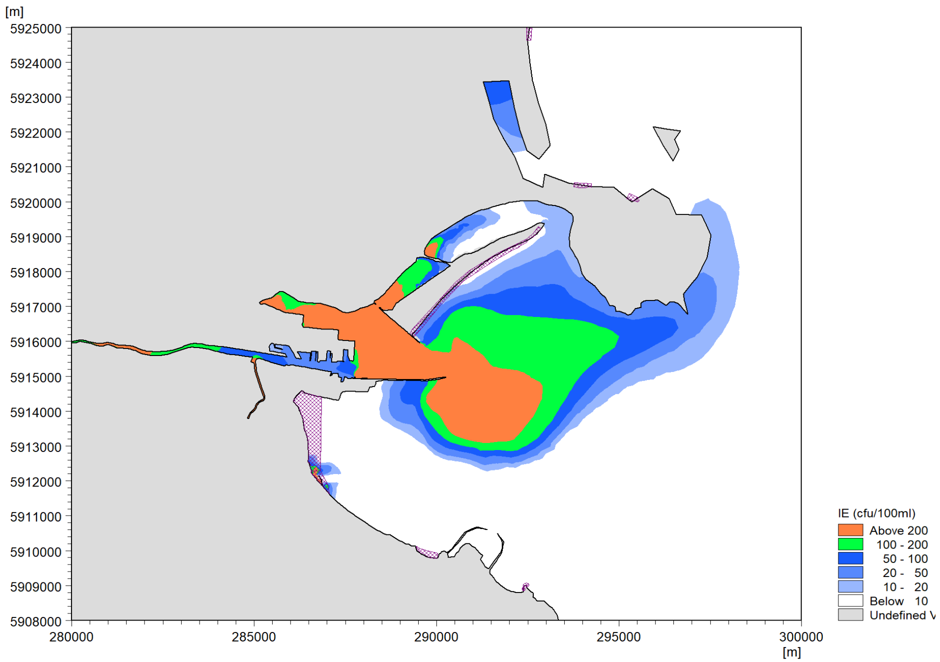


Winter **Summer**

Figure 4-8 Modelled concentration of IE (mg/l, surface layer, 95%ile). Colour contours are representative of the EQS, where blue is 'Excellent', green is 'Good', and orange is less than good. Purple shading represents designated BW polygons.

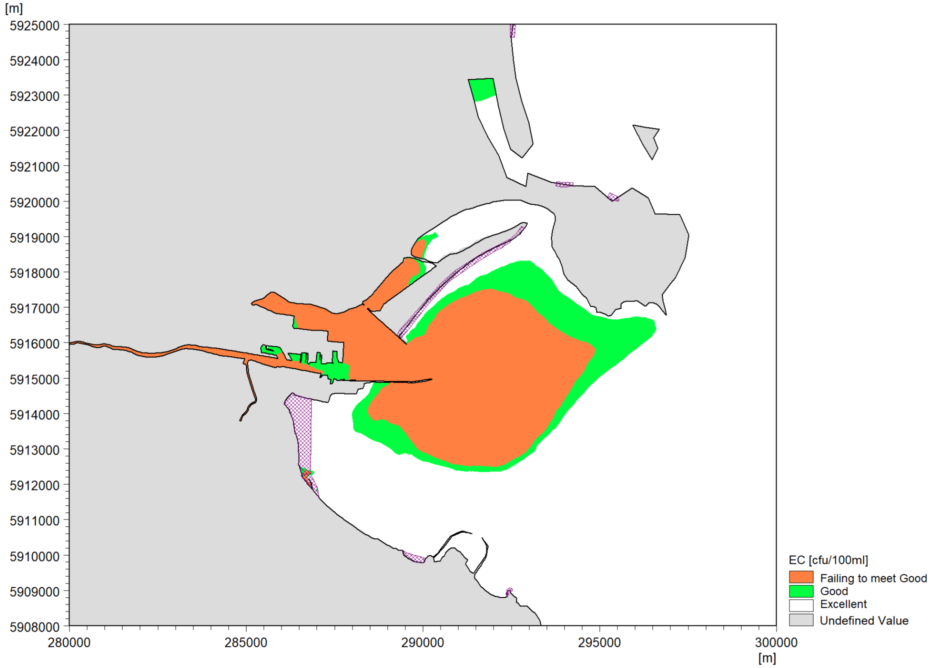


Winter

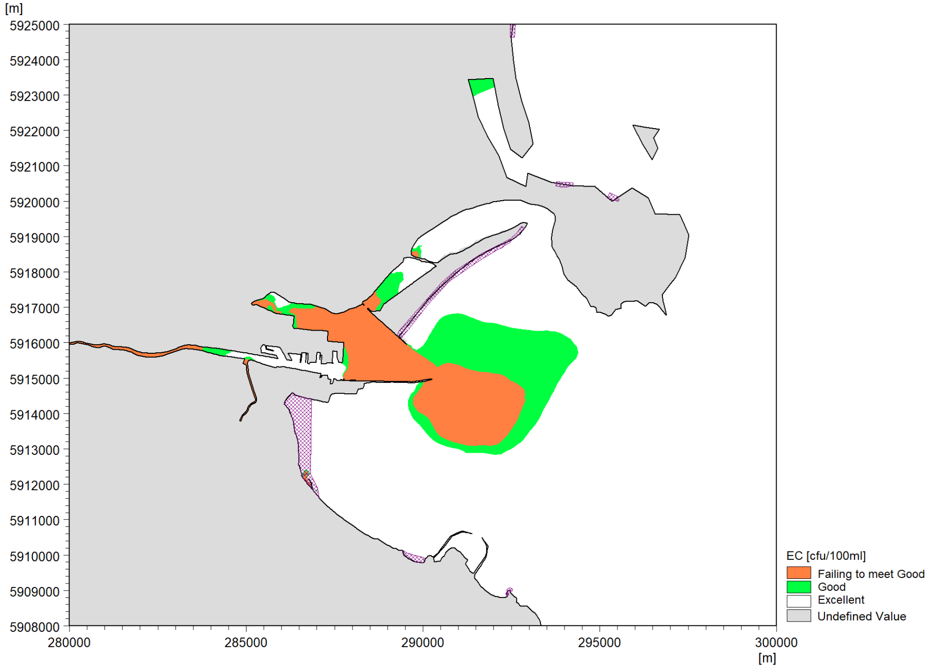


Summer

Figure 4-9 Classification of modelled concentration of EC (mg/l, surface layer, 95%ile). Colour contours are representative to the EQS, where white is Excellent, green is Good, and orange represents areas failing to meet Good. Purple shading represents designated BW polygons.

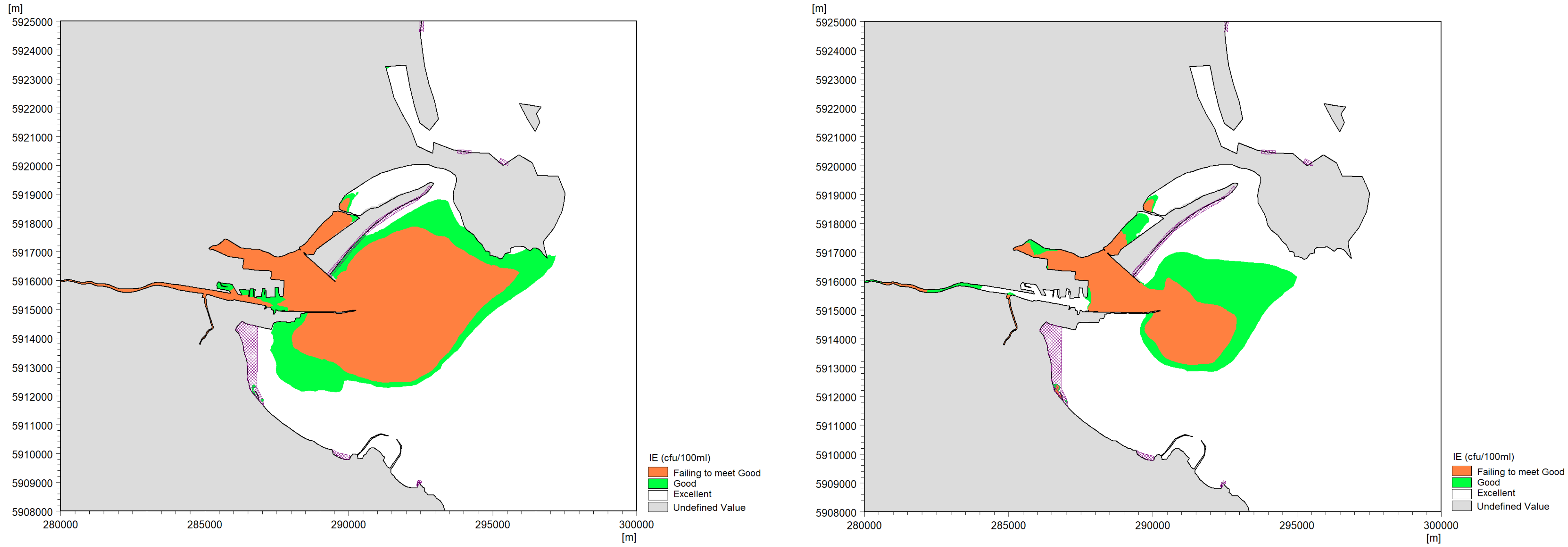


Winter



Summer

Figure 4-10 Classification of modelled concentration of IE (mg/l, surface layer, 95%ile). Colour contours are representative to the EQS, where green is Good, and orange represents areas failing to meet Good. Purple shading represents designated BW polygons.



Winter **Summer**

4.2 Future Scenario: Notionally Clean

4.2.1 DIN (Figure 4-11 & Figure 4-12)

Concentration plots for DIN under the 'notionally clean' scenario for both summer and winter are presented in Figure 4-11, while indicative quality plots are presented in Figure 4-12.

Higher concentrations are associated with the winter scenario, reflecting the higher load contribution in winter conditions from the Ringsend works.

Seasonal variability is seen in the indicative quality plots for DIN (Figure 4-12), notable through the greater extent of 'Good' indicative quality in place of 'High' indicative quality in the Tolka Estuary.

With regards the WFD objectives, the DIN EQS is applicable in the coastal Dublin Bay WB. Both summer and winter scenarios demonstrate that the modelled water quality meet the threshold of at least of 'Good' indicative quality for Dublin Bay WB with areas of 'High' indicative quality noted across all WBs in both the summer and Winter scenario.

In terms of DIN indicative quality in transitional waters, areas of 'Good' indicative quality are present in both the Tolka Estuary, and Liffey Estuary Lower WBs under the winter scenario.

4.2.2 MRP (Figure 4-13 & Figure 4-14)

Plots of MRP concentration (Figure 4-13) and indicative quality (Figure 4-14) are presented for summer and winter.

Higher overall concentrations are observed in the winter plot, as a result of the higher concentration and discharge from the Ringsend outfall associated with the winter condition.

Both scenarios see a mixing zone associated with the Ringsend discharge, with the winter mixing zone measuring approximately 200m by 2.5km, which reduces to 150m by 1.5km in the summer scenario.

Outside of the mixing zone, WFD objectives are met for the summer scenario, with no areas exceeding the threshold of 'Good' indicative quality as defined using the observed salinities within the Liffey Estuary Lower WB. Under the winter scenario, areas of the Tolka Estuary are at the 'Good' threshold, with one small area exceeding the threshold of 'Good' (as defined for the Liffey Estuary Lower WB), located at the northern end of the North Bull Wall, measuring approximately 100m by 150m. It should be noted that this area actually meets the 'Good' threshold for the Tolka Estuary WB (as shown in Figure 4-14) with a concentration of 0.048 mg P/l, against a winter threshold of 0.05 mg P/l.

Further analysis of modelled concentrations at the EPA monitoring locations for the Tolka Estuary and Liffey Estuary Lower WBs demonstrate the contributing impact from the Ringsend discharge against the relevant EQS threshold for the respective WBs. Within the Tolka Estuary, three of the five monitoring stations used within TSAS assessments are within the model domain (DB330, DB340 & DB350). Impacts from the Ringsend discharge are between 26% and 66% of the EQS threshold for winter, and between 26% and 35% for summer. For the Liffey Estuary Lower, all five monitoring points that make up TSAS calculations are within the model domain (DB120, DB210, DB220, DB410 & DB420). Here the contributing impact from the Ringsend discharge is between 13% and 48% of the EQS threshold for winter, and between 6% and 20% for summer.

Under this 'notionally clean' scenario WFD objectives are therefore met, with the Ringsend WwTP discharge utilising up to 66% of the assimilative capacity, relative to the 'Good' threshold, (at DB350, under the winter condition).

This analysis shows there is additional assimilative capacity within each waterbody (between approximately 87% and 34%) before the EQS for MRP would be exceeded at the EPA monitoring locations.

The distribution of modelled indicative qualities for MRP are very similar to that of DIN (Figure 4-14), with defined mixing zones associated with the Ringsend outfall in both winter and summer scenarios. Beyond the mixing zone, 'High' WQ prevails in the summer scenario across all WBs, indicating WFD objectives are met under a 'notionally clean' scenario. For the winter condition, areas of 'Good' Indicative quality are present in both the Tolka Estuary, and Liffey Estuary Lower WBs.

Figure 4-11 Modelled concentration of DIN (mg/l, depth average, 95%ile). Colour contours are representative to the Liffey Estuary Lower EQS, where blue is high, green is good, and orange is less than good.

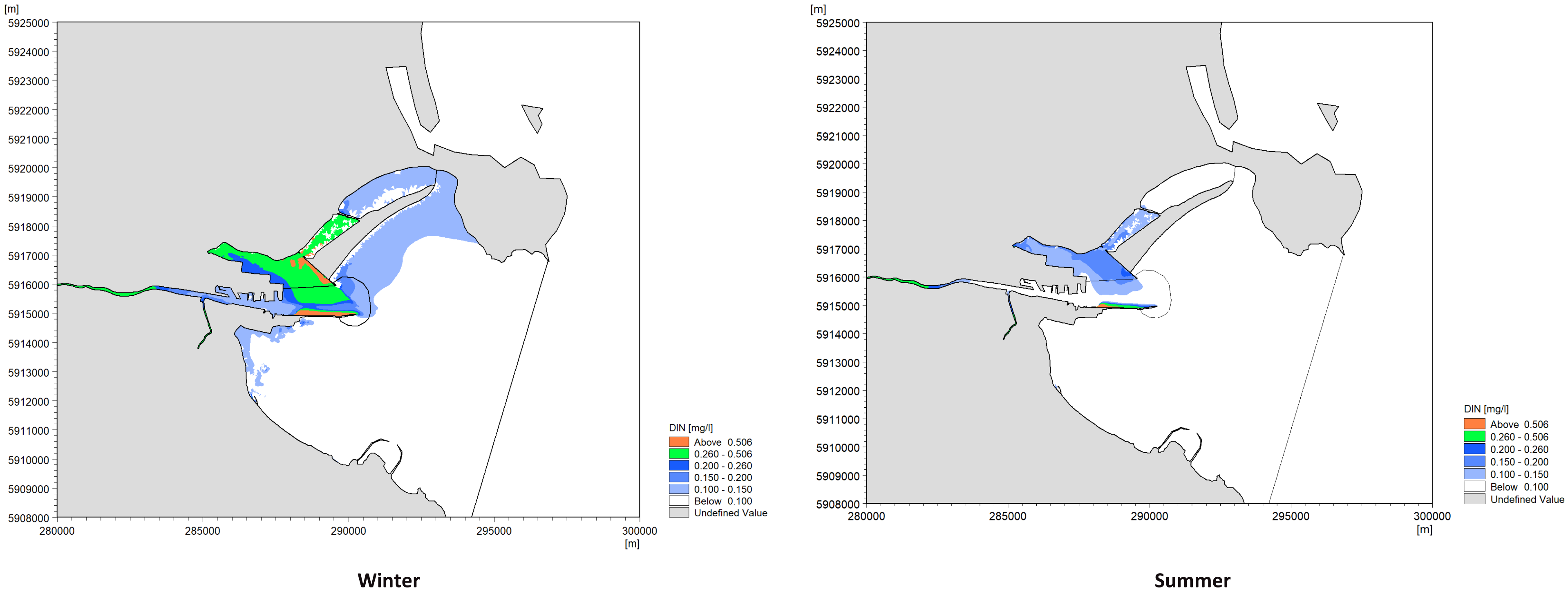


Figure 4-12 Classification of modelled DIN concentrations (mg/l, depth average, 50%ile). Colour contours are representative to the EQS within the respective TSAS assessment waterbody areas.

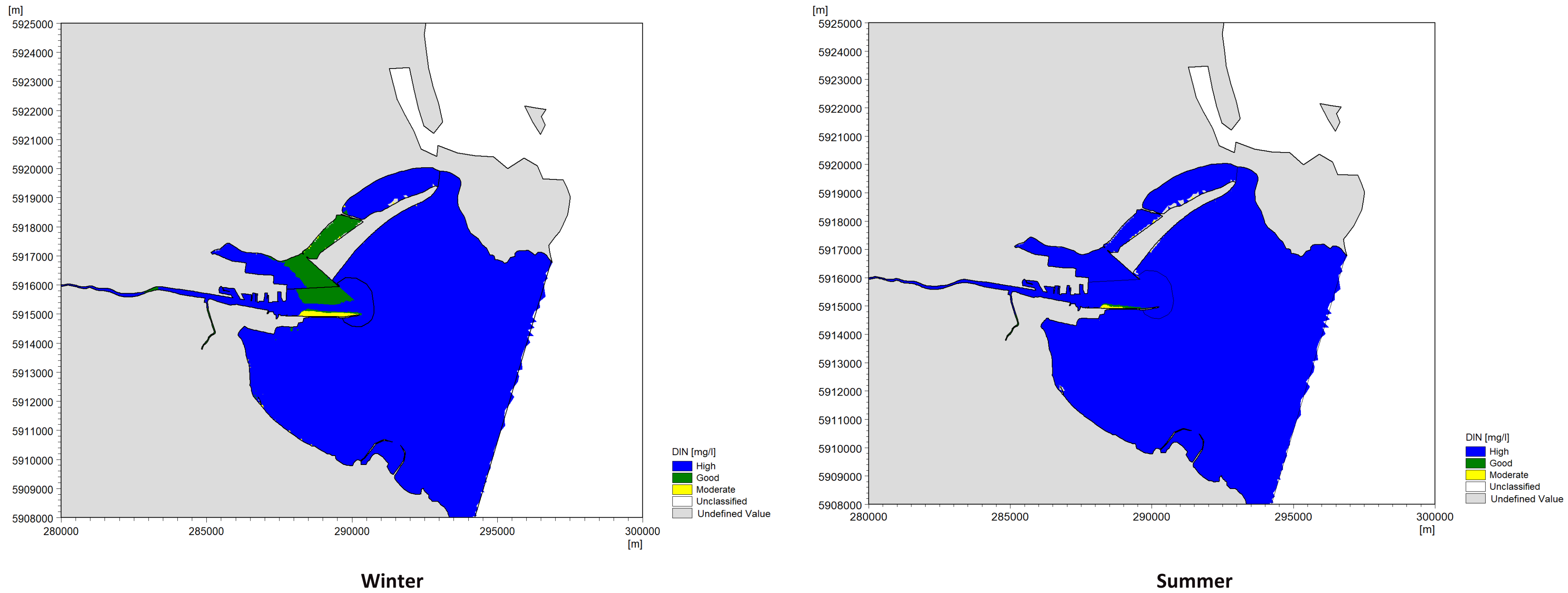
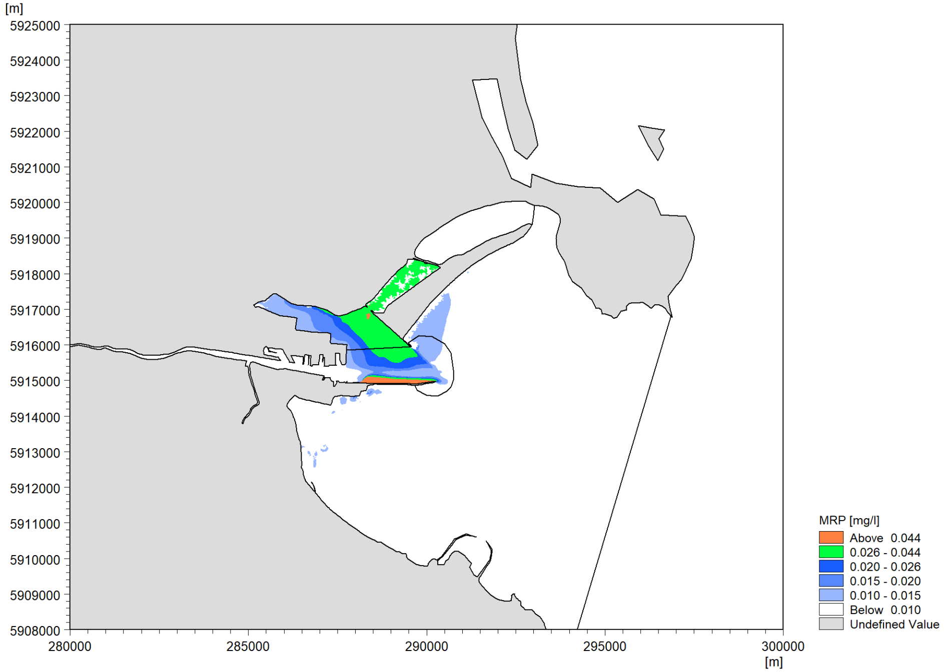
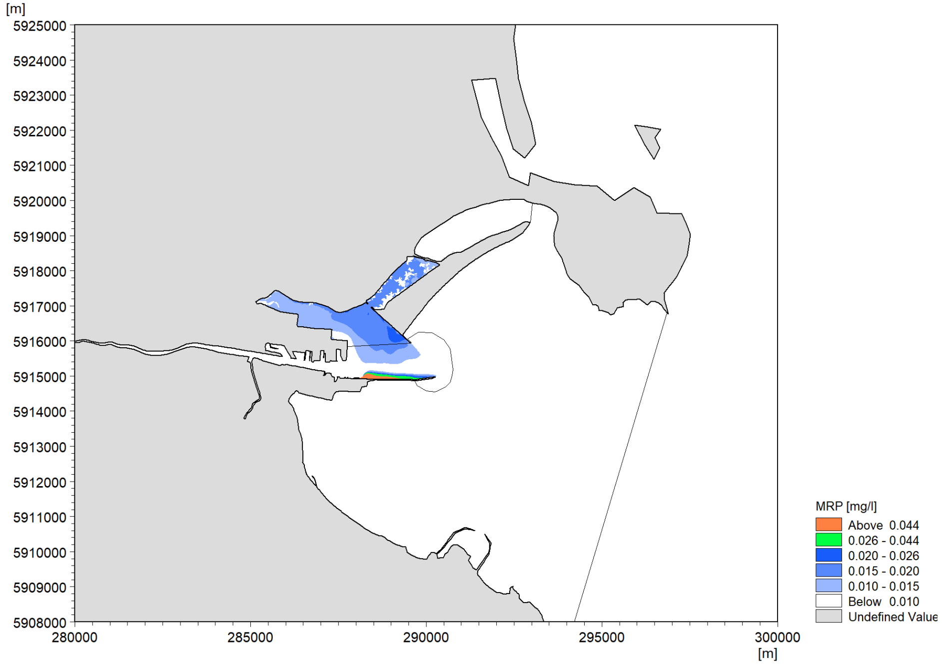


Figure 4-13 Modelled concentration of MRP (mg/l, depth average, 95%ile). Colour contours are representative to the Liffey Estuary Lower EQS, where blue is high, green is good, and orange is less than good .

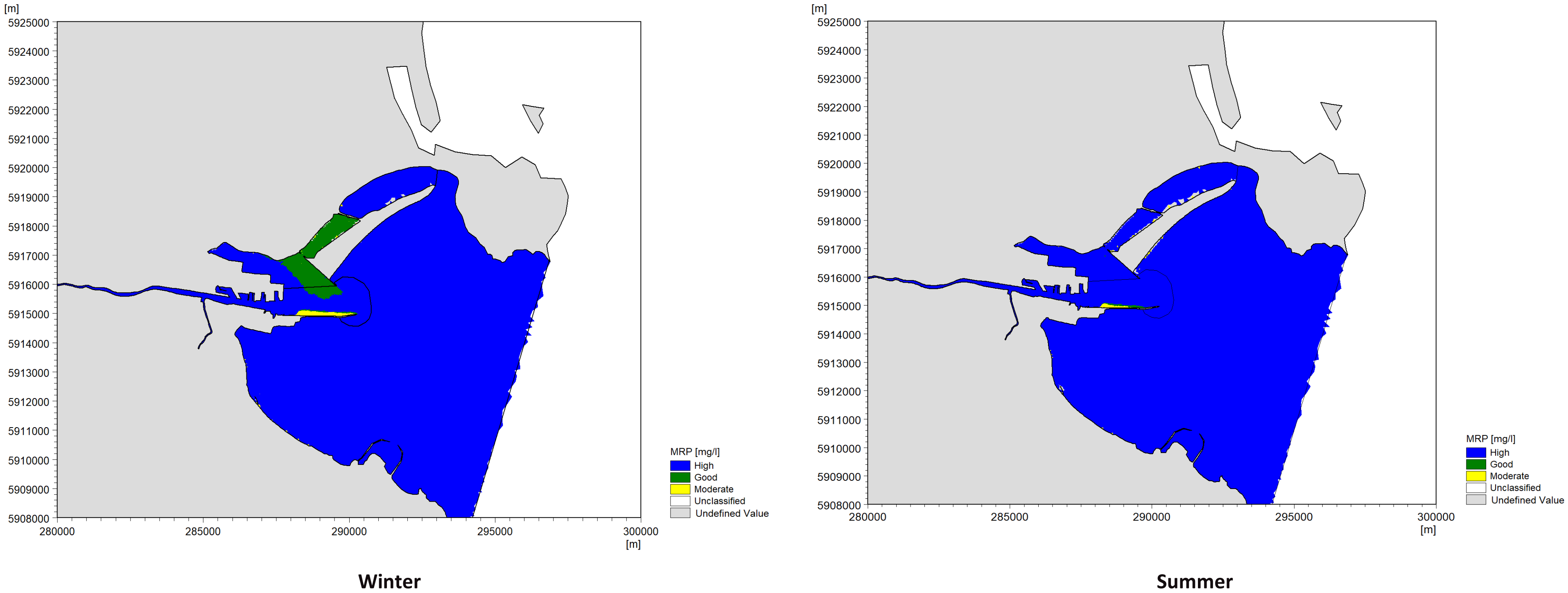


Winter



Summer

Figure 4-14 Classification of modelled MRP concentrations (mg/l, depth average, 50%ile). Colour contours are representative to the EQS within the respective TSAS assessment waterbody areas.



4.3 Future Mass Emissions Scenario

Results of the 'Mass Emissions Scenario' have been prepared as an animated dashboard covering the period of FFT discharge from Ringsend, and the time over which concentrations within the receiving waterbody return to ambient values. Snapshots from the animations are provided in Appendix B and Appendix C and described below.

4.3.1 BOD – Winter (Appendix B1) & Summer (Appendix B2)

The footprint of the mixing zone for BOD is relatively consistent across both winter and summer scenarios, with higher concentrations in winter. The extent of the mixing zone and resulting plume of elevated BOD concentrations disperses quickly after cessation of the mass emissions event. The mixing zone at HW has a smaller footprint except the first HW directly after the mass emissions discharge has just ended, while at LW the mixing zone extends along the Great South Wall, under the influence of the ebbing tide. Modelled concentrations that exceed the 'Good' threshold (green contour) are not seen to extend into Dublin Bay or across the channel into the Tolka Estuary. This indicated that, beyond the mixing zone associated with the Ringsend outfall, WFD objective of achieving 'Good' status is maintained.

4.3.2 DIN – Winter (Appendix B3) & Summer (Appendix B4)

As noted in Section 2.3, for this scenario only the Ringsend discharge is modelled with no other inputs or background concentrations. This is similar to a 'notionally clean' scenario, but without any contribution from local rivers.

In both winter and summer conditions a defined mixing plume is located next to the Ringsend outfall which is elongated along the Great South Wall. The extent of the mixing plume is slightly larger in winter than in summer.

The modelled concentrations are presented using an EQS threshold based on the observed median salinity for the Liffey Estuary Lower WB, with the blue contour for 'High' classification and green for 'Good' classification.

Away from the primary mixing plume from Ringsend, an area with modelled concentrations that exceed the 'Good' classification is observed in the Tolka Estuary WB on the north side of the estuary, against the North Bull Wall – peaking at HW immediately after the mass emission discharge has ended, with concentrations reducing thereafter. Under winter conditions this is observed for the first two days following which concentrations return to ambient conditions after the fourth day (panel 7 & 8), under summer conditions concentrations return to 'Good' on the following LW (panel 2).

4.3.3 MRP – Winter (Appendix B5) & Summer (Appendix B6)

As with the DIN scenario, only the Ringsend discharge is modelled, and no other sources are present in the simulation. This is similar to a 'notionally clean' scenario, but without any contribution from local rivers. The contour plots follow the same structure as DIN, displaying 'High' & 'Good' for the Liffey Estuary Lower WB with blue & green contours.

The general footprint of the mixing zone for MRP is similar to the mixing plume of DIN, with a primary mixing zone associated with the Ringsend outfall, and an elongated footprint along the Great South Wall. Impacts are at their greatest immediately after the mass emissions event, with an area which exceeds the 'Good' threshold observed along the North Bull Wall at HW (both summer and winter), and on the subsequent LW for the summer scenario. A small patch of less than 'Good' remains at the North Bull Wall on the subsequent LW for the winter scenario, and a day later (panel 4).

Within the Tolka Estuary, other than the times indicated above, indicative quality remains at 'High' or 'Good' status. Areas of green are routinely seen against the North Bull Wall (more evident at HW), noting this indicates at least 'Good' classification, since the green contour is based on the EQS threshold for 'Good' with respect to the Liffey Estuary Lower WB, which is slightly lower than the threshold for the Tolka Estuary WB.

4.3.4 Un-ionised Ammonia (UA) – Winter (Appendix B7) & Summer (Appendix B8)

As discussed in sections 4.1 & 4.2 the result of UA is largely unremarkable, with a very localised impact constrained within the weir structure associated with the Ringsend discharge. A very small mixing plume is observed, measuring approximately 300m by 75m. This is evident in the static plots presented in Appendix B7 & B8. As previously indicated, the non-regulatory target of 21µg/l is not exceeded in the winter scenario but is exceeded locally for the summer scenario for a small footprint of 300m by 75m.

4.4 Future Storm Tank Scenario (Summer)

4.4.1 EC – Summer (Appendix C1)

The footprint of the bacterial plume for EC, above the EQS threshold for 'Good' classification status, is shown to be at its largest extent at HW and LW (six and twelve hours) after cessation of the storm tank discharge (panel 4 & 5). Peak concentrations will have been higher than the threshold for 'Good' classification in the initial six hours after the cessation of the discharge, as during this period tidal currents will not have had sufficient time to disperse the plume over a large area.

The bacterial plume is seen to further disperse over the subsequent tide, with 'Good' classification modelled throughout the area beyond the Poolbeg Lighthouse, into Dublin Bay. Ambient conditions are achieved by the third HW (31 hours after event ends) and subsequent LW (38 hours after event ends - panels 8 & 9), with the footprint and concentrations of EC at LW (panel 8, 39 hours after the event starts) closely resembling the LW event before the storm tank scenario (panel 1), with concentrations effectively returning to ambient conditions.

As seen in the statistical plots presented in Section 4.1, the plumes are not observed to interact with the local designated BWs.

4.4.2 IE – Summer (Appendix C2)

The bacterial plume for IE is seen to develop, disperse and return to background concentrations in a similar manner to that of the EC plume. The largest footprint of the discharge plume from the Ringsend discharge, at concentrations that exceed the 'Good' threshold, are again observed on the first HW and subsequent LW after the storm tank event (panel 4 & 5, six and twelve hours after the cessation of the storm tank discharge, respectively).

As seen in the statistical plots presented in Section 4.1, the plumes are not observed to interact with the local designated BWs.

5. CONCLUSIONS

This report details WQ modelling undertaken to support a licence review for Greater Dublin Drainage Area Agglomeration.

Results from the modelling of BOD indicate a localised mixing zone around the outfall structures of the Ringsend WwTP where the EQS is not achieved locally. Results are broadly consistent between the winter and summer scenarios modelled. WFD objectives of maintaining 'Good' status are met for all areas outside of the mixing zone. As the discharge from Ringsend WwTP is discharging at concentrations above the local EQS, the presence of a mixing zone is to be expected.

For the 'Mass Emissions Scenario', the plume is seen to disperse quickly (within 24 hours) after the mass emissions event ends, and concentrations that are above the 'Good' threshold are not seen to extend into Dublin Bay or across the channel into the Tolka Estuary.

DIN

The modelling of DIN shows different impacts between the seasonal configurations, with lower impacts in summer, consistent with the lower load from the Ringsend WwTP. Under the 'Future Scenario', while there are local impacts above the 'Good' threshold in the immediate vicinity of the discharge on the lower Liffey Estuary, in Dublin Bay WB, where the DIN EQS is applicable, Good or High indicative quality was modelled for both summer and winter conditions.

Under the 'Mass Emissions Scenario', where the Ringsend discharge is modelled in isolation, areas beyond the primary mixing plume show 'Good' classification in the Tolka Estuary WB on the north side of the estuary, against the North Bull Wall. This is only observed under winter conditions for the first two days and concentrations return to ambient ('High') conditions after the fourth day.

MRP

The impact of MRP shows seasonal variability between the summer and winter scenarios. 'High' WQ dominates the summer condition for areas outside of the mixing zone of the Ringsend outfall. For the winter condition, 'Moderate' WQ is seen to extend across to the Tolka Estuary, while a larger area of 'Good' WQ is seen to encircle North Bull Island, cover the entire Tolka Estuary, and the estuary mouth of the Liffey. WFD objectives would be achieved under the summer scenario but not the winter scenario.

Under the 'notionally clean' scenario, the picture changes, with the modelling impacts achieving 'Good' status beyond the mixing zone of the Ringsend works under both summer and winter scenarios.

Under the 'Mass Emissions Scenario', where the Ringsend discharge is modelled in isolation, the footprint is primarily associated with the immediate vicinity of Ringsend WwTP. Impacts are at their greatest immediately after FFT flows cease, with an area of modelled concentrations which exceed the 'Good' threshold along the North Bull Wall at HW for the winter scenario. Other than this, WQ remains at 'High' status.

UA

The impacts of un-ionised ammonia are very localised, and contained within the outlet structures at the Ringsend outfall, with impacts not extending beyond the (repaired) weir structure.

Bacteria

For bacteria, seasonal impacts are demonstrated by a larger footprint in the winter scenarios, which is consistent with the higher overall total load (concentration and discharge) from all sources as well reduced natural decay conditions. The extent of the bacterial plume is not seen to reach or interact with local designated BW sites at Dollymount Strand and Sandymount Strand.

For the 'Storm Tank Scenario' the footprint is largest one day after the 100,000m^3 storm tank discharge event ends and modelled concentrations return back to ambient conditions within two days.

Based on the modelling undertaken the proposed discharge is likely to be compatible with the achievement of WFD objectives for the receiving transitional and coastal waterbodies, on the basis of the contributing impact from Ringsend WwTP. Under the future Scenario, all WFD objectives are met, with the exception of MRP. However, WFD objectives are met for MRP under the 'notionally clean' scenario, with Ringsend WwTP utilising between 13% and 66% of the assimilative capacity against the 'Good' threshold at the EPA monitoring locations.

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APPENDIX A

Table of Runs

A.1 TABLE OF RUNS

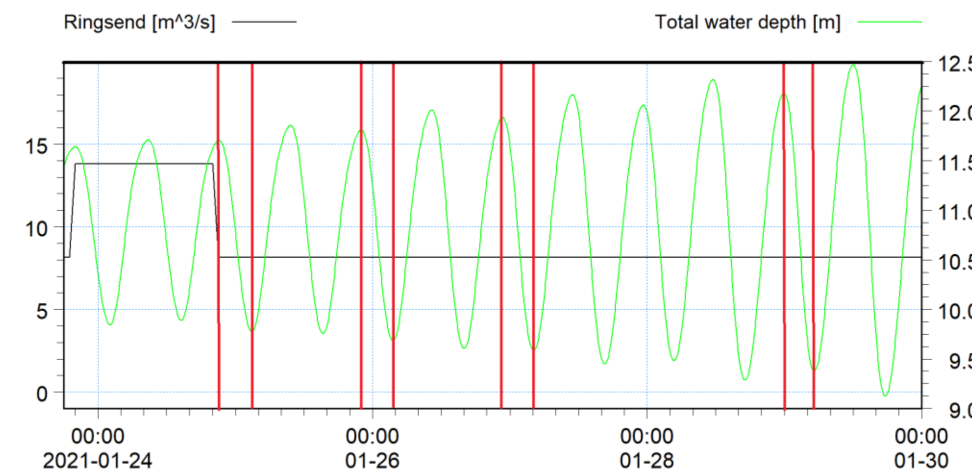
No.	Description				Physical Constraints	Rivers & Streams											Discharges					Extra
	Hydrodynamic Runs - 9 No. Water Quality Runs - 44 No.	Decay Constant	Initial Condition	Boundary Condition	ESB Cooling Water Channel	Liffey	Dodder + Slang	Tolka	Camac	Santry	Royal Canal	Grand Canal	Mayne	Sluice	Elm Park Stream	Trimleston Stream	Ringsend Effluent	Synergen Power Stn	Covanta WtE	GDD	Shanganagh Outfall	Storm Tank Discharge
1.0	Baseline (2019-2021) WINTER				Present Day (Broken)	27.2 m^3/s	3.1 m^3/s	3. m^3/s	0.8 m^3/s	0.2 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.08 m^3/s	0.03 m^3/s	6.1 m^3/s	6.1 m^3/s	3.9 m^3/s	N/A	0.35 m^3/s	N/A
1.1	BOD	2.31E-07 s^{-1}	0.75	0.5		0.67 mg/l	0.79 mg/l	1. mg/l	1.43 mg/l	0.94 mg/l	1. mg/l	1. mg/l	1.9 mg/l	1.9 mg/l	0.94 mg/l	0.94 mg/l	41.8 mg/l	0. mg/l	0. mg/l		7. mg/l	
1.2	DIN	1.93E-07 s^{-1}	0.2	0.1		2.71 mg N /l	1.36 mg N /l	2.3 mg N /l	2.01 mg N /l	2.41 mg N /l	0.7 mg N /l	0.7 mg N /l	2.54 mg N /l	2.54 mg N /l	2.41 mg N /l	2.41 mg N /l	17.8 mg N /l	0. mg N /l	0. mg N /l		14.4 mg N /l	
1.3	MRP	1.35E-07 s^{-1}	0.02	0.02		0.03 mg P /l	0.02 mg P /l	0.05 mg P /l	0.05 mg P /l	0.06 mg P /l	0.05 mg P /l	0.05 mg P /l	0.06 mg P /l	0.06 mg P /l	0.06 mg P /l	0.06 mg P /l	1.8 mg P /l	0. mg P /l	0. mg P /l		3. mg P /l	
1.4	Total Ammonia	2.31E-06 s^{-1}	0.02	0		0.04 mg N /l	0.05 mg N /l	0.06 mg N /l	0.08 mg N /l	0.05 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.05 mg N /l	0.05 mg N /l	14.5 mg N /l	0. mg N /l	0. mg N /l		0. mg N /l	
1.5	E. Coli	1.49E-05 s^{-1}	0	0		2517.3 /100ml	2180.6 /100ml	2413.8 /100ml	2982.3 /100ml	2380. /100ml	355.4 /100ml	355.4 /100ml	2500. /100ml	2500. /100ml	2010. /100ml	1018.4 /100ml	106739. /100ml	0. /100ml	0. /100ml		100000. /100ml	
1.6	Intestinal Enterococci	7.44E-06 s^{-1}	0	0		660.6 /100ml	466.5 /100ml	645.2 /100ml	364.9 /100ml	526.8 /100ml	29.25 /100ml	29.25 /100ml	500. /100ml	500. /100ml	228. /100ml	414.8 /100ml	35500. /100ml	0. /100ml	0. /100ml		16700. /100ml	
2.0	Baseline (2019-2021) SUMMER				Present Day (Broken)	9.1 m^3/s	1.4 m^3/s	0.9 m^3/s	0.3 m^3/s	0.1 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.03 m^3/s	0.01 m^3/s	4.7 m^3/s	6.1 m^3/s	3.9 m^3/s	N/A	0.35 m^3/s	N/A
2.1	BOD	2.31E-07 s^{-1}	0.75	0.5		0.71 mg/l	1.23 mg/l	1.89 mg/l	1.33 mg/l	0.73 mg/l	1. mg/l	1. mg/l	1.47 mg/l	1.47 mg/l	0.73 mg/l	0.73 mg/l	25. mg/l	0. mg/l	0. mg/l		7. mg/l	
2.2	DIN	1.16E-06 s^{-1}	0.05	0.01		2.44 mg N /l	1.26 mg N /l	1.93 mg N /l	1.26 mg N /l	1.74 mg N /l	0.4 mg N /l	0.4 mg N /l	1.51 mg N /l	1.51 mg N /l	1.74 mg N /l	1.74 mg N /l	15.4 mg N /l	0. mg N /l	0. mg N /l		14.4 mg N /l	
2.3	MRP	8.10E-07 s^{-1}	0.02	0.01		0.03 mg P /l	0.02 mg P /l	0.05 mg P /l	0.06 mg P /l	0.09 mg P /l	0.02 mg P /l	0.02 mg P /l	0.1 mg P /l	0.1 mg P /l	0.09 mg P /l	0.09 mg P /l	2.4 mg P /l	0. mg P /l	0. mg P /l		3. mg P /l	
2.4	Total Ammonia	2.31E-06 s^{-1}	0.02	0		0.04 mg N /l	0.02 mg N /l	0.06 mg N /l	0.04 mg N /l	0.02 mg N /l	0.1 mg N /l	0.1 mg N /l	0.23 mg N /l	0.23 mg N /l	0.02 mg N /l	0.02 mg N /l	10.2 mg N /l	0. mg N /l	0. mg N /l		0. mg N /l	
2.5	E. Coli	2.67E-05 s^{-1}	0	0		1011. /100ml	2170. /100ml	1587.8 /100ml	2132.6 /100ml	1580. /100ml	473.6 /100ml	473.6 /100ml	2500. /100ml	2500. /100ml	3838.4 /100ml	2197.4 /100ml	21558. /100ml	0. /100ml	0. /100ml		100000. /100ml	
2.6	Intestinal Enterococci	1.33E-05 s^{-1}	0	0		199.1 /100ml	571.6 /100ml	733.8 /100ml	816.8 /100ml	1126.77 /100ml	254.3 /100ml	254.3 /100ml	500. /100ml	500. /100ml	1263.9 /100ml	1076.8 /100ml	7373. /100ml	0. /100ml	0. /100ml		16700. /100ml	
3.0	Future Condition WINTER - Design Concentrations				Repaired	27.2 m^3/s	3.1 m^3/s	3. m^3/s	0.8 m^3/s	0.2 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.08 m^3/s	0.03 m^3/s	8.15 m^3/s	6.1 m^3/s	3.9 m^3/s	1.63 m^3/s	0.52 m^3/s	N/A
3.1	BOD	2.31E-07 s^{-1}	0.75	0.5		0.67 mg/l	0.79 mg/l	1. mg/l	1.43 mg/l	0.94 mg/l	1. mg/l	1. mg/l	1.9 mg/l	1.9 mg/l	0.94 mg/l	0.94 mg/l	25. mg/l	0. mg/l	0. mg/l	25. mg/l	13. mg/l	
3.2	DIN	1.93E-07 s^{-1}	0.2	0.1		2.71 mg N /l	1.36 mg N /l	2.3 mg N /l	2.01 mg N /l	2.41 mg N /l	0.7 mg N /l	0.7 mg N /l	2.54 mg N /l	2.54 mg N /l	2.41 mg N /l	2.41 mg N /l	15. mg N /l	0. mg N /l	0. mg N /l	50. mg N /l	45. mg N /l	
3.3	MRP	1.35E-07 s^{-1}	0.02	0.02		0.03 mg P /l	0.02 mg P /l	0.05 mg P /l	0.05 mg P /l	0.06 mg P /l	0.05 mg P /l	0.05 mg P /l	0.06 mg P /l	0.06 mg P /l	0.06 mg P /l	0.06 mg P /l	1.2 mg P /l	0. mg P /l	0. mg P /l	4.8 mg P /l	2.5 mg P /l	
3.4	Total Ammonia	2.31E-06 s^{-1}	0.02	0		0.04 mg N /l	0.05 mg N /l	0.06 mg N /l	0.08 mg N /l	0.05 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.05 mg N /l	0.05 mg N /l	1. mg N /l	0. mg N /l	0. mg N /l	44.4 mg N /l	40. mg N /l	
3.5	E. Coli	1.49E-05 s^{-1}	0	0		2517.3 /100ml	2180.6 /100ml	2413.8 /100ml	2982.3 /100ml	2380. /100ml	355.4 /100ml	355.4 /100ml	2500. /100ml	2500. /100ml	2010. /100ml	1018.4 /100ml	106739. /100ml	0. /100ml	0. /100ml	20000. /100ml	125000. /100ml	
3.6	Intestinal Enterococci	7.44E-06 s^{-1}	0	0		660.6 /100ml	466.5 /100ml	645.2 /100ml	364.9 /100ml	526.8 /100ml	29.25 /100ml	29.25 /100ml	500. /100ml	500. /100ml	228. /100ml	414.8 /100ml	35500. /100ml	0. /100ml	0. /100ml	10000. /100ml	31250. /100ml	
4.0	Future Condition SUMMER - Design Concentrations				Repaired	9.1 m^3/s	1.4 m^3/s	0.9 m^3/s	0.3 m^3/s	0.1 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.03 m^3/s	0.01 m^3/s	6.05 m^3/s	6.1 m^3/s	3.9 m^3/s	1.63 m^3/s	0.52 m^3/s	N/A
4.1	BOD	2.31E-07 s^{-1}	0.75	0.5		0.71 mg/l	1.23 mg/l	1.89 mg/l	1.33 mg/l	0.73 mg/l	1. mg/l	1. mg/l	1.47 mg/l	1.47 mg/l	0.73 mg/l	0.73 mg/l	25. mg/l	0. mg/l	0. mg/l	25. mg/l	13. mg/l	
4.2	DIN	1.16E-06 s^{-1}	0.05	0.01		2.44 mg N /l	1.26 mg N /l	1.93 mg N /l	1.26 mg N /l	1.74 mg N /l	0.4 mg N /l	0.4 mg N /l	1.51 mg N /l	1.51 mg N /l	1.74 mg N /l	1.74 mg N /l	6.3 mg N /l	0. mg N /l	0. mg N /l	50. mg N /l	45. mg N /l	
4.3	MRP	8.10E-07 s^{-1}	0.02	0.01		0.03 mg P /l	0.02 mg P /l	0.05 mg P /l	0.06 mg P /l	0.09 mg P /l	0.02 mg P /l	0.02 mg P /l	0.1 mg P /l	0.1 mg P /l	0.09 mg P /l	0.09 mg P /l	0.7 mg P /l	0. mg P /l	0. mg P /l	4.8 mg P /l	2.5 mg P /l	
4.4	Total Ammonia	2.31E-06 s^{-1}	0.02	0		0.04 mg N /l	0.02 mg N /l	0.06 mg N /l	0.04 mg N /l	0.02 mg N /l	0.1 mg N /l	0.1 mg N /l	0.23 mg N /l	0.23 mg N /l	0.02 mg N /l	0.02 mg N /l	1. mg N /l	0. mg N /l	0. mg N /l	38.9 mg N /l	35. mg N /l	
4.5	E. Coli	2.67E-05 s^{-1}	0	0		1011. /100ml	2170. /100ml	1587.8 /100ml	2132.6 /100ml	1580. /100ml	473.6 /100ml	473.6 /100ml	2500. /100ml	2500. /100ml	3838.4 /100ml	2197.4 /100ml	100000. /100ml	0. /100ml	0. /100ml	20000. /100ml	100000. /100ml	
4.6	Intestinal Enterococci	1.33E-05 s^{-1}	0	0		199.1 /100ml	571.6 /100ml	733.8 /100ml	816.8 /100ml	1126.77 /100ml	254.3 /100ml	254.3 /100ml	500. /100ml	500. /100ml	1263.9 /100ml	1076.8 /100ml	25000. /100ml	0. /100ml	0. /100ml	10000. /100ml	25000. /100ml	
5.0	Notionally Clean Future Condition WINTER - Design Concentrations				Repaired	27.2 m^3/s	3.1 m^3/s	3. m^3/s	0.8 m^3/s	0.2 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.08 m^3/s	0.03 m^3/s	8.15 m^3/s	6.1 m^3/s	3.9 m^3/s	1.63 m^3/s	0.52 m^3/s	~~N/A~~
5.1	DIN	1.93E-07 s^{-1}	0	0		0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	15. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	
5.2	MRP	1.35E-07 s^{-1}	0	0		0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	1.2 mg P /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	
6.0	Notionally Clean Future Condition SUMMER - Design Concentrations				Repaired	9.1 m^3/s	1.4 m^3/s	0.9 m^3/s	0.3 m^3/s	0.1 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.03 m^3/s	0.01 m^3/s	6.05 m^3/s	6.1 m^3/s	3.9 m^3/s	1.63 m^3/s	0.52 m^3/s	~~N/A~~
6.1	DIN	1.16E-06 s^{-1}	0	0		0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	0.32 mg N /l	6.3 mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	
6.2	MRP	8.10E-07 s^{-1}	0	0		0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.006 mg N /l	0.7 mg P /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	
7.0	Future Condition WINTER - Mass Emission Load Scenarios				Repaired	27.2 m^3/s	3.1 m^3/s	3. m^3/s	0.8 m^3/s	0.2 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.08 m^3/s	0.03 m^3/s	Time Series	6.1 m^3/s	3.9 m^3/s	Time Series	0.52 m^3/s	N/A
7.1	BOD	2.31E-07 s^{-1}	0.75	0.5		0.67 mg/l	0.79 mg/l	1. mg/l	1.43 mg/l	0.94 mg/l	1. mg/l	1. mg/l	1.9 mg/l	1.9 mg/l	0.94 mg/l	0.94 mg/l	25. mg/l	0. mg/l	0. mg/l	25. mg/l	13. mg/l	
7.2	DIN	1.93E-07 s^{-1}	0	0		0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	9. mg N /l	0. mg N /l	0. mg N /l	0. mg/l	0. mg/l	
7.3	MRP	0.000000135	0	0		0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0.7 mg P /l	0. mg P /l	0. mg P /l	0. mg/l	0. mg/l	
7.4	Total Ammonia	0.00000231	0.02	0		0.04 mg N /l	0.05 mg N /l	0.06 mg N /l	0.08 mg N /l	0.05 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.1 mg N /l	0.05 mg N /l	0.05 mg N /l	1. mg N /l	0. mg N /l	0. mg N /l	44.4 mg/l	40. mg/l	
8.0	Future Condition SUMMER - Mass Emission Load Scenarios				Repaired	9.1 m^3/s	1.4 m^3/s	0.9 m^3/s	0.3 m^3/s	0.1 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.03 m^3/s	0.01 m^3/s	Time Series	6.1 m^3/s	3.9 m^3/s	Time Series	0.52 m^3/s	N/A
8.1	BOD	2.31481E-07	0.75	0.5		0.71 mg/l	1.23 mg/l	1.89 mg/l	1.33 mg/l	0.73 mg/l	1. mg/l	1. mg/l	1.47 mg/l	1.47 mg/l	0.73 mg/l	0.73 mg/l	25. mg/l	0. mg/l	0. mg/l	25. mg/l	13. mg/l	
8.2	DIN	0.00000116	0	0		0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	0. mg N /l	6.3 mg N /l	0. mg N /l	0. mg N /l	0. mg/l	0. mg/l	
8.3	MRP	0.00000081	0	0		0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0. mg P /l	0.7 mg P /l	0. mg P /l	0. mg P /l	0. mg/l	0. mg/l	
8.4	Total Ammonia	0.00000231	0.02	0		0.04 mg N /l	0.02 mg N /l	0.06 mg N /l	0.04 mg N /l	0.02 mg N /l	0.1 mg N /l	0.1 mg N /l	0.23 mg N /l	0.23 mg N /l	0.02 mg N /l	0.02 mg N /l	1. mg N /l	0. mg N /l	0. mg N /l	38.9 mg/l	35. mg/l	
9.0	Future Condition SUMMER - Storm Tank discharge				Repaired	9.1 m^3/s	1.4 m^3/s	0.9 m^3/s	0.3 m^3/s	0.1 m^3/s	0.1 m^3/s	0.1 m^3/s	0.2 m^3/s	0.4 m^3/s	0.03 m^3/s	0.01 m^3/s	Time Series	6.1 m^3/s	3.9 m^3/s	Time Series	0.52 m^3/s	Time Series
9.5	E. Coli	2.66503E-05	0	0		1011. /100ml	2170. /100ml	1587.8 /100ml	2132.6 /100ml	1580. /100ml	473.6 /100ml	473.6 /100ml	2500. /100ml	2500. /100ml	3838.4 /100ml	2197.4 /100ml	21558. /100ml	0. /100ml	0. /100ml	20000. /100ml	100000. /100ml	2600000. /100ml
9.6	Intestinal Enterococci	1.33251E-05	0	0		199.1 /100ml	571.6 /100ml	733.8 /100ml	816.8 /100ml	1126.77 /100ml	254.3 /100ml	254.3 /100ml	500. /100ml	500. /100ml	1263.9 /100ml	1076.8 /100ml	7373. /100ml	0. /100ml	0. /100ml	10000. /100ml	25000. /100ml	300000. /100ml

WQ Data Source:
Acclimatize
EPA
Donor EPA Data
DHI (Original Study)
Irish Water / Uisce Eireann

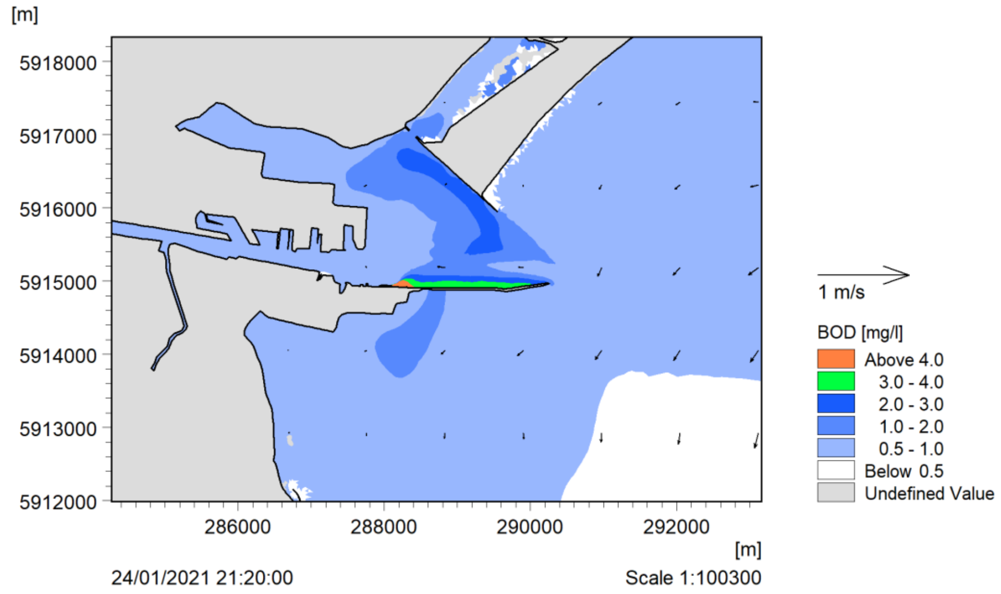
APPENDIX B

Results: Mass Emissions Scenario

B.1 BOD (WINTER) – MASS EMISSIONS SCENARIO



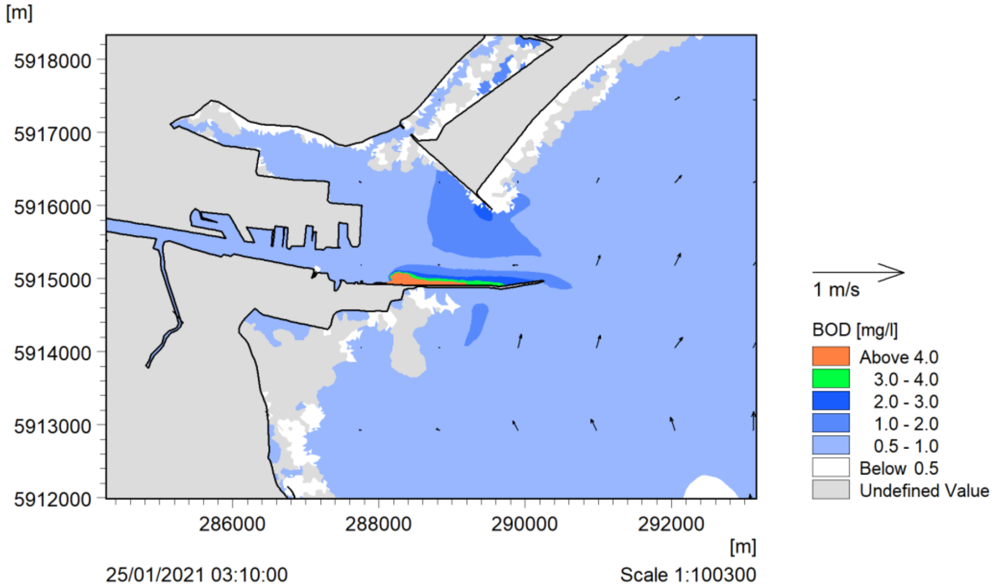
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



BOD 1

Mass Emissions – Winter

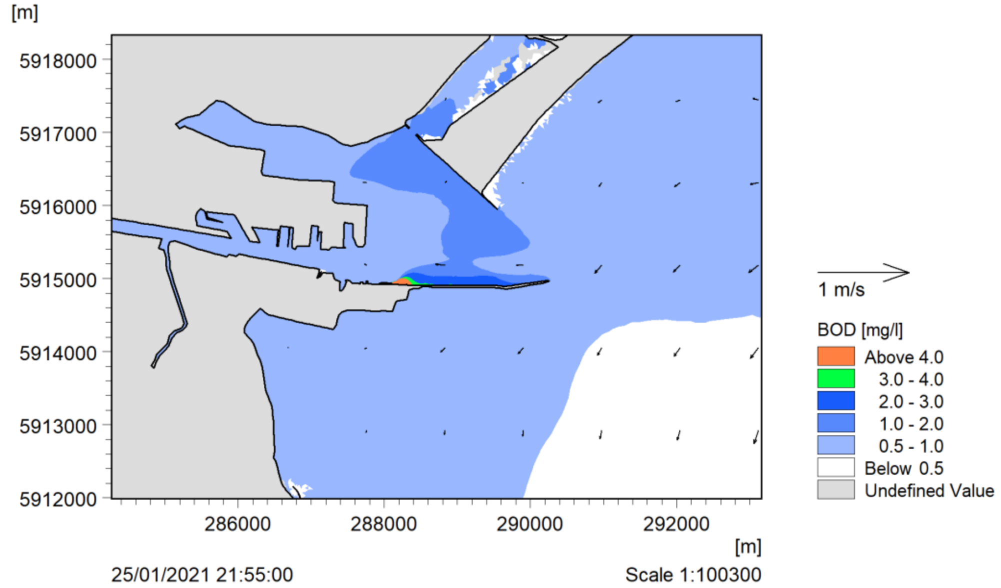
HW coinciding with the end of the mass emissions discharge.



BOD 2

Mass Emissions – Winter

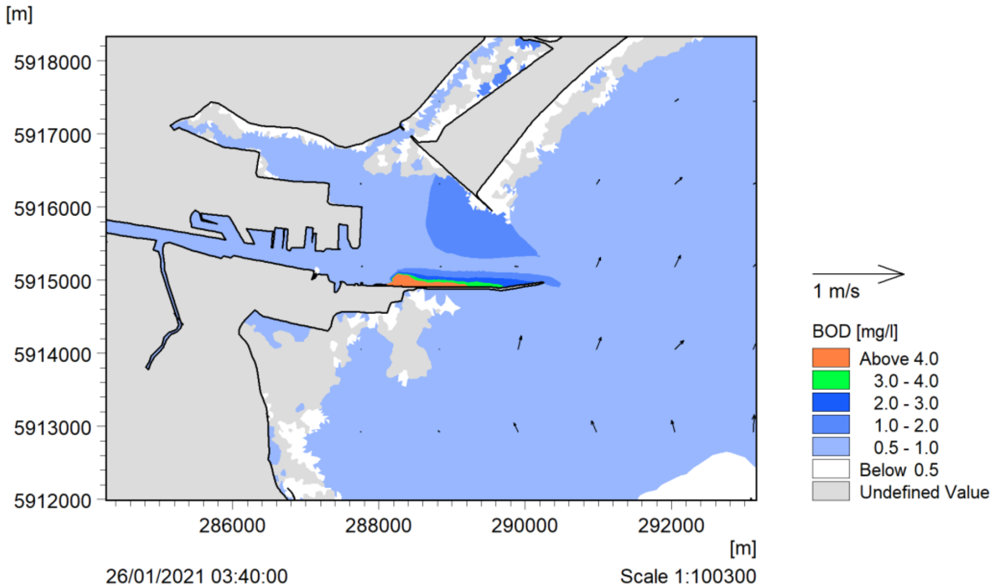
LW approximately 6 hours after end of the mass emissions discharge.



BOD 3

Mass Emissions – Winter

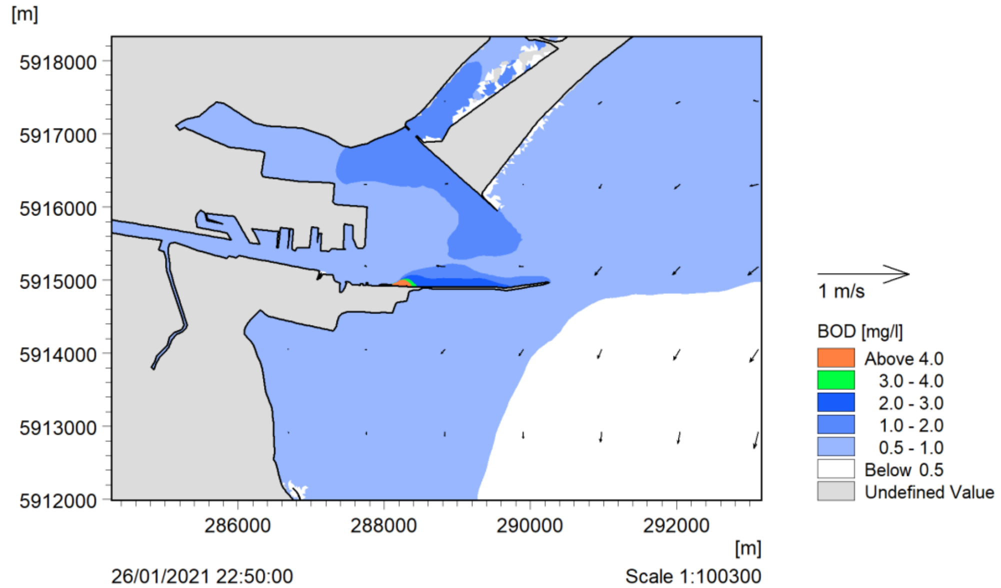
HW, 1 day after the end of the mass emissions discharge.



BOD 4

Mass Emissions – Winter

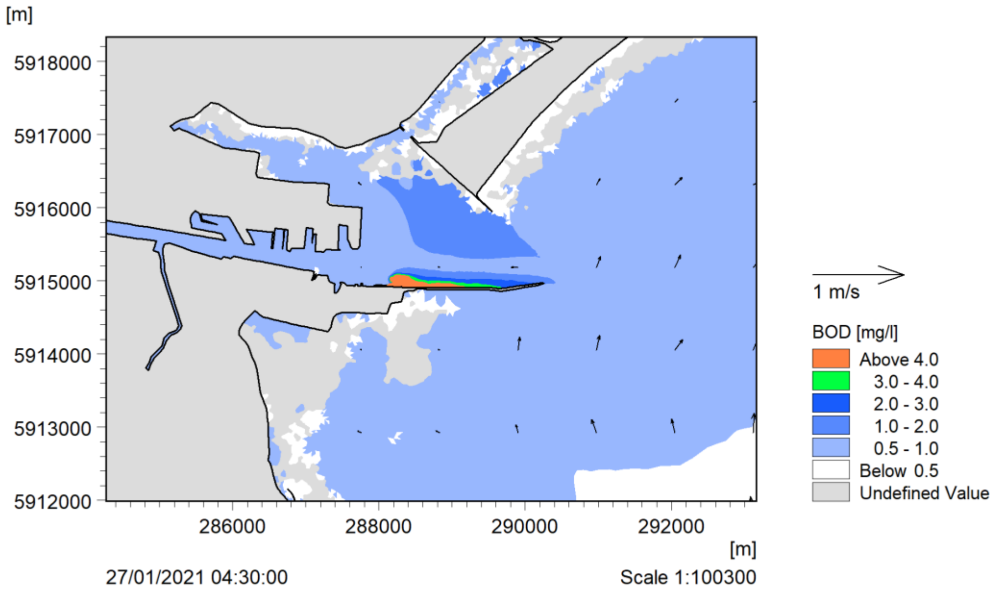
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



BOD 5

Mass Emissions – Winter

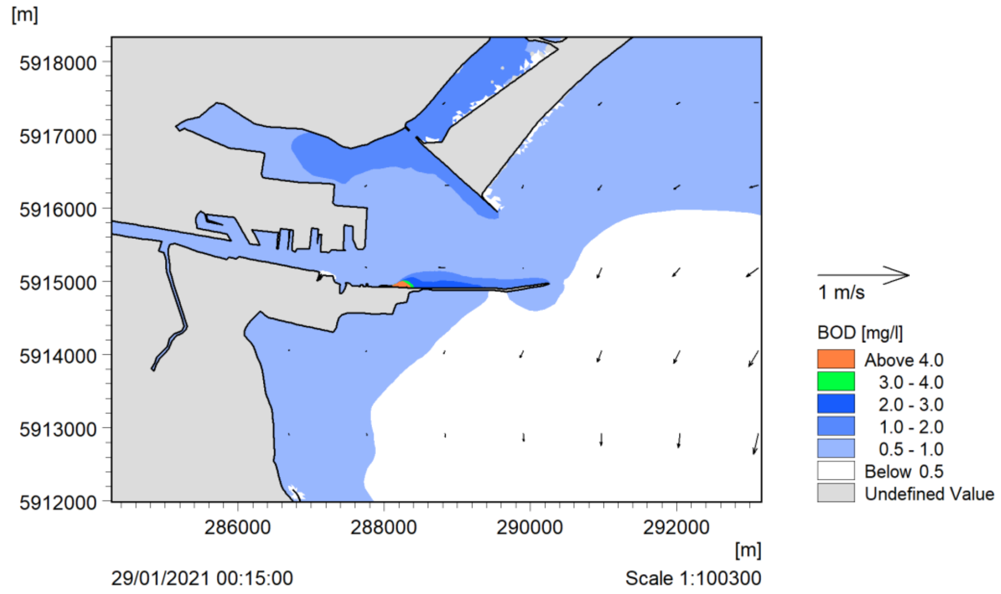
HW, 2 days after the end of the mass emissions discharge.



BOD 6

Mass Emissions – Winter

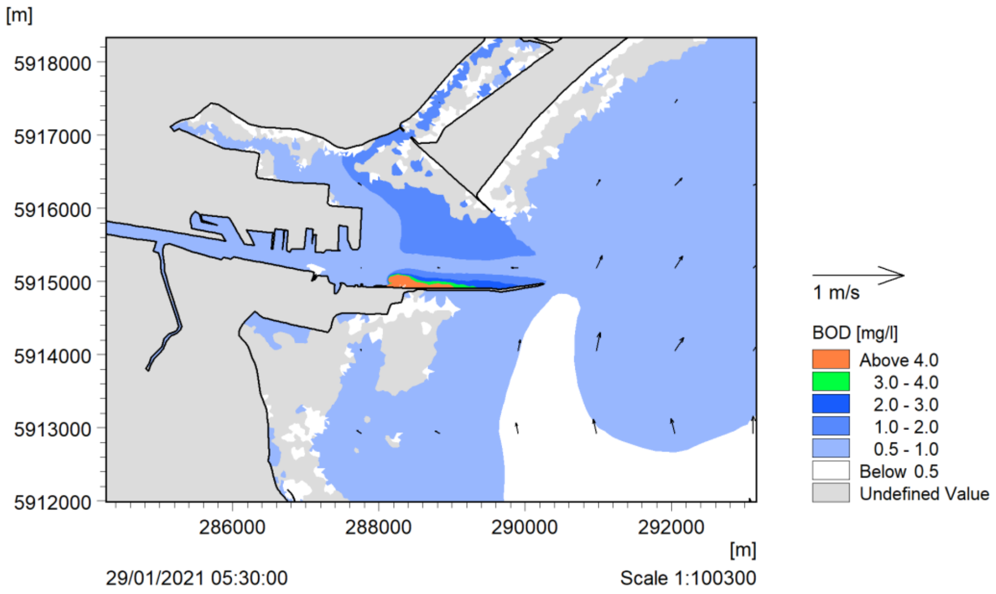
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



BOD 7

Mass Emissions – Winter

HW, 4 days after the end of the mass emissions discharge.

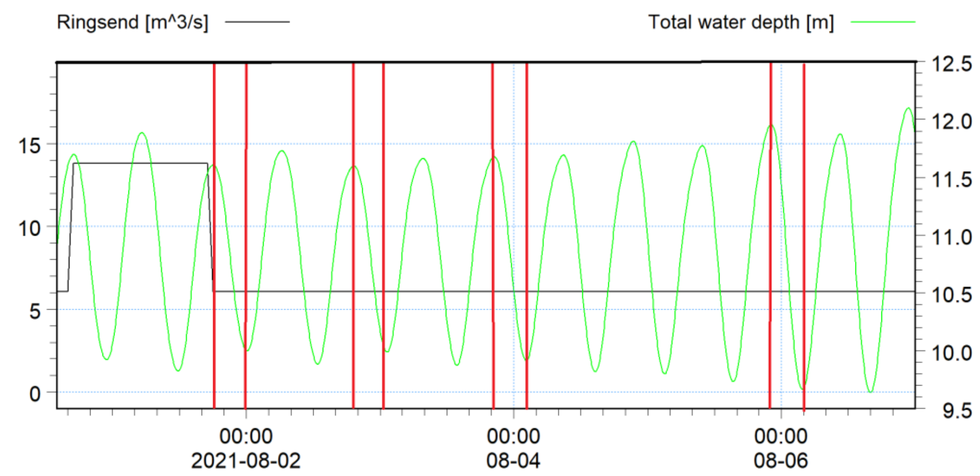


BOD 8

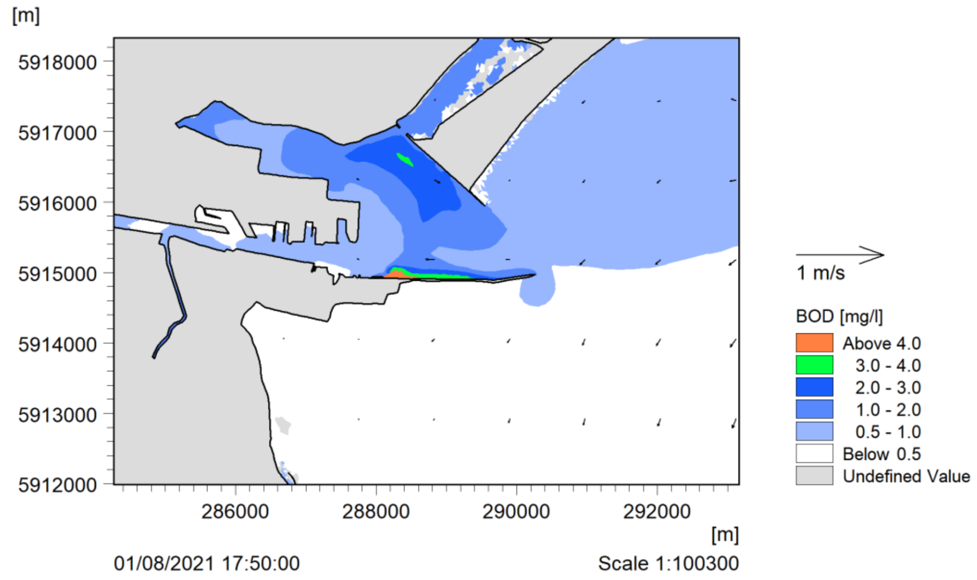
Mass Emissions – Winter

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.2 BOD (SUMMER) – MASS EMISSIONS SCENARIO



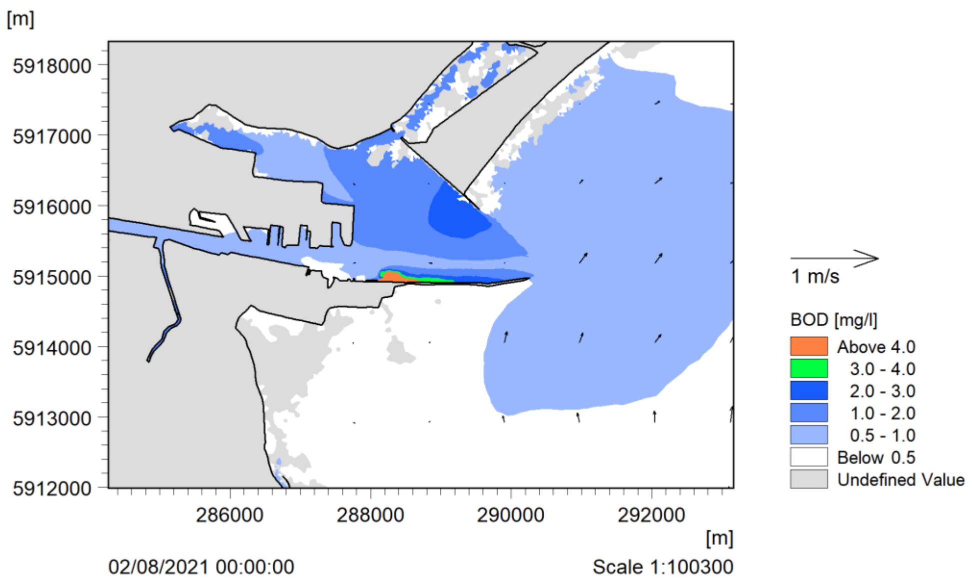
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



BOD 1

Mass Emissions – Summer

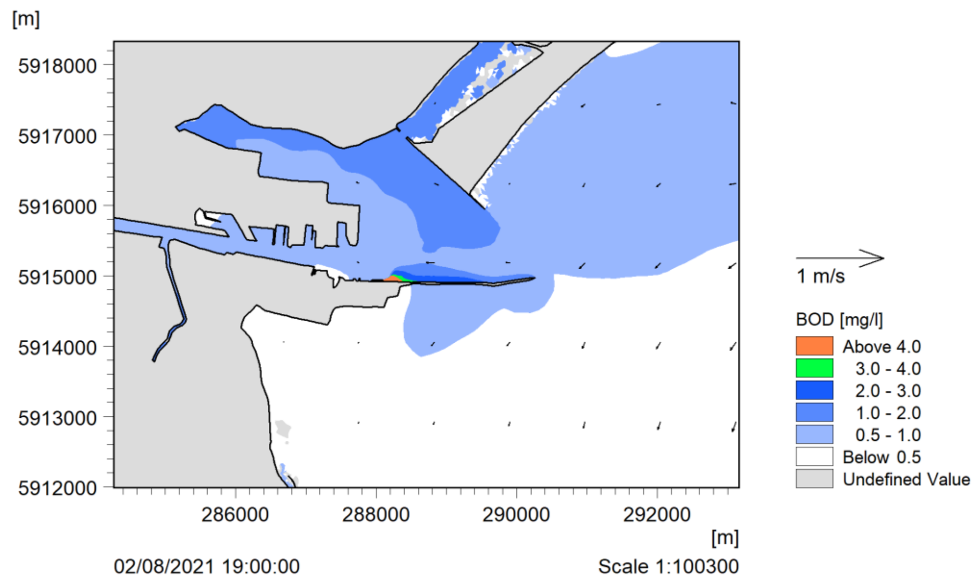
HW coinciding with the end of the mass emissions discharge.



BOD 2

Mass Emissions – Summer

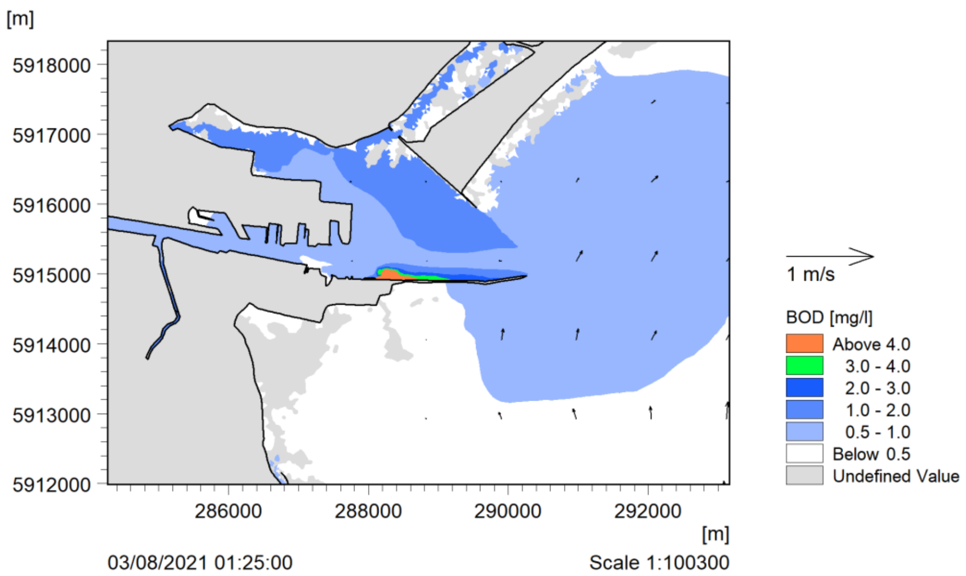
LW approximately 6 hours after end of the mass emissions discharge.



BOD 3

Mass Emissions – Summer

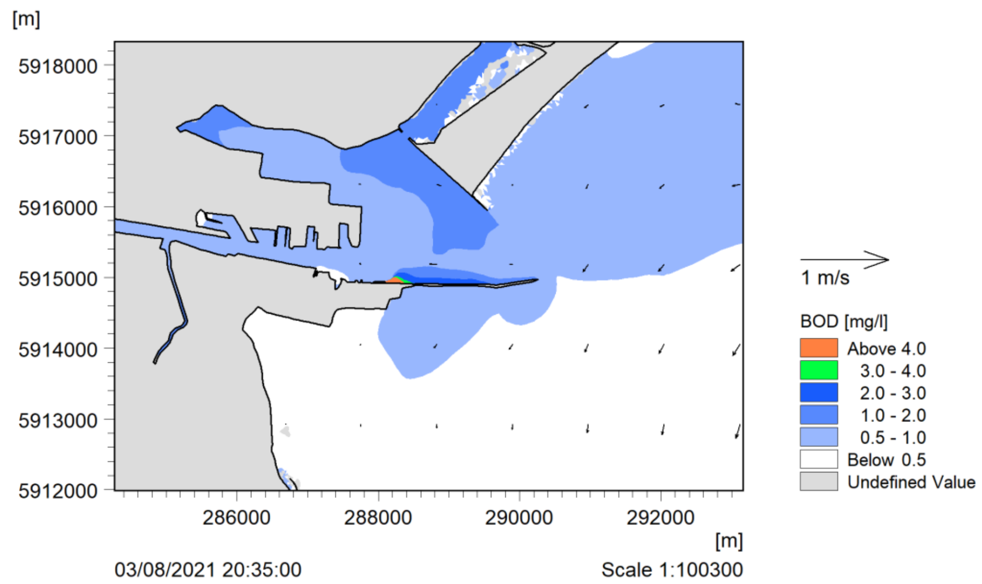
HW, 1 day after the end of the mass emissions discharge.



BOD 4

Mass Emissions – Summer

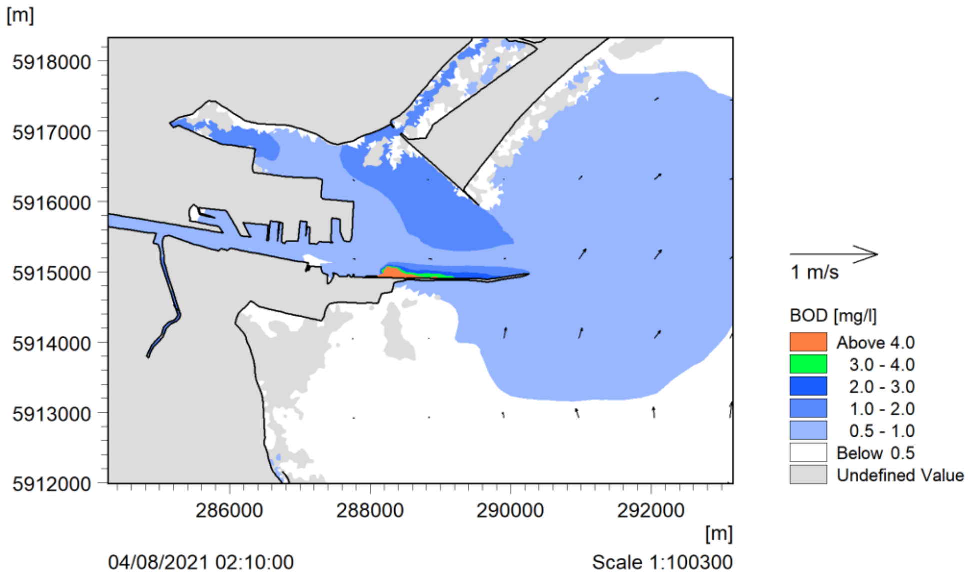
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



BOD 5

Mass Emissions – Summer

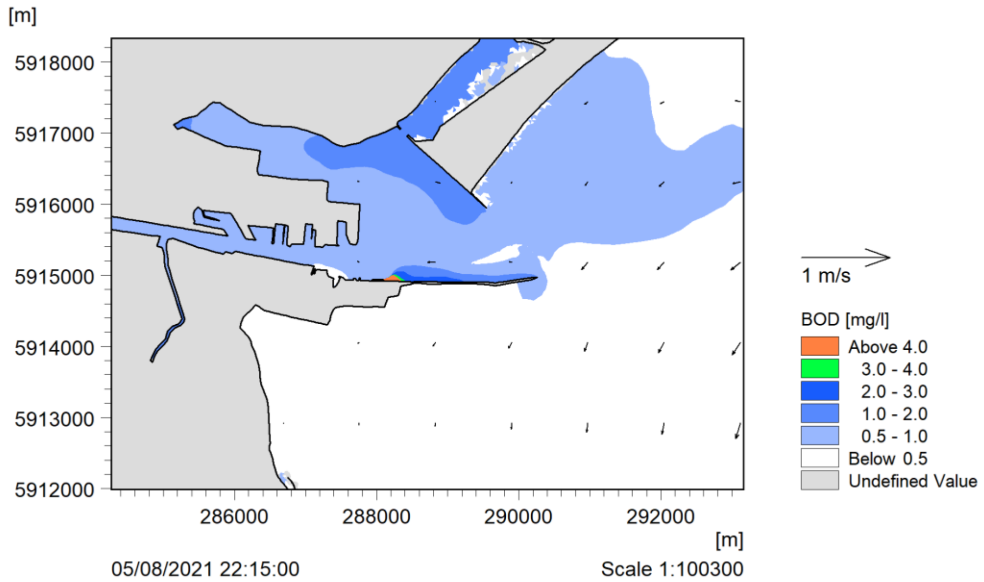
HW, 2 days after the end of the mass emissions discharge.



BOD 6

Mass Emissions – Summer

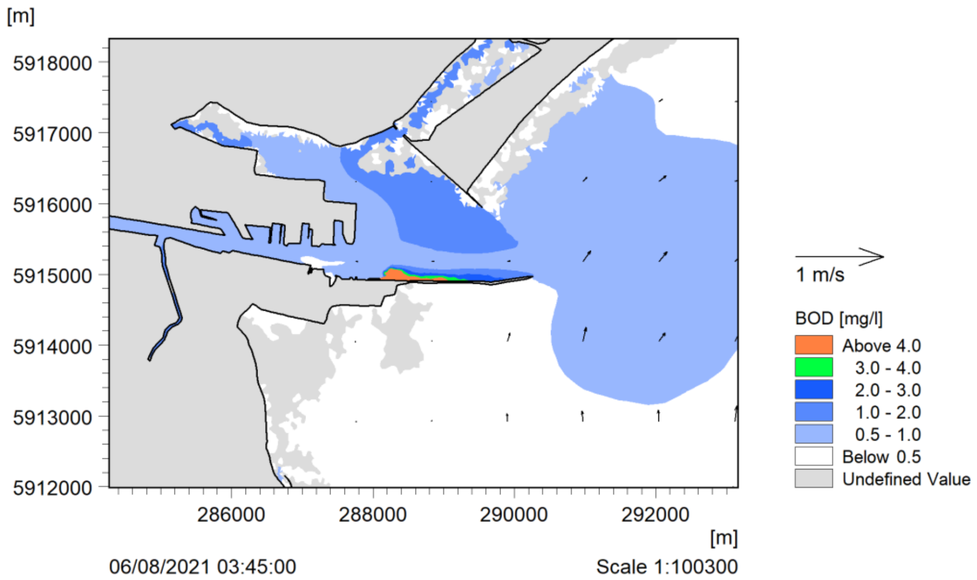
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



BOD 7

Mass Emissions – Summer

HW, 4 days after the end of the mass emissions discharge.

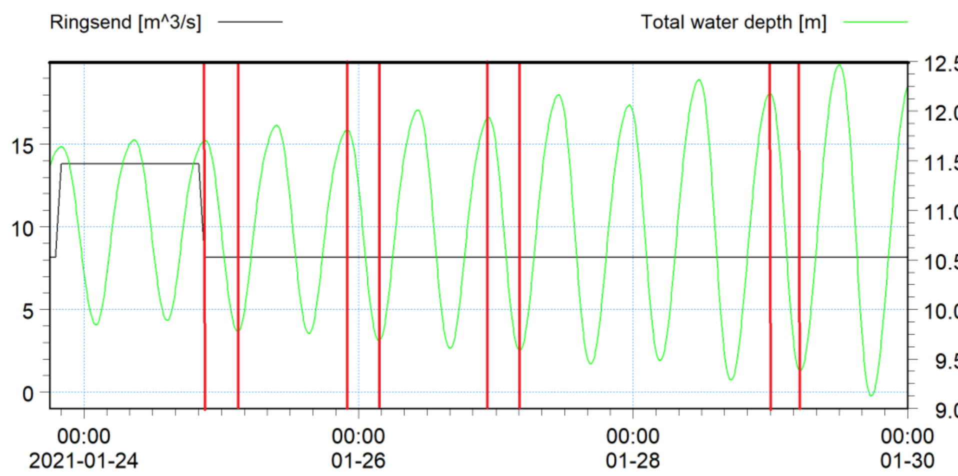


BOD 8

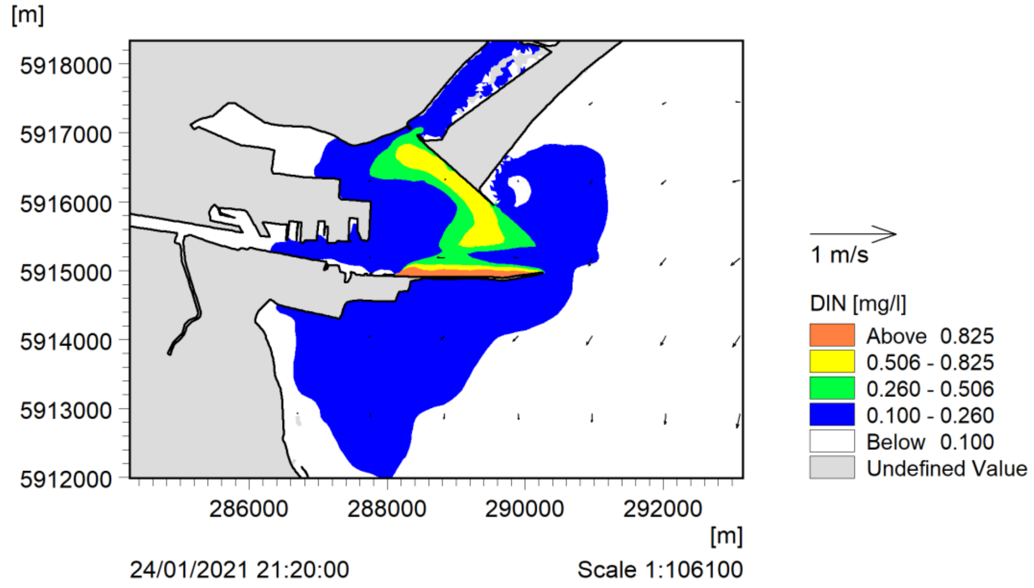
Mass Emissions – Summer

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.3 DIN (WINTER) – MASS EMISSIONS SCENARIO



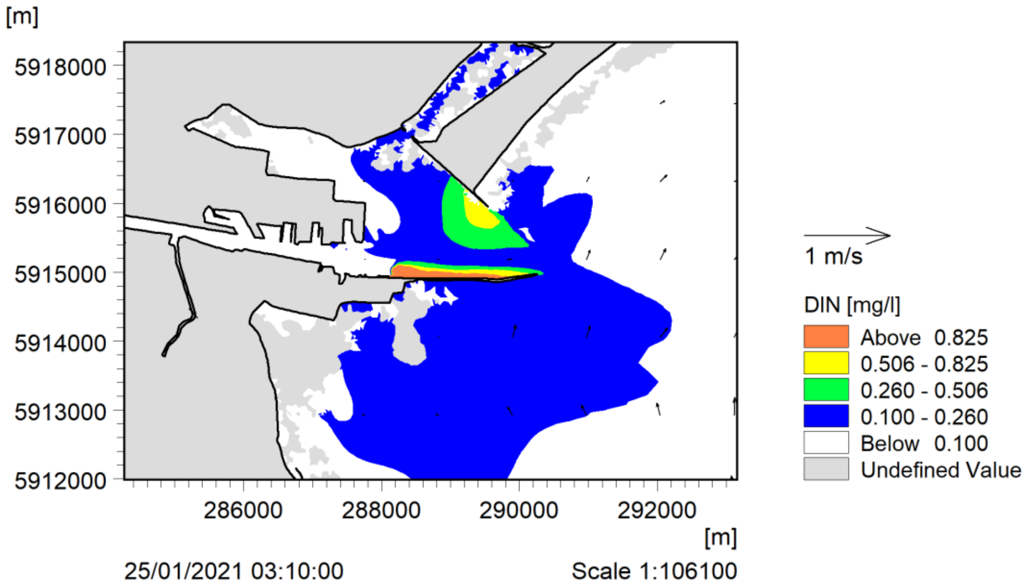
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



DIN 1

Mass Emissions – Winter

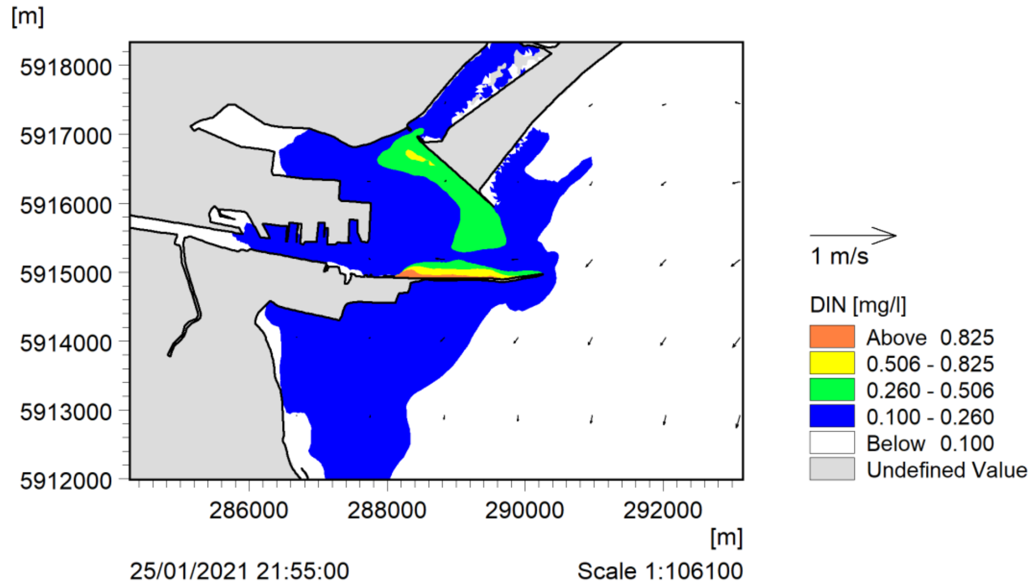
HW coinciding with the end of the mass emissions discharge.



DIN 2

Mass Emissions – Winter

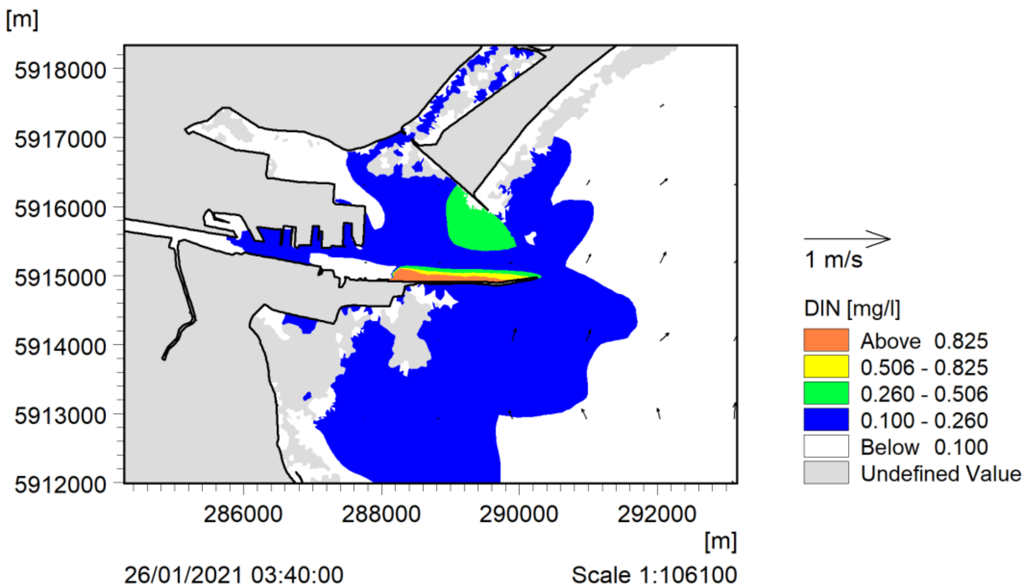
LW approximately 6 hours after end of the mass emissions discharge.



DIN 3

Mass Emissions – Winter

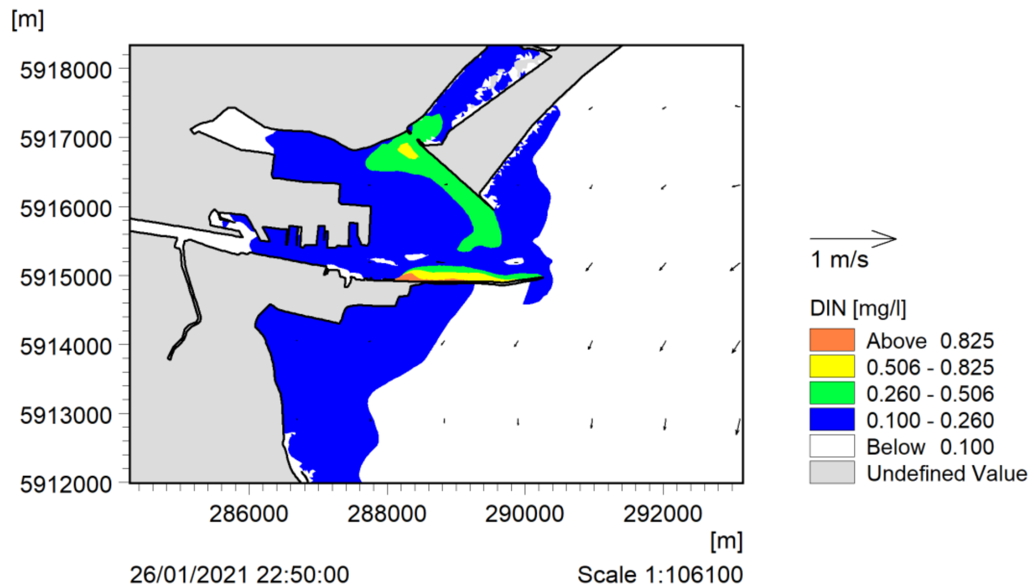
HW, 1 day after the end of the mass emissions discharge.



DIN 4

Mass Emissions – Winter

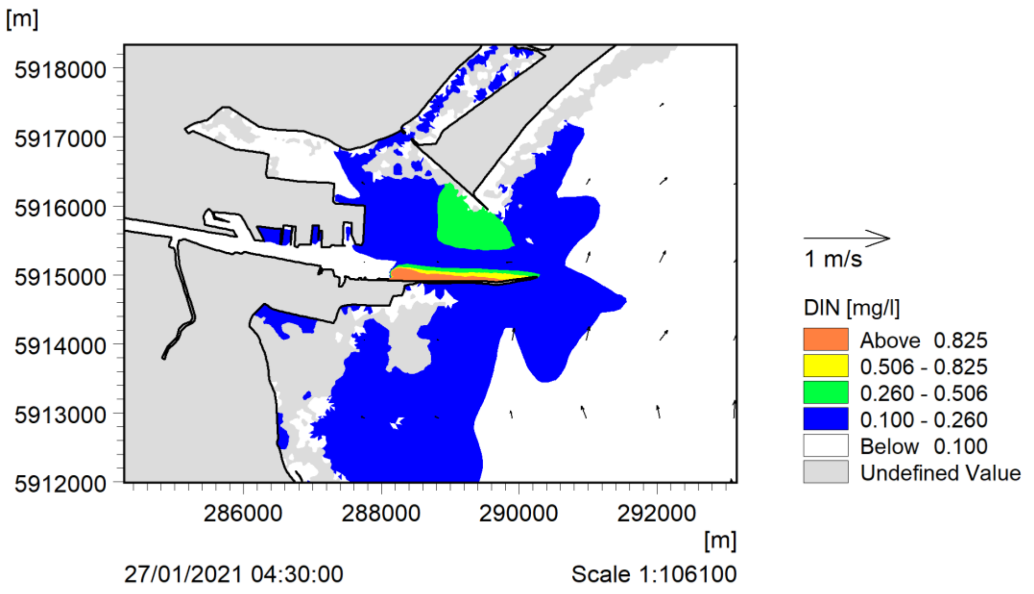
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



DIN 5

Mass Emissions – Winter

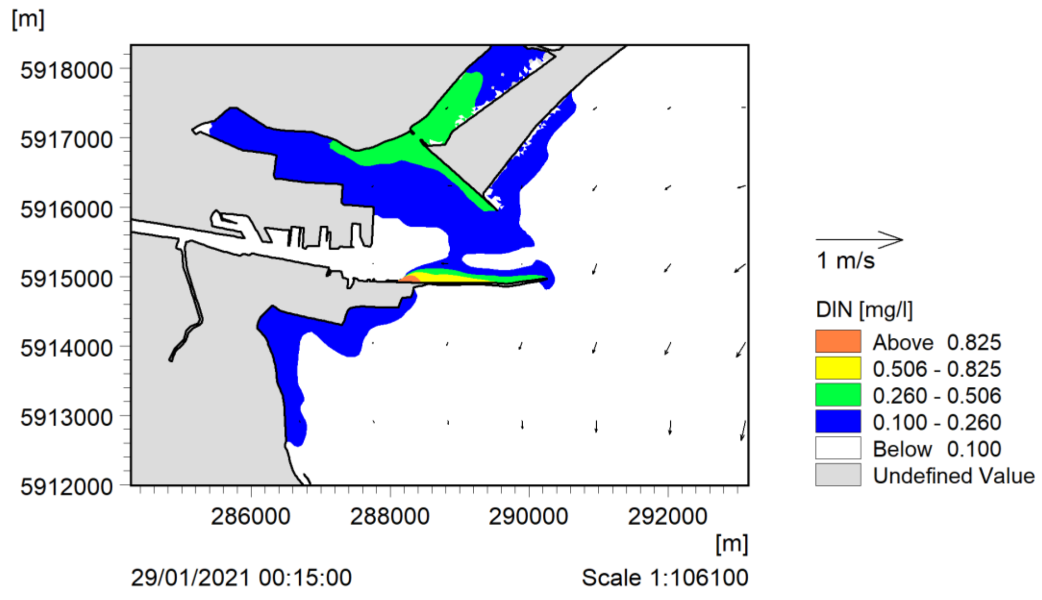
HW, 2 days after the end of the mass emissions discharge.



DIN 6

Mass Emissions – Winter

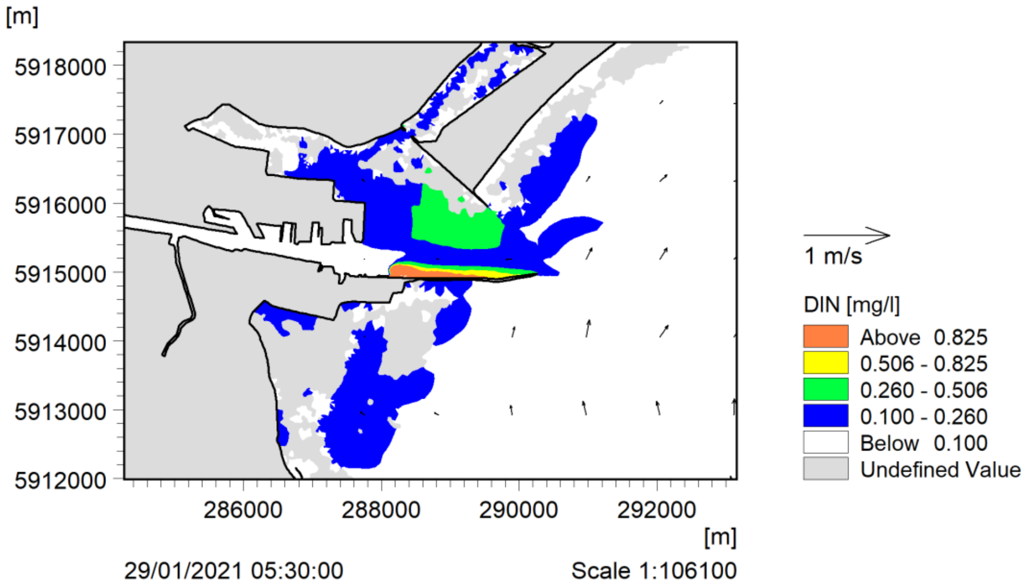
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



DIN 7

Mass Emissions – Winter

HW, 4 days after the end of the mass emissions discharge.

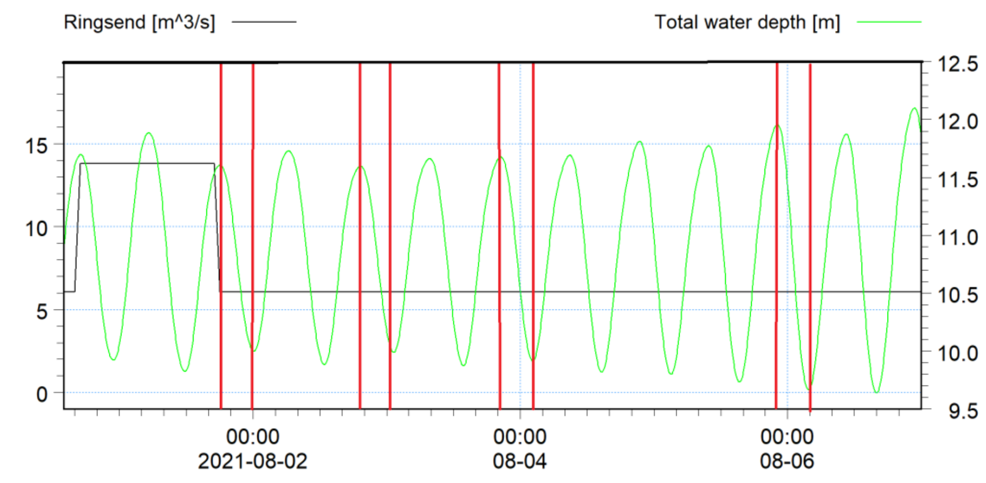


DIN 8

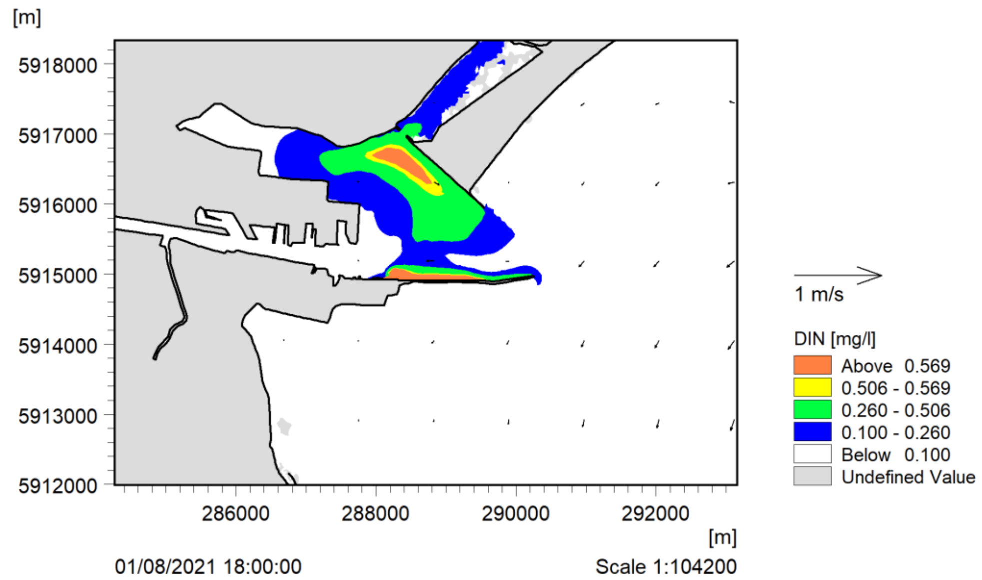
Mass Emissions – Winter

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.4 DIN (SUMMER) – MASS EMISSIONS SCENARIO



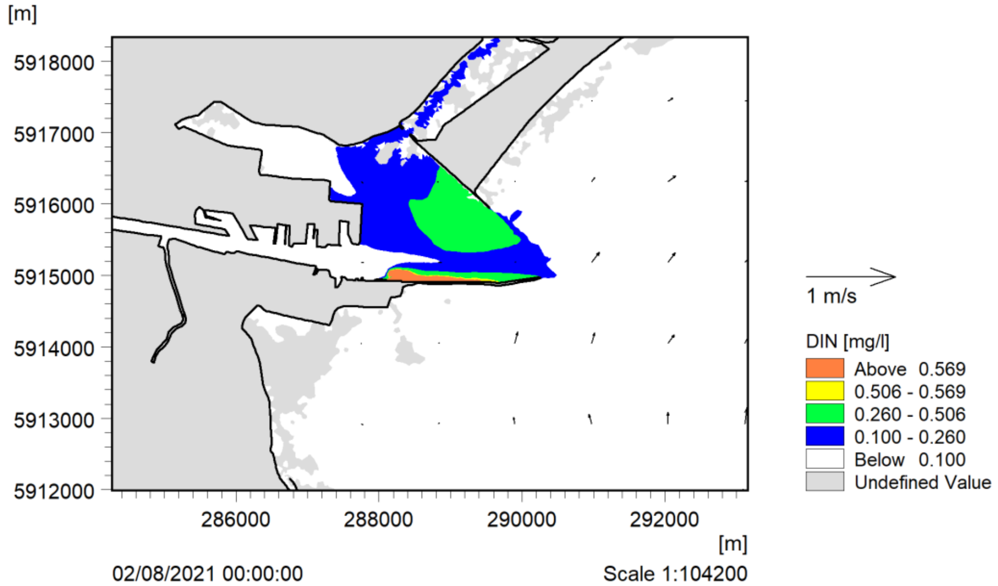
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



DIN 1

Mass Emissions – Summer

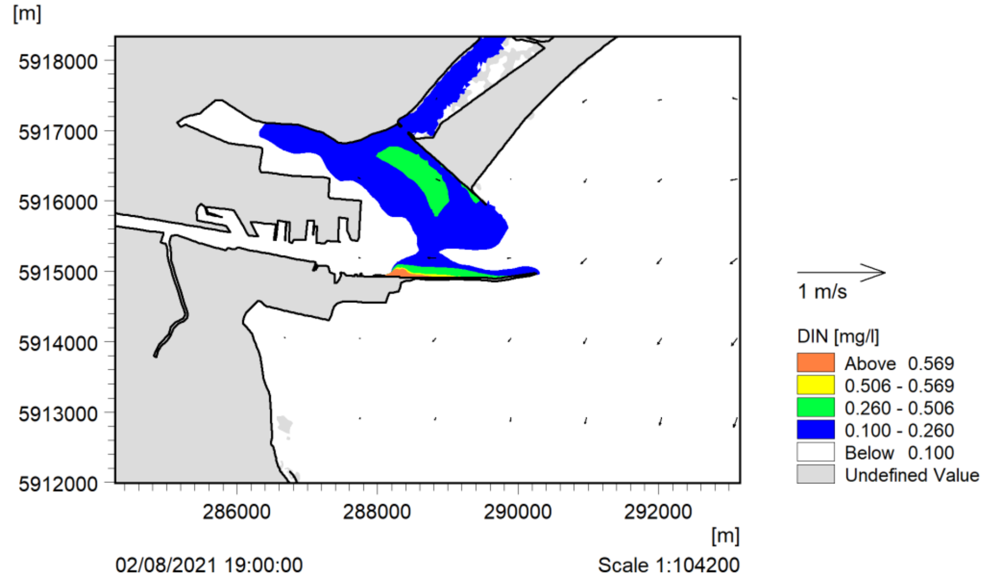
HW coinciding with the end of the mass emissions discharge.



DIN 2

Mass Emissions – Summer

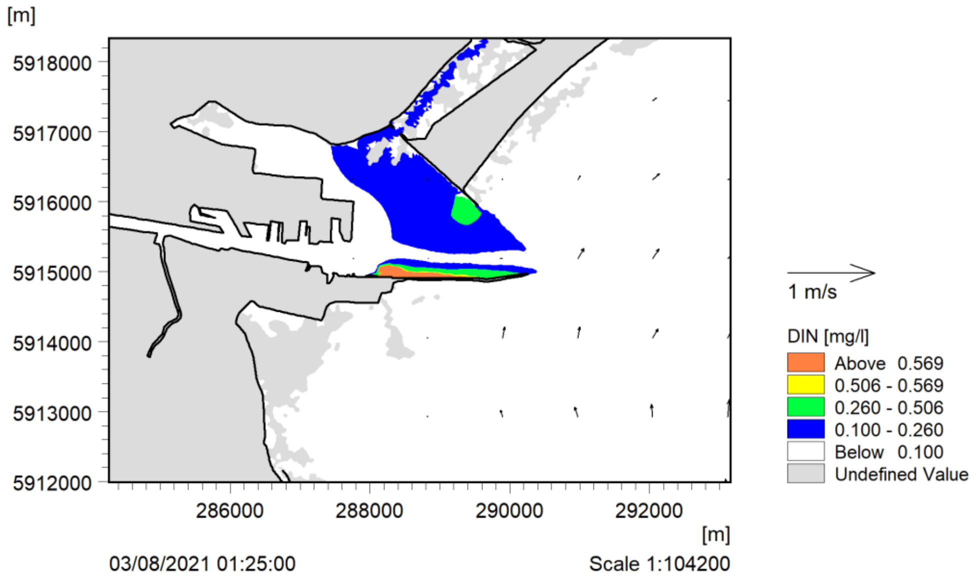
LW approximately 6 hours after end of the mass emissions discharge.



DIN 3

Mass Emissions – Summer

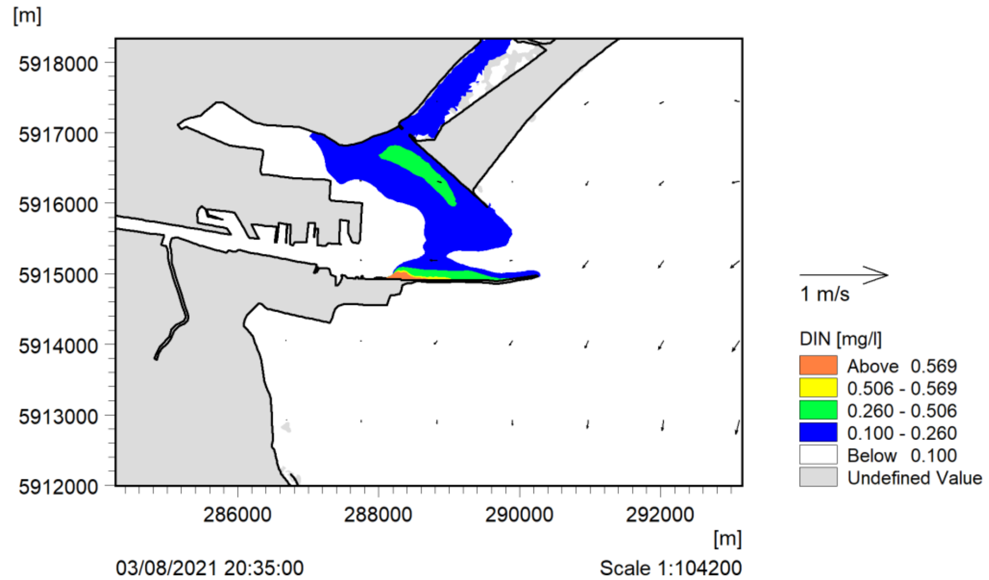
HW, 1 day after the end of the mass emissions discharge.



DIN 4

Mass Emissions – Summer

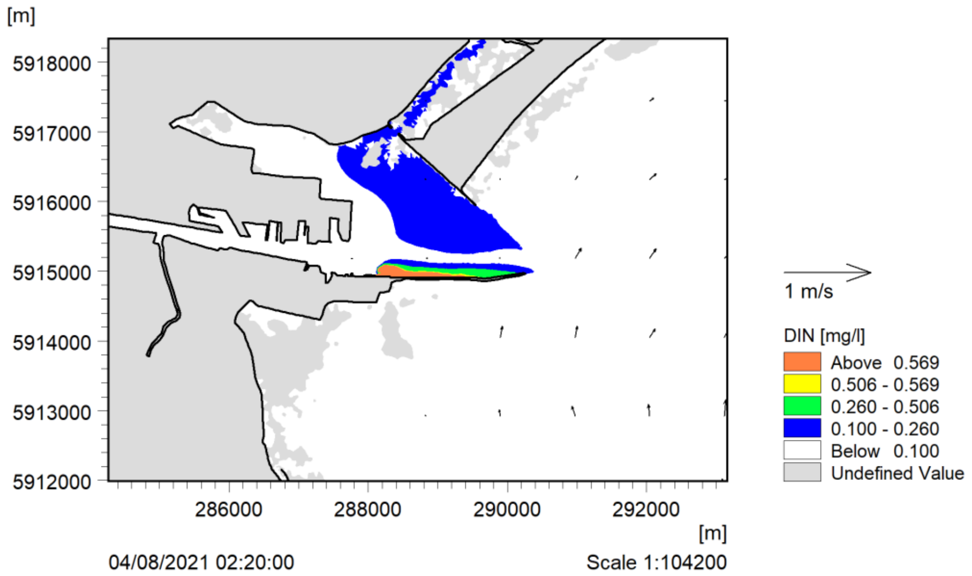
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



DIN 5

Mass Emissions – Summer

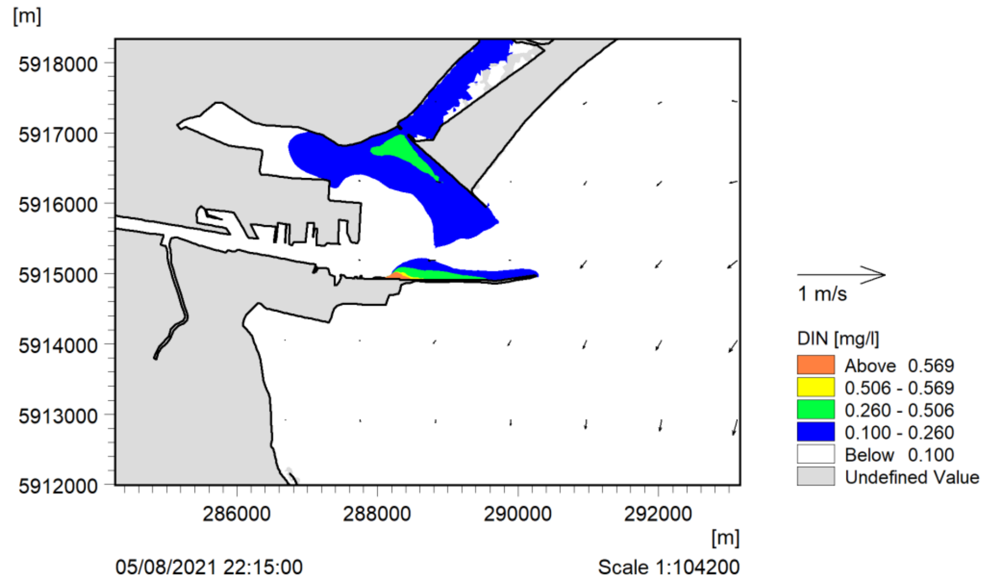
HW, 2 days after the end of the mass emissions discharge.



DIN 6

Mass Emissions – Summer

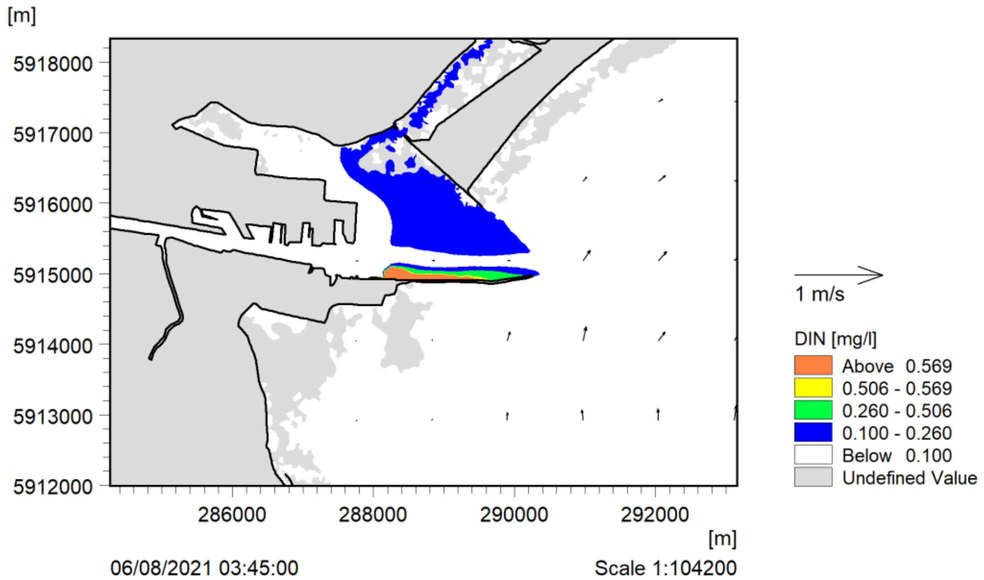
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



DIN 7

Mass Emissions – Summer

HW, 4 days after the end of the mass emissions discharge.

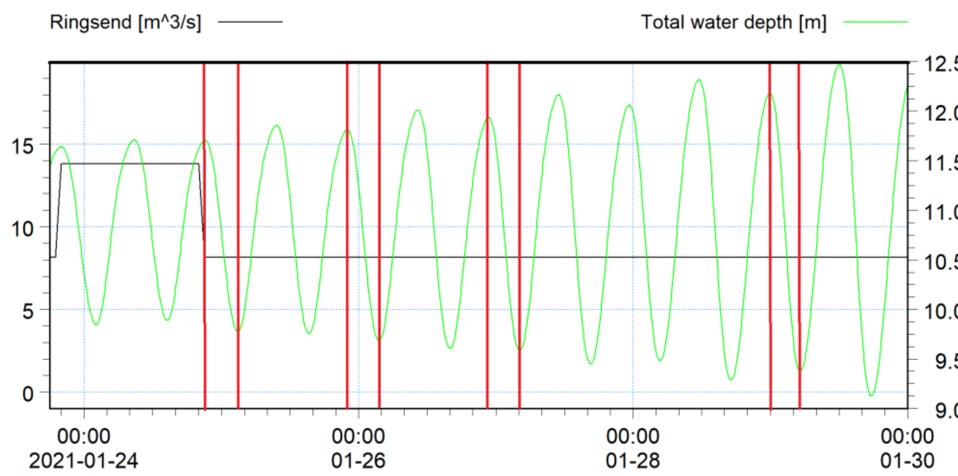


DIN 8

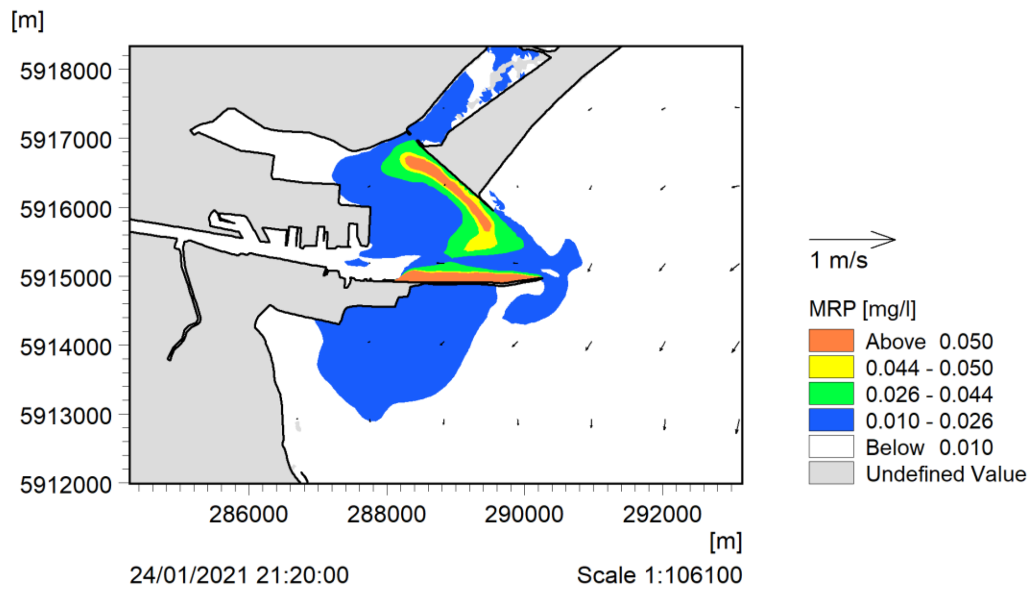
Mass Emissions – Summer

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.5 MRP (WINTER) – MASS EMISSIONS SCENARIO



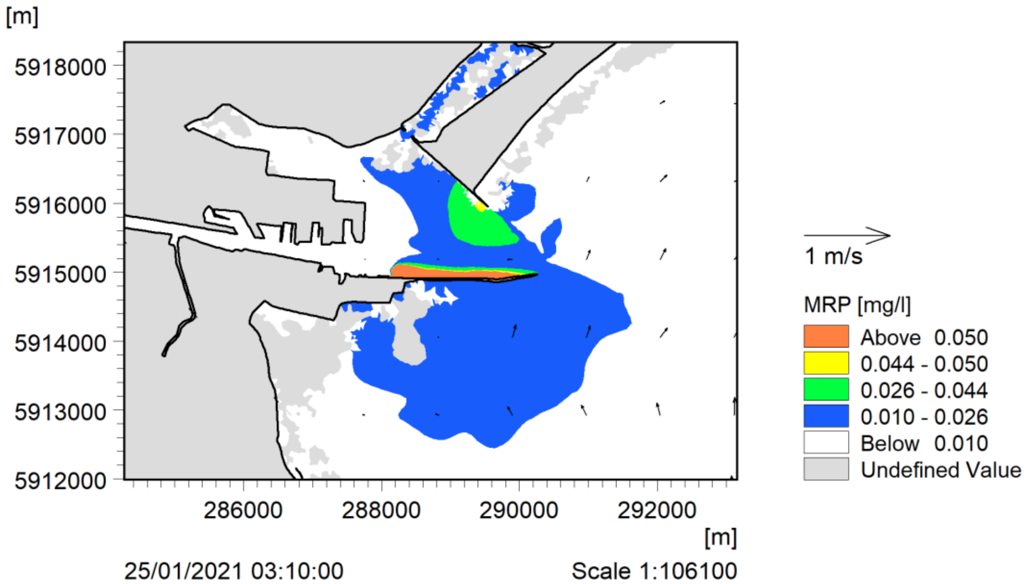
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



MRP 1

Mass Emissions – Winter

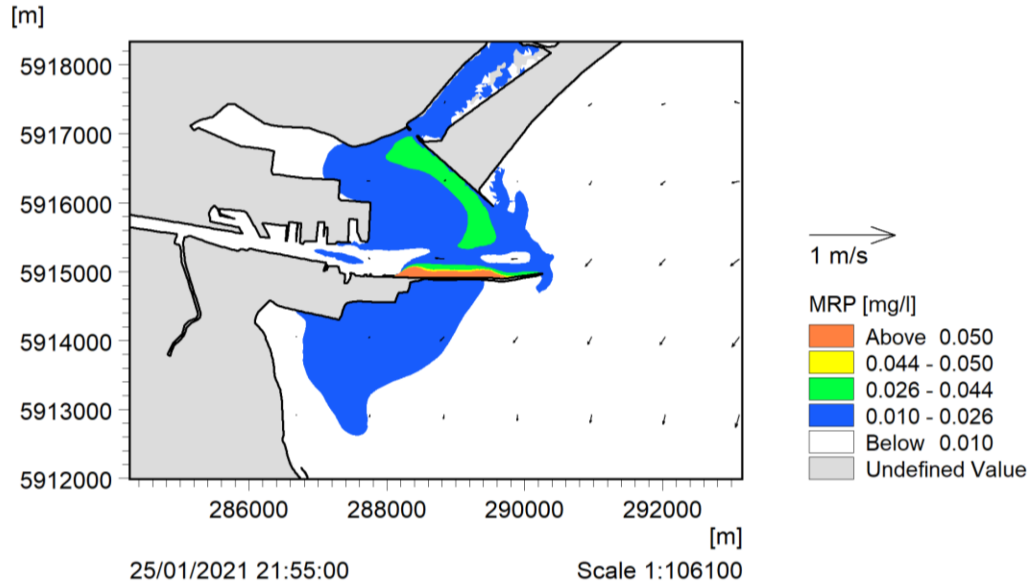
HW coinciding with the end of the mass emissions discharge.



MRP 2

Mass Emissions – Winter

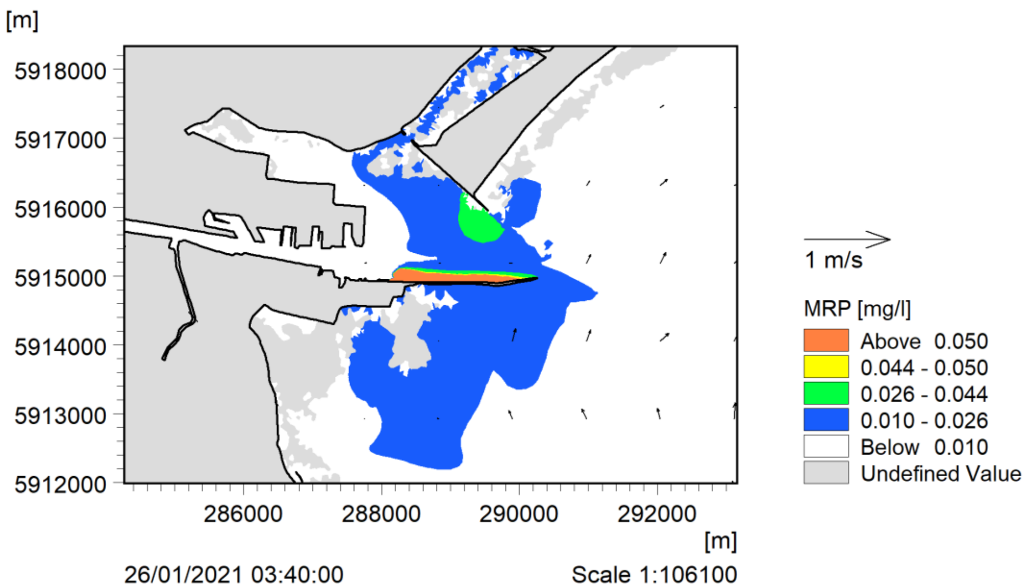
LW approximately 6 hours after end of the mass emissions discharge.



MRP 3

Mass Emissions – Winter

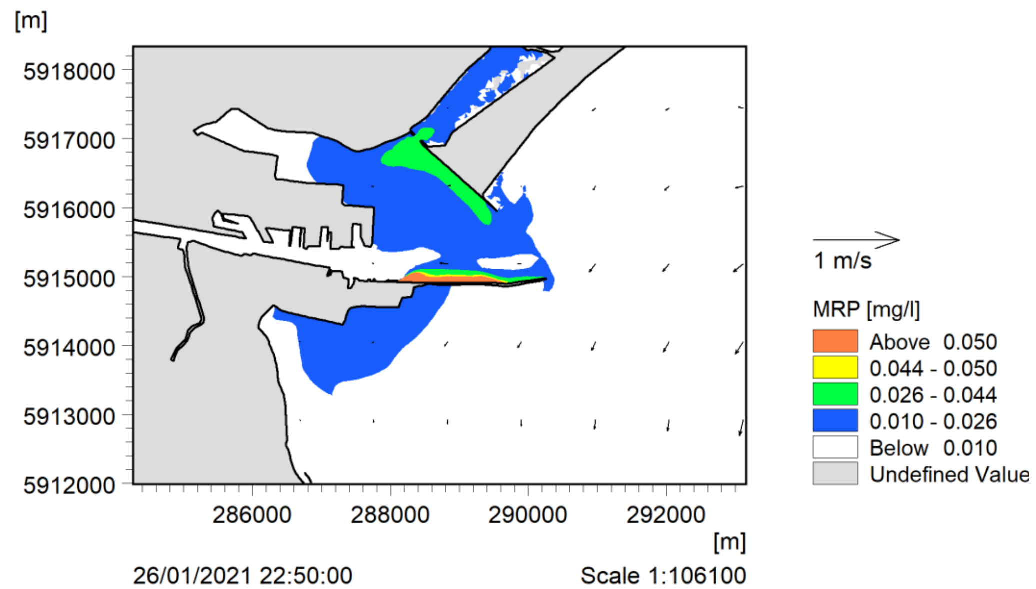
HW, 1 day after the end of the mass emissions discharge.



MRP 4

Mass Emissions – Winter

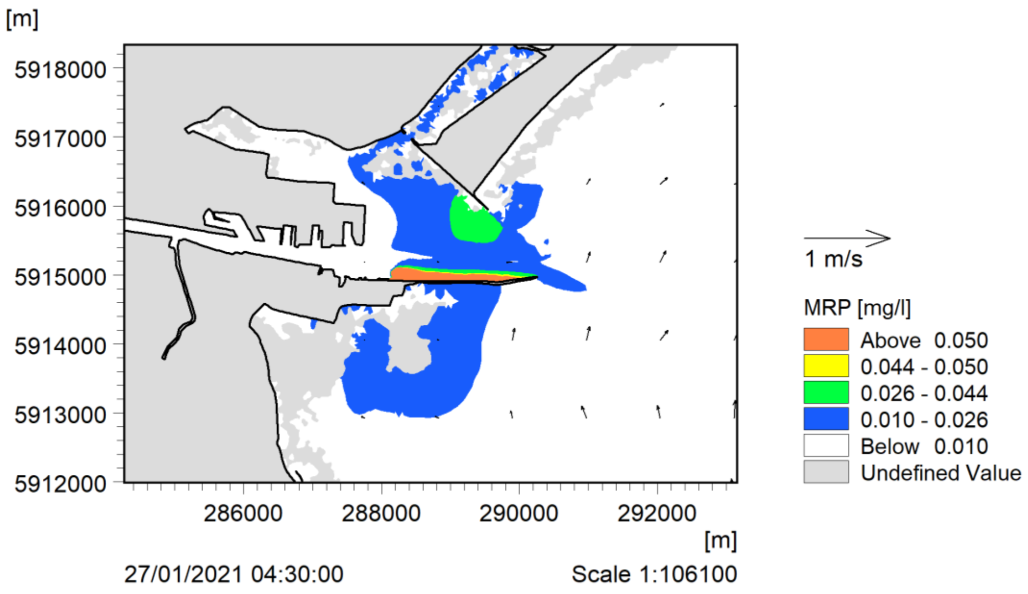
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



MRP 5

Mass Emissions – Winter

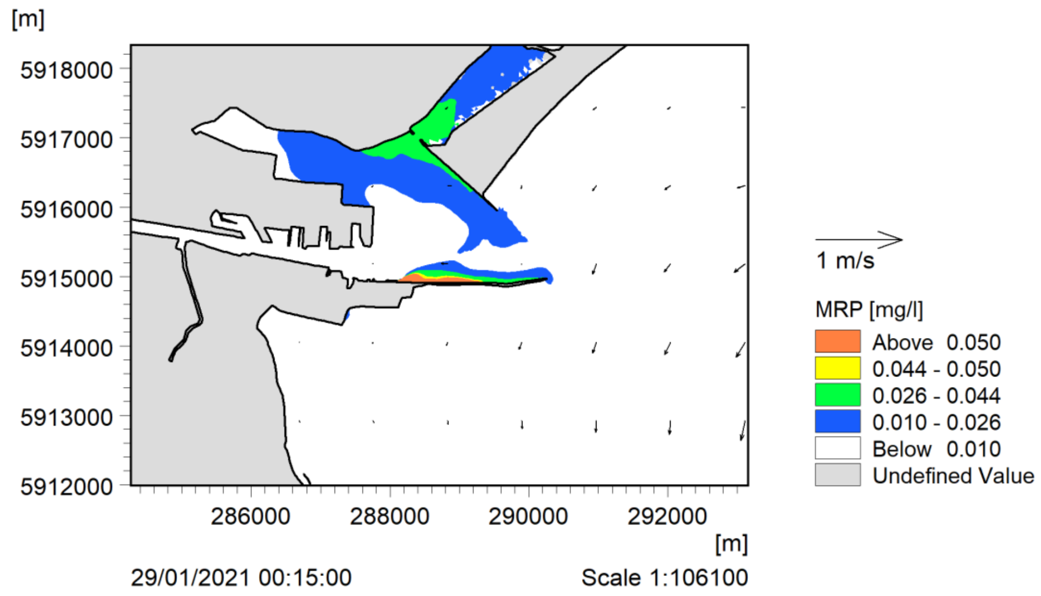
HW, 2 days after the end of the mass emissions discharge.



MRP 6

Mass Emissions – Winter

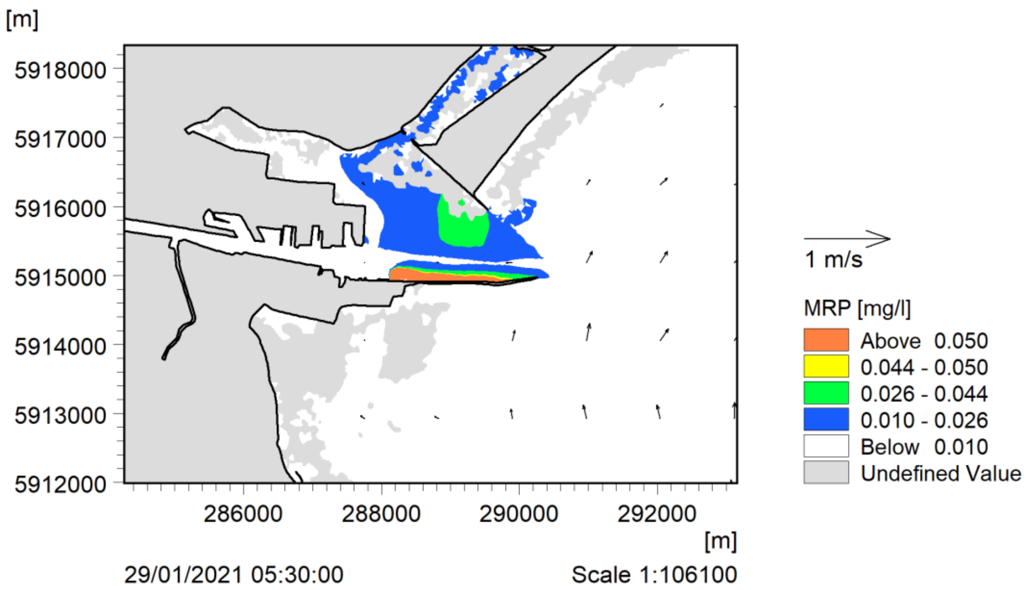
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



MRP 7

Mass Emissions – Winter

HW, 4 days after the end of the mass emissions discharge.

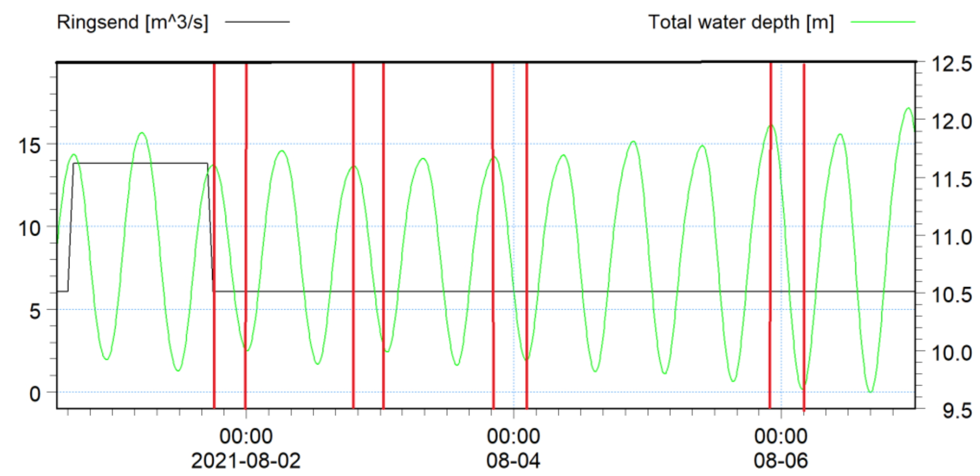


MRP 8

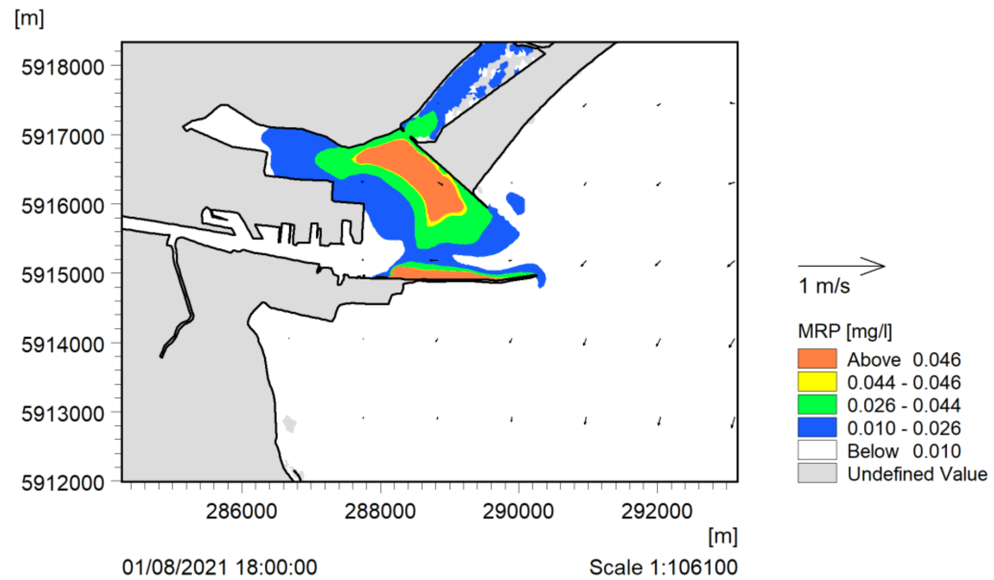
Mass Emissions – Winter

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.6 MRP (SUMMER) – MASS EMISSIONS SCENARIO



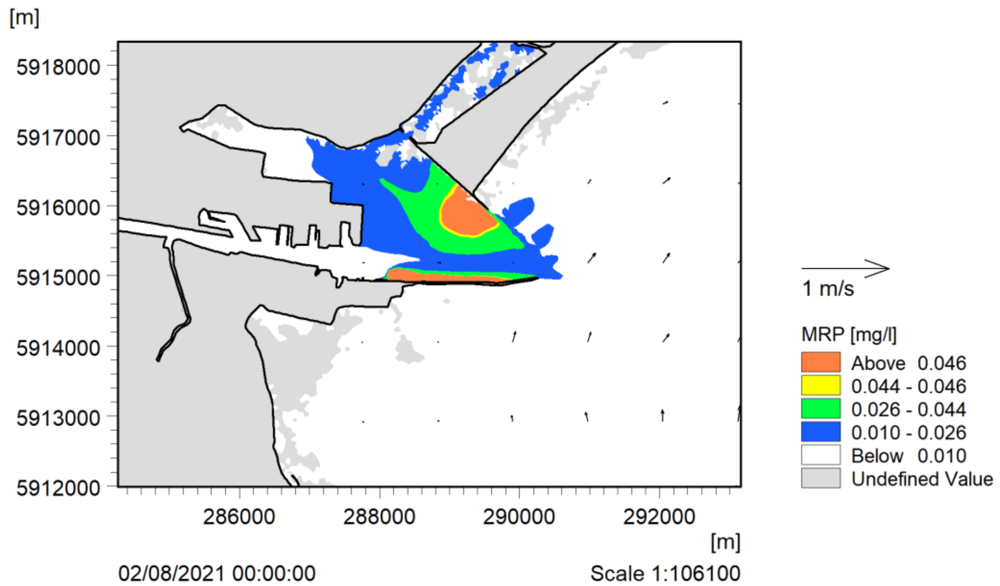
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



MRP 1

Mass Emissions – Summer

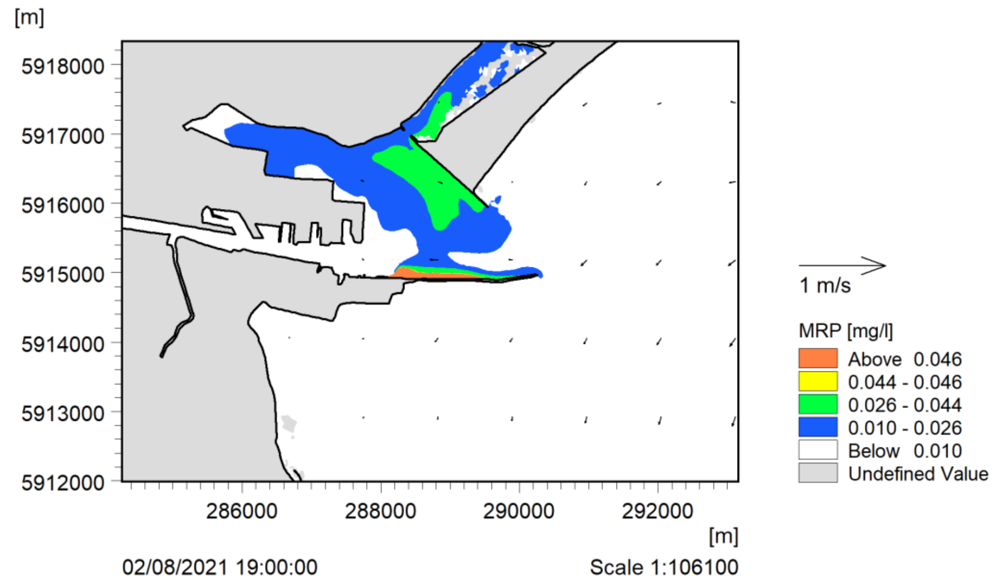
HW coinciding with the end of the mass emissions discharge.



MRP 2

Mass Emissions – Summer

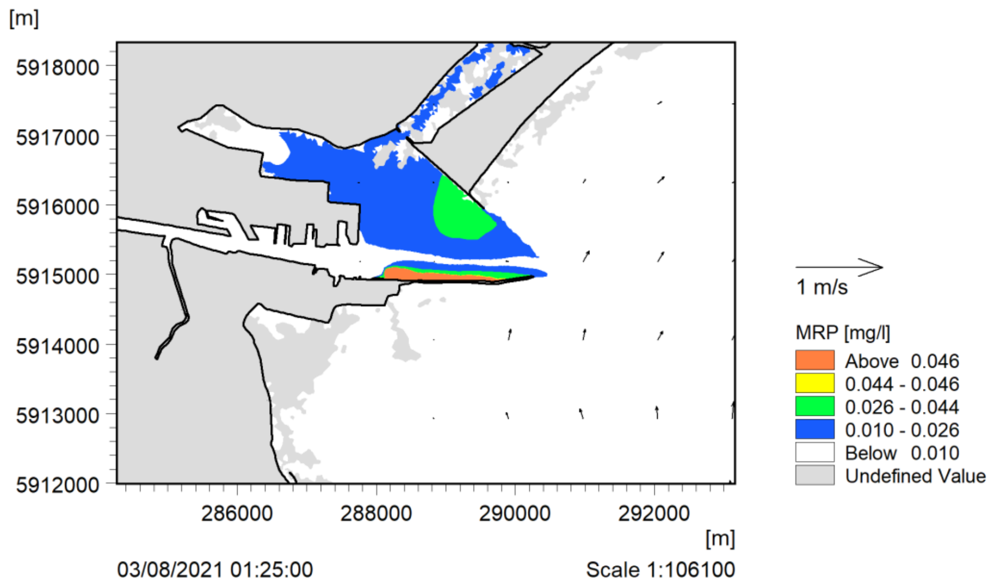
LW approximately 6 hours after end of the mass emissions discharge.



MRP 3

Mass Emissions – Summer

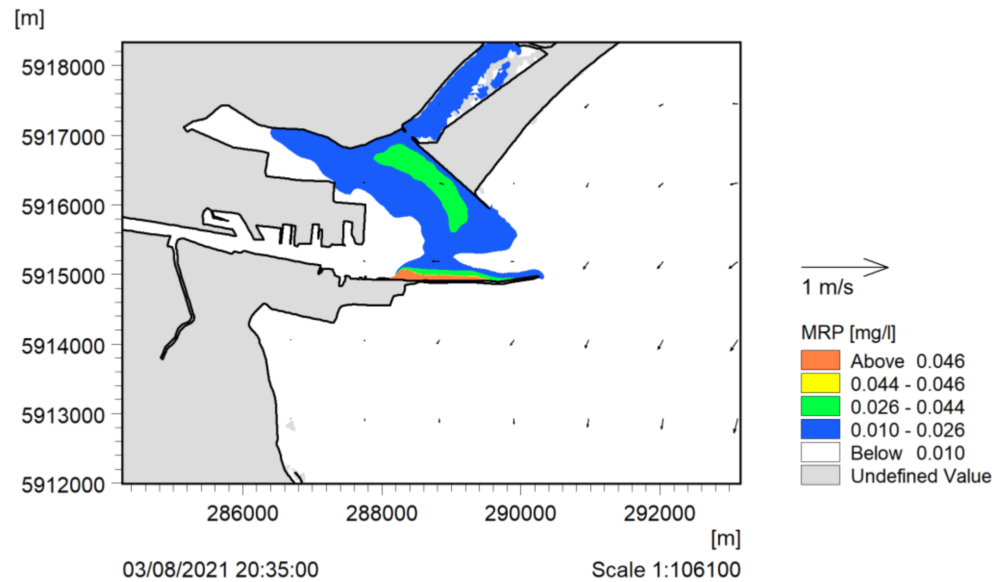
HW, 1 day after the end of the mass emissions discharge.



MRP 4

Mass Emissions – Summer

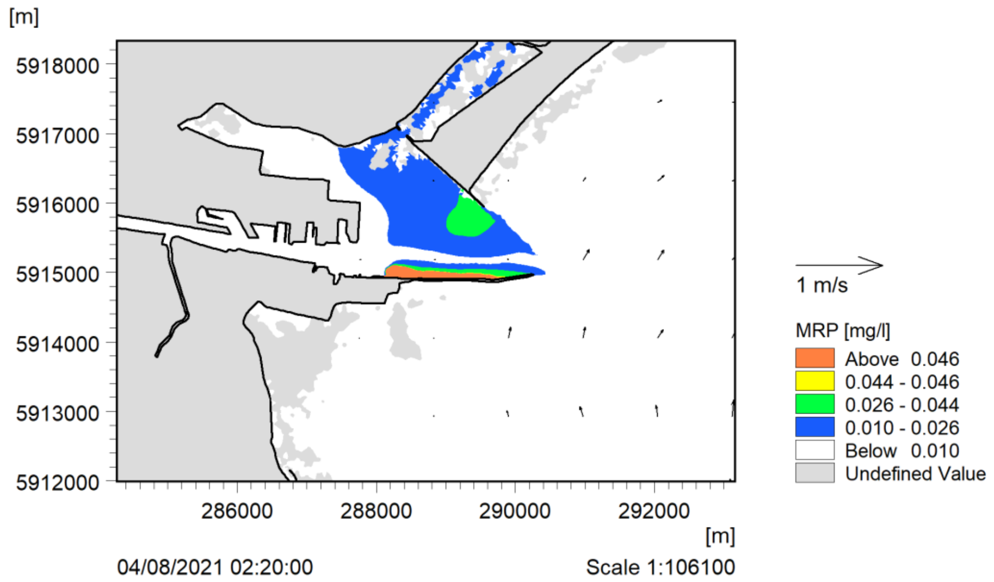
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



MRP 5

Mass Emissions – Summer

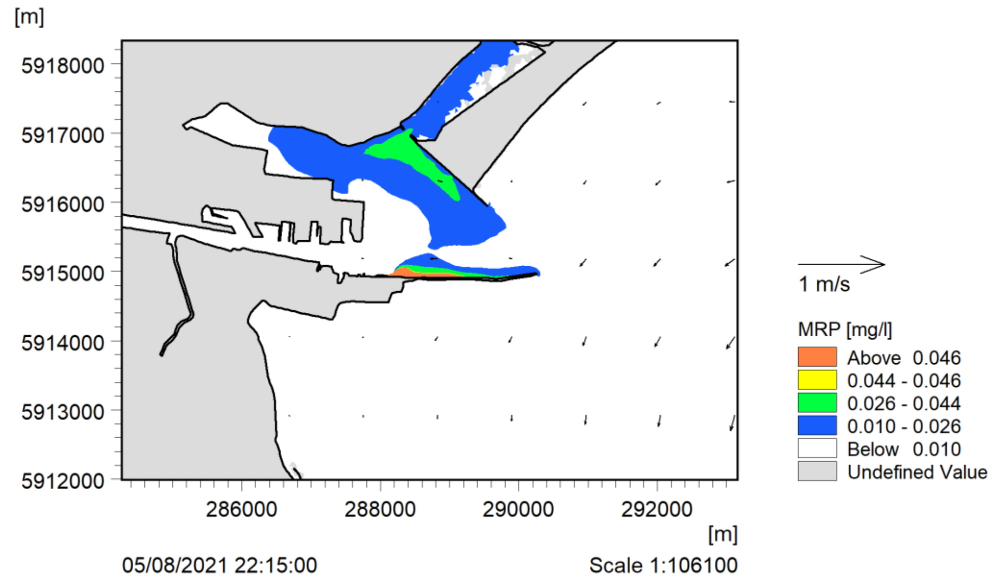
HW, 2 days after the end of the mass emissions discharge.



MRP 6

Mass Emissions – Summer

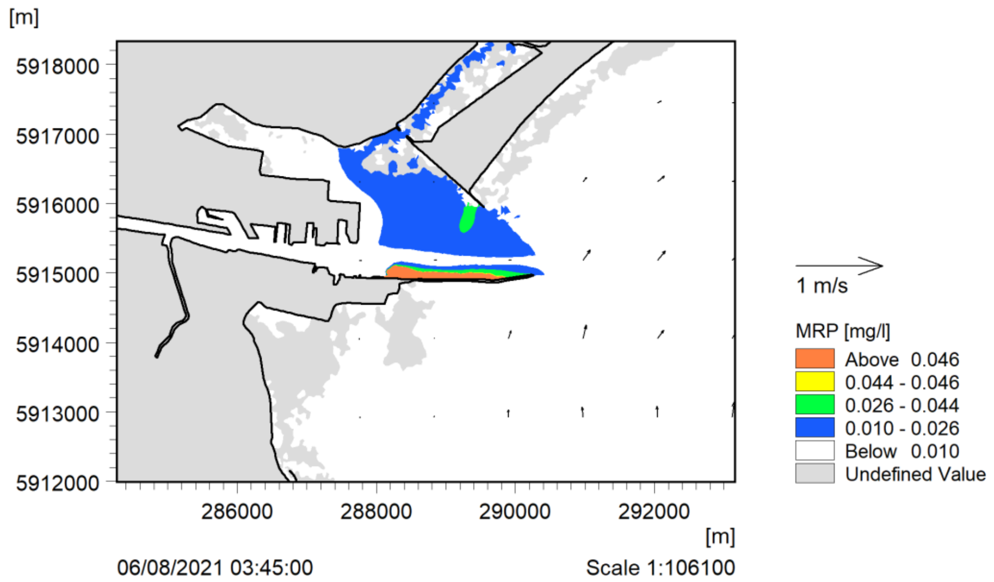
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



MRP 7

Mass Emissions – Summer

HW, 4 days after the end of the mass emissions discharge.

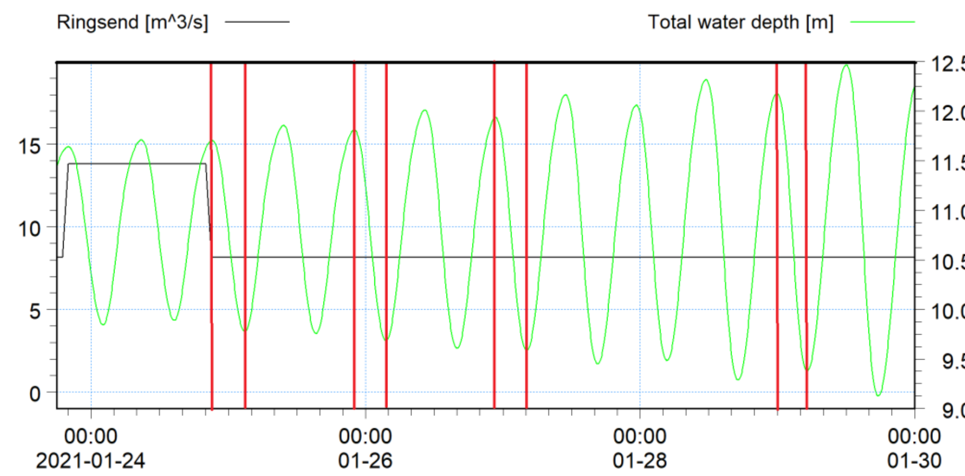


MRP 8

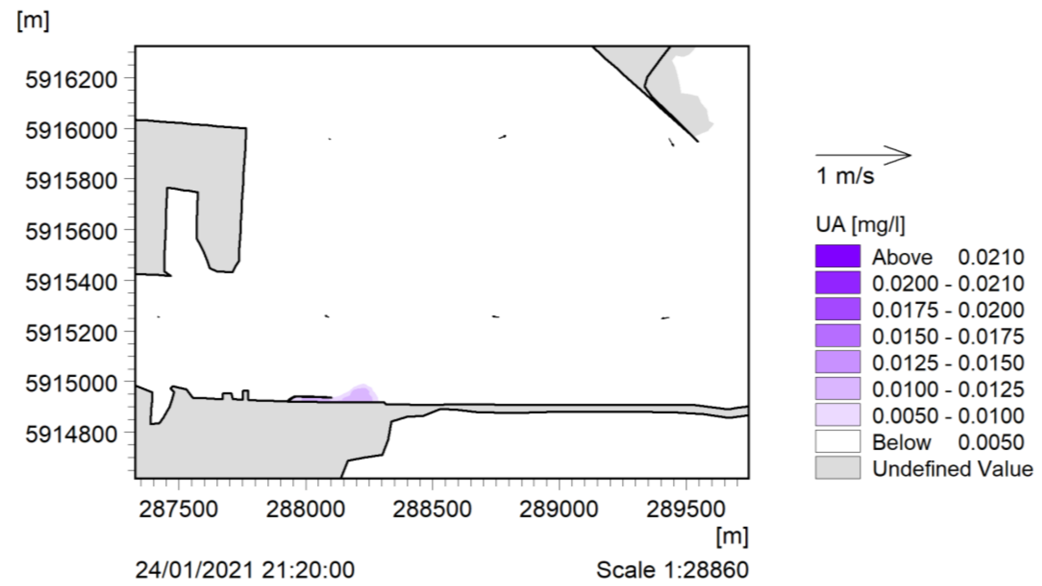
Mass Emissions – Summer

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.7 UA (WINTER) – MASS EMISSIONS SCENARIO



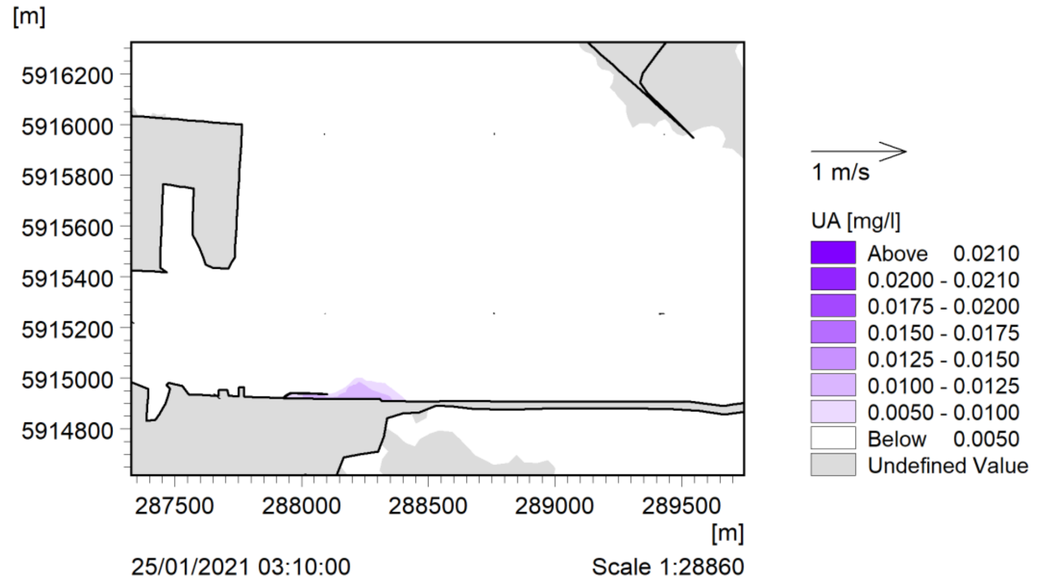
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



UA 1

Mass Emissions – Winter

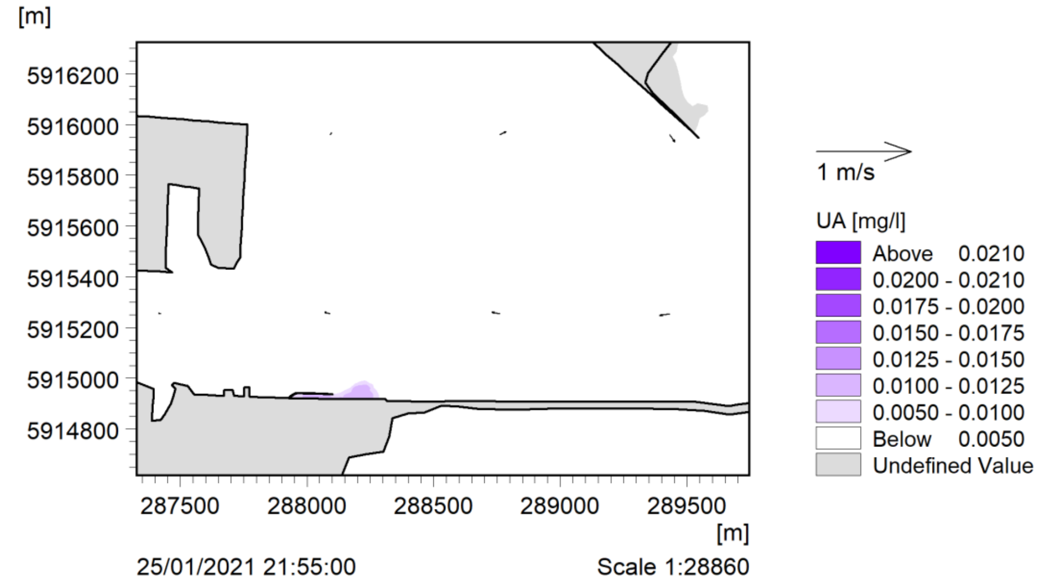
HW coinciding with the end of the mass emissions discharge.



UA 2

Mass Emissions – Winter

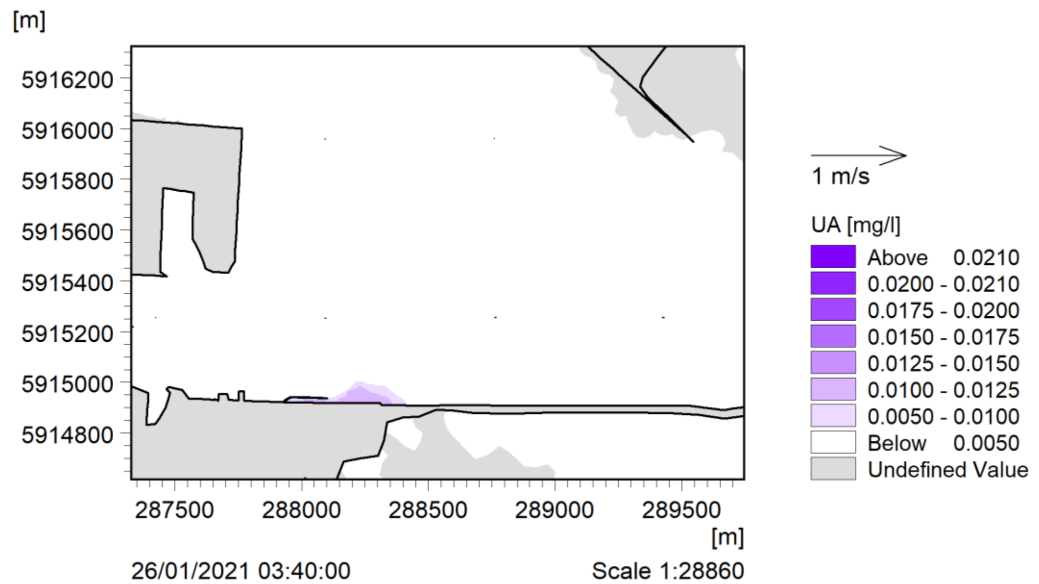
LW approximately 6 hours after end of the mass emissions discharge.



UA 3

Mass Emissions – Winter

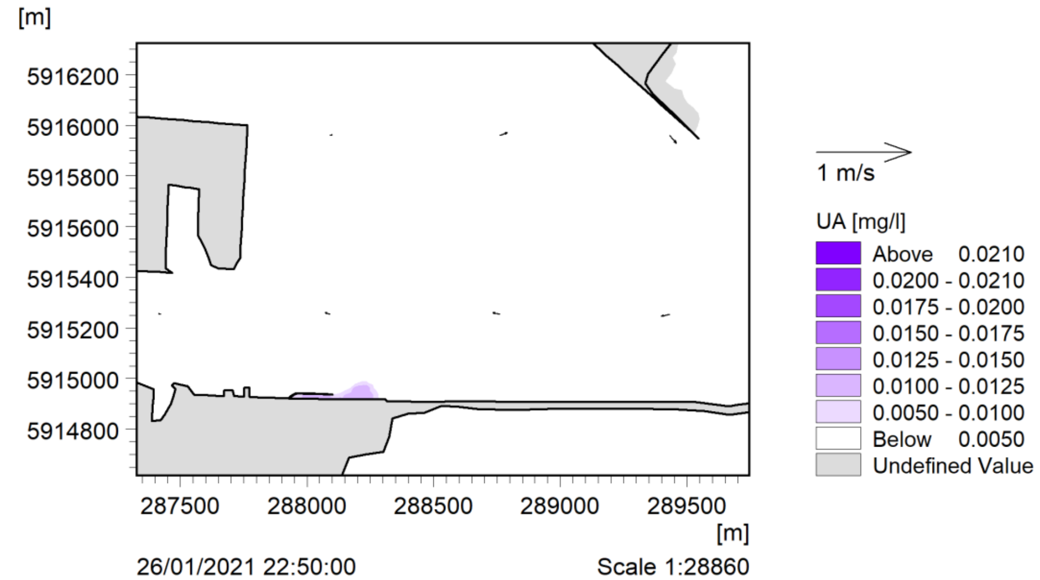
HW, 1 day after the end of the mass emissions discharge.



UA 4

Mass Emissions – Winter

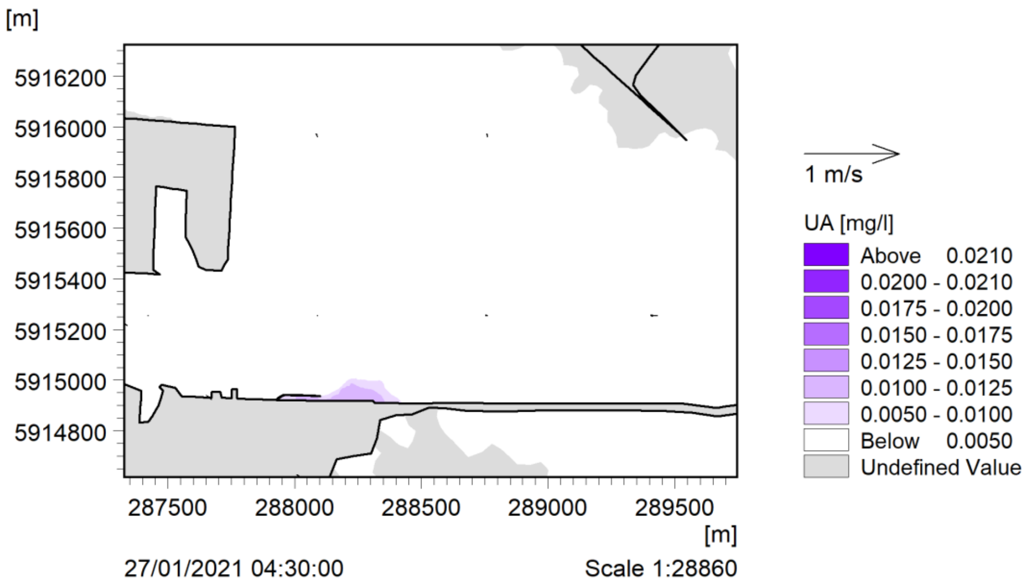
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



UA 5

Mass Emissions – Winter

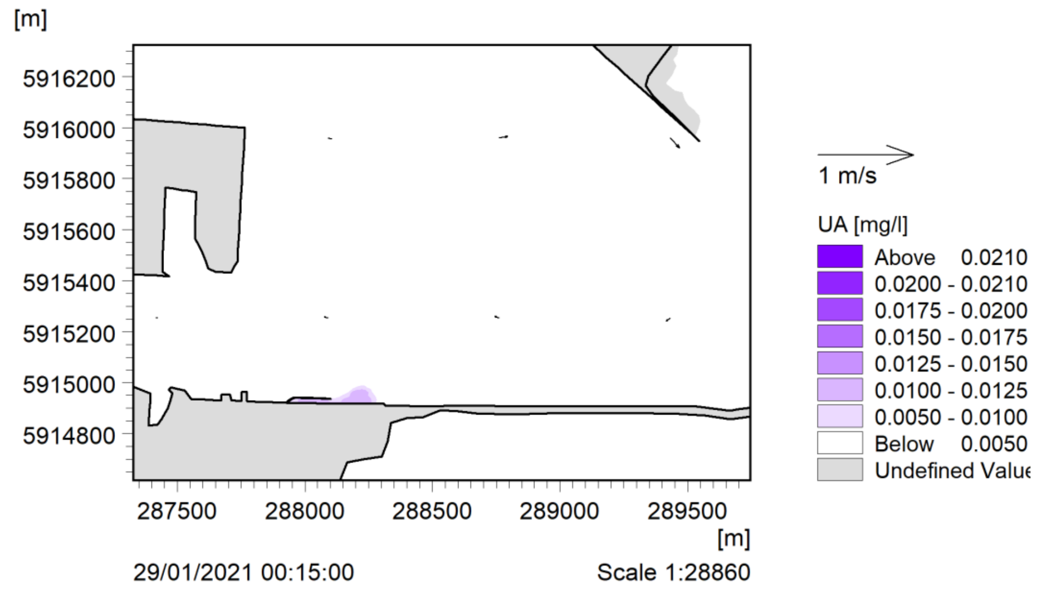
HW, 2 days after the end of the mass emissions discharge.



UA 6

Mass Emissions – Winter

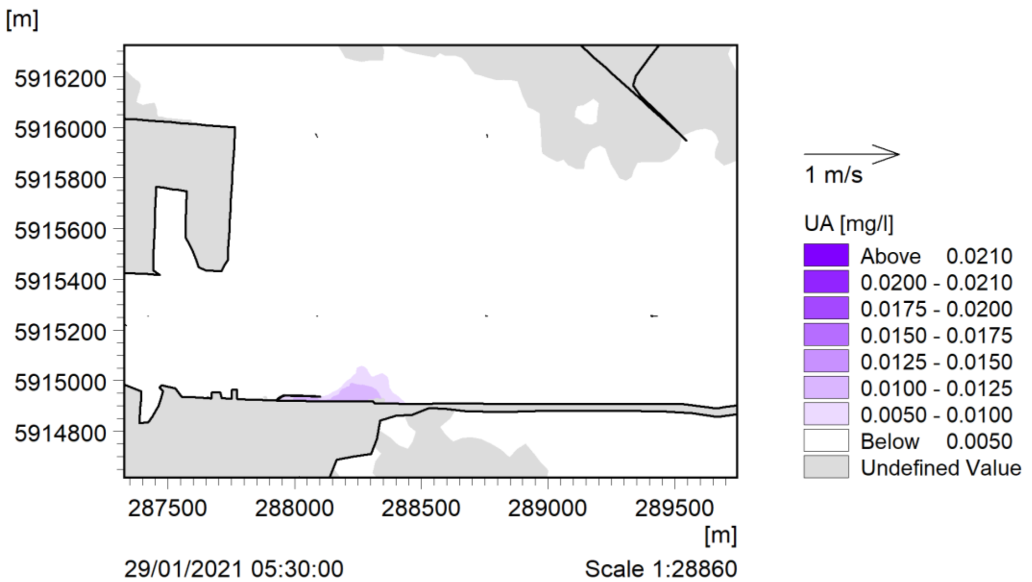
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



UA 7

Mass Emissions – Winter

HW, 4 days after the end of the mass emissions discharge.

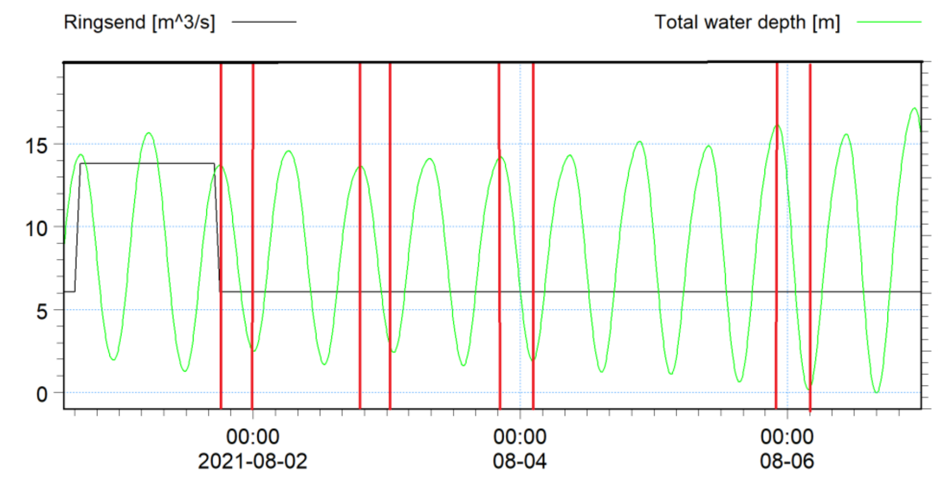


UA 8

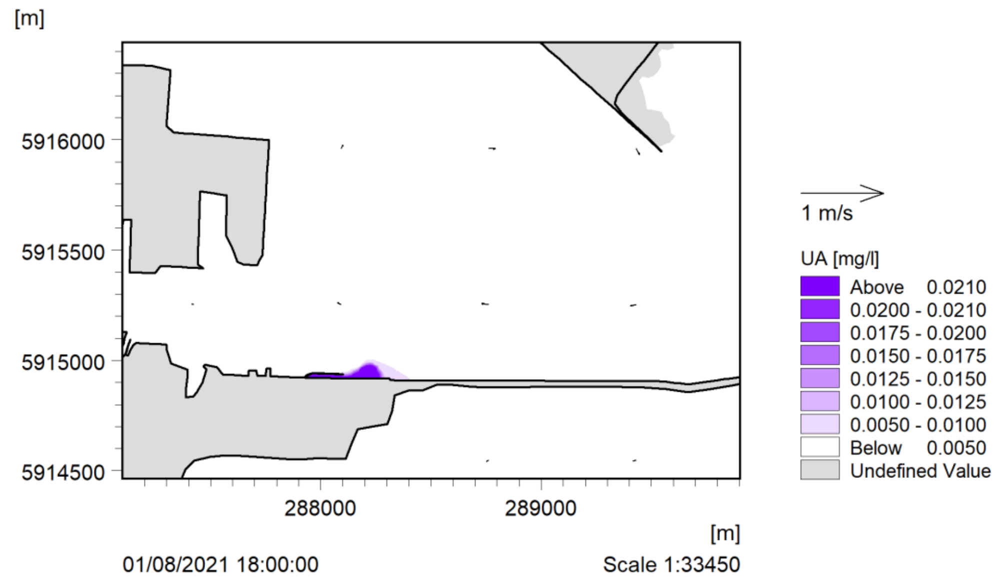
Mass Emissions – Winter

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

B.8 UA (SUMMER) – MASS EMISSIONS SCENARIO



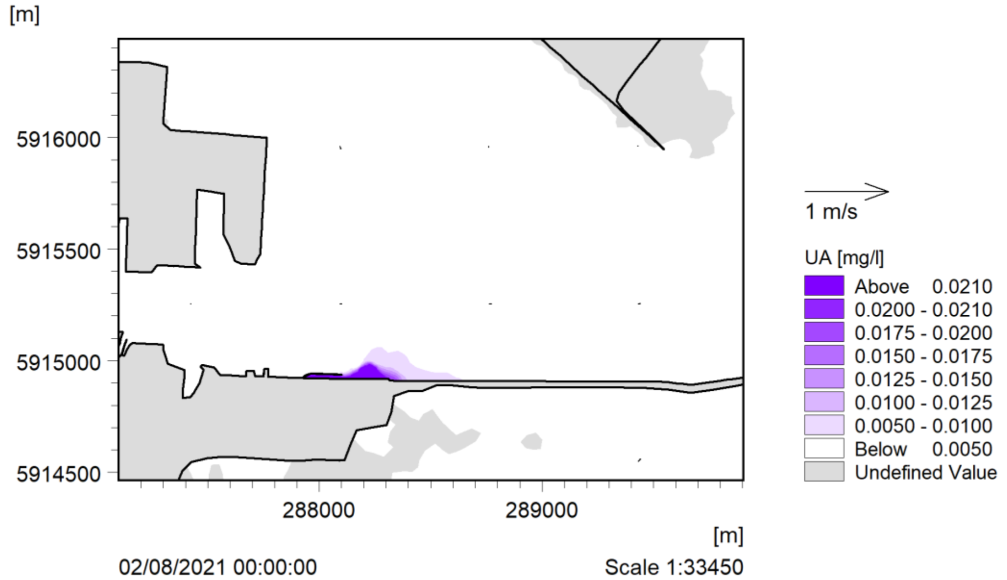
Time Series of modelled mass emission discharge and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



UA 1

Mass Emissions – Summer

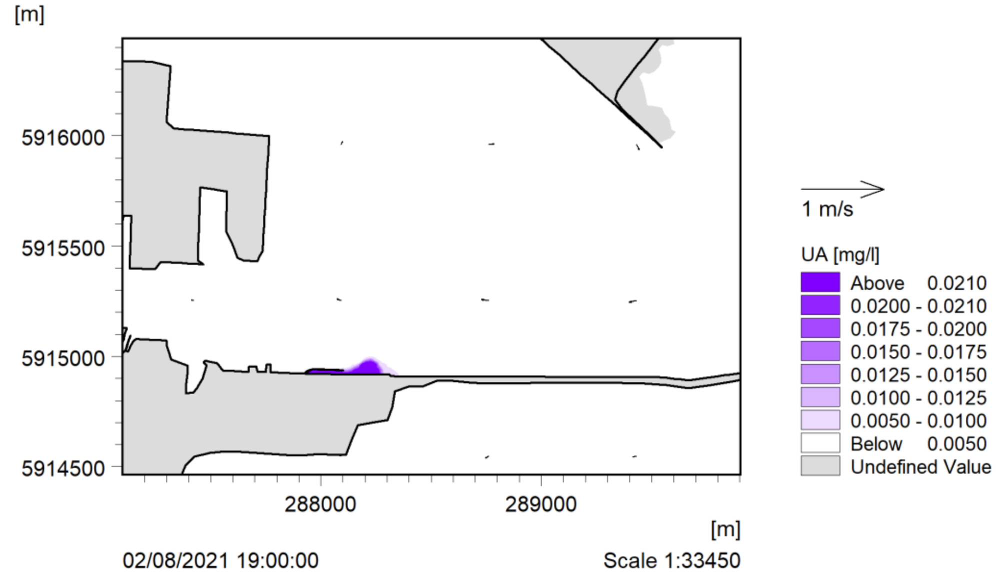
HW coinciding with the end of the mass emissions discharge.



UA 2

Mass Emissions – Summer

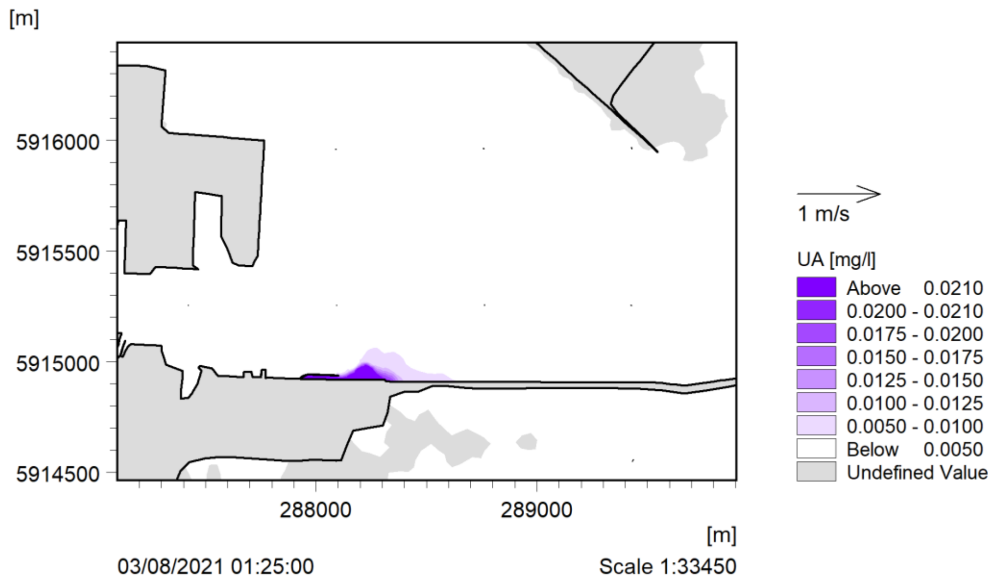
LW approximately 6 hours after end of the mass emissions discharge.



UA 3

Mass Emissions – Summer

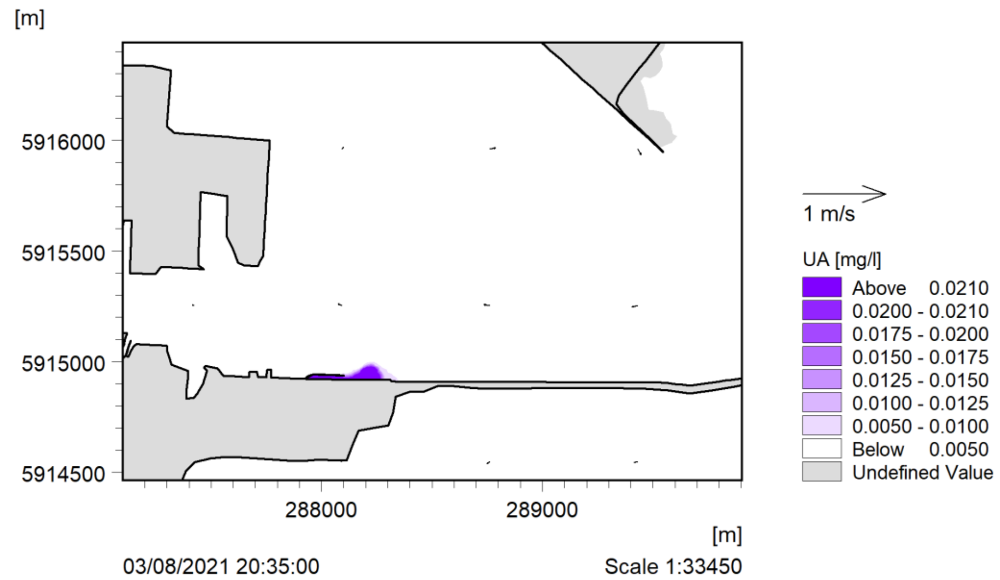
HW, 1 day after the end of the mass emissions discharge.



UA 4

Mass Emissions – Summer

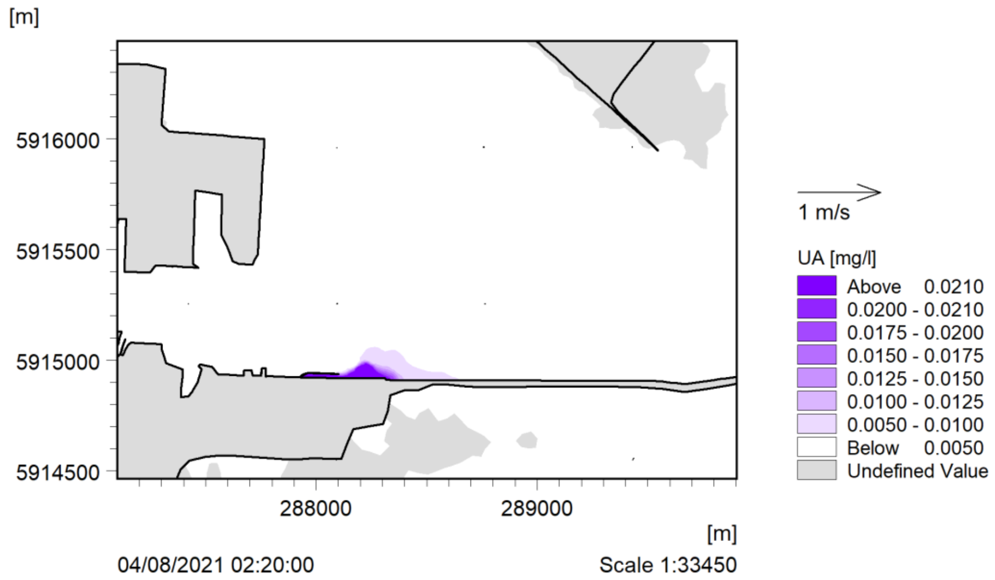
Subsequent LW 1 day and 6 hours after the end of the mass emissions discharge.



UA 5

Mass Emissions – Summer

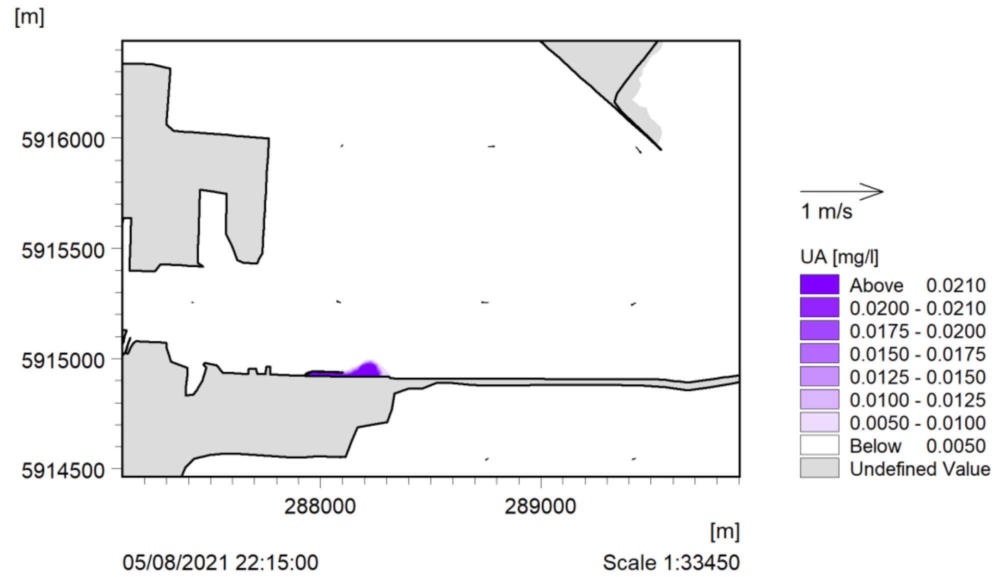
HW, 2 days after the end of the mass emissions discharge.



UA 6

Mass Emissions – Summer

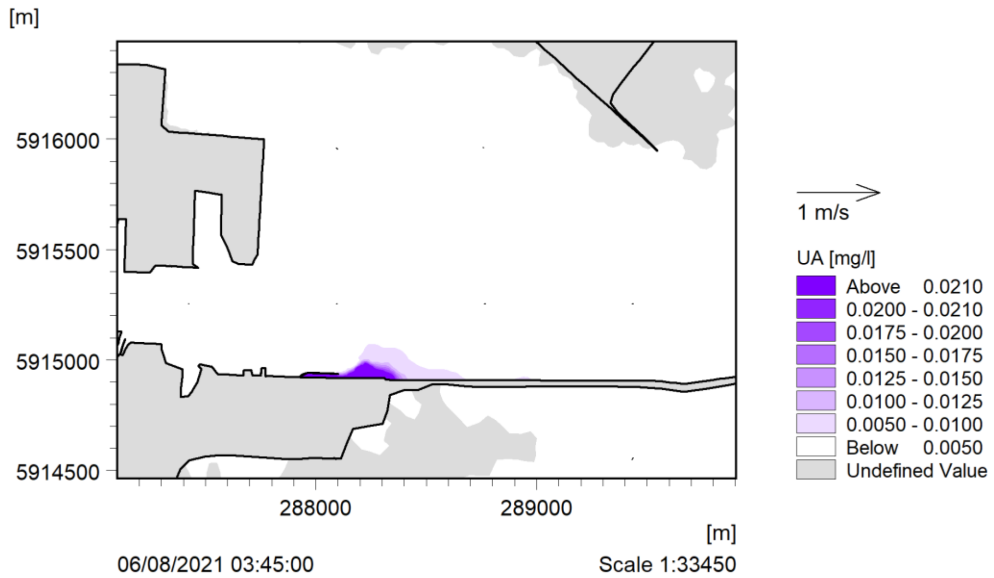
Subsequent LW 2 days and 6 hours after the end of the mass emissions discharge.



UA 7

Mass Emissions – Summer

HW, 4 days after the end of the mass emissions discharge.



UA 8

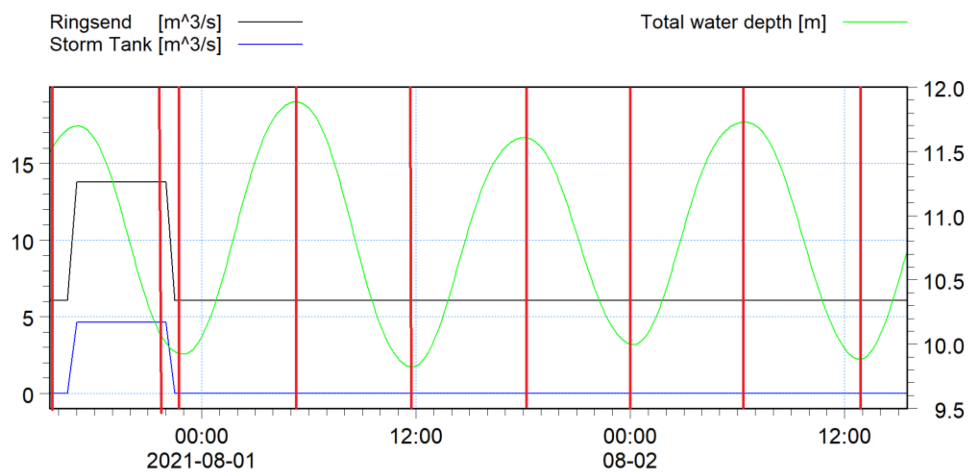
Mass Emissions – Summer

Subsequent LW 4 days and 6 hours after the end of the mass emissions discharge.

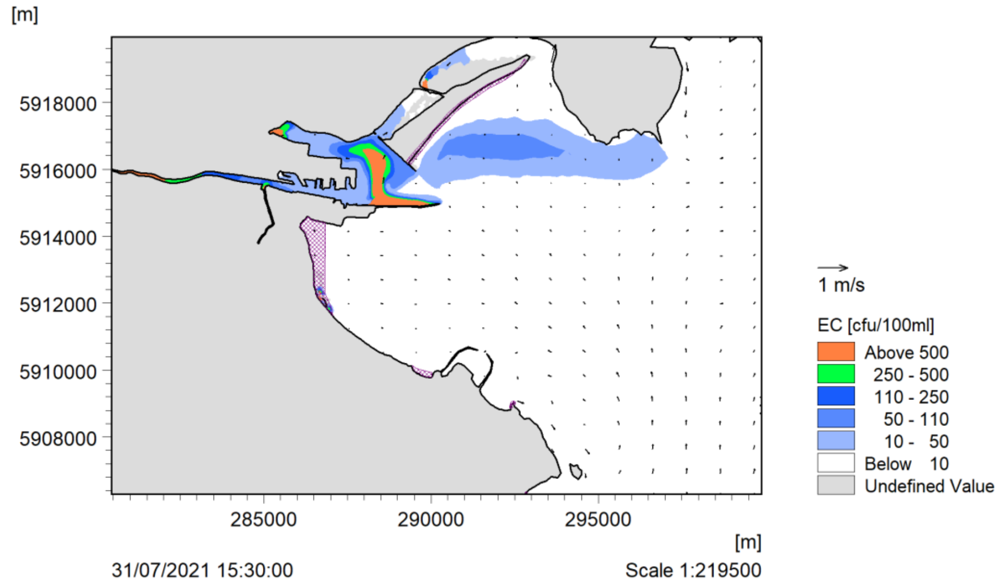
APPENDIX C

Results: Storm Tank Scenario

C.1 STORM TANK SCENARIO – EC



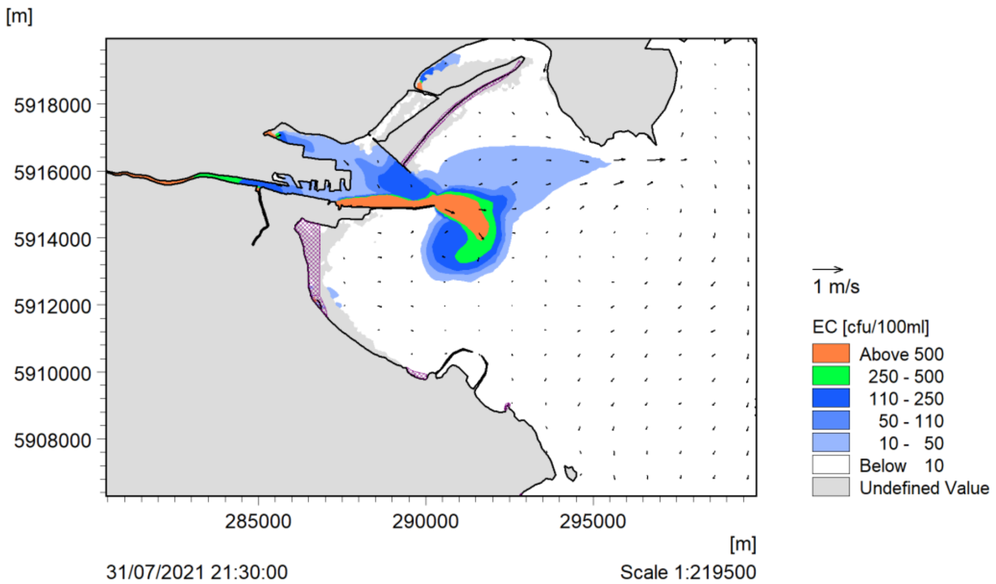
Time Series of modelled discharge rates and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



EC 1

Storm Tank Scenario

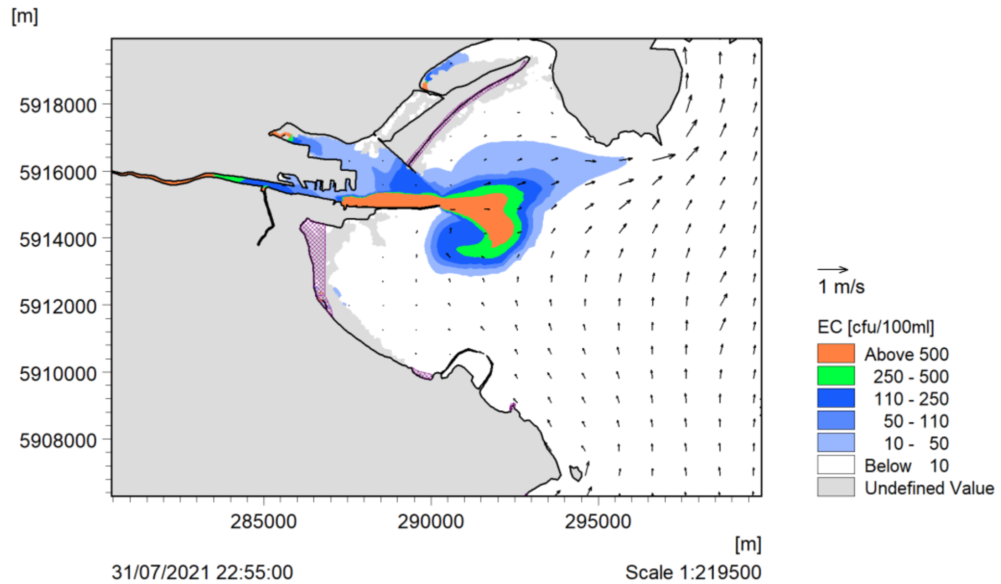
1 Hour before event start (flooding tide)



EC 2

Storm Tank Scenario

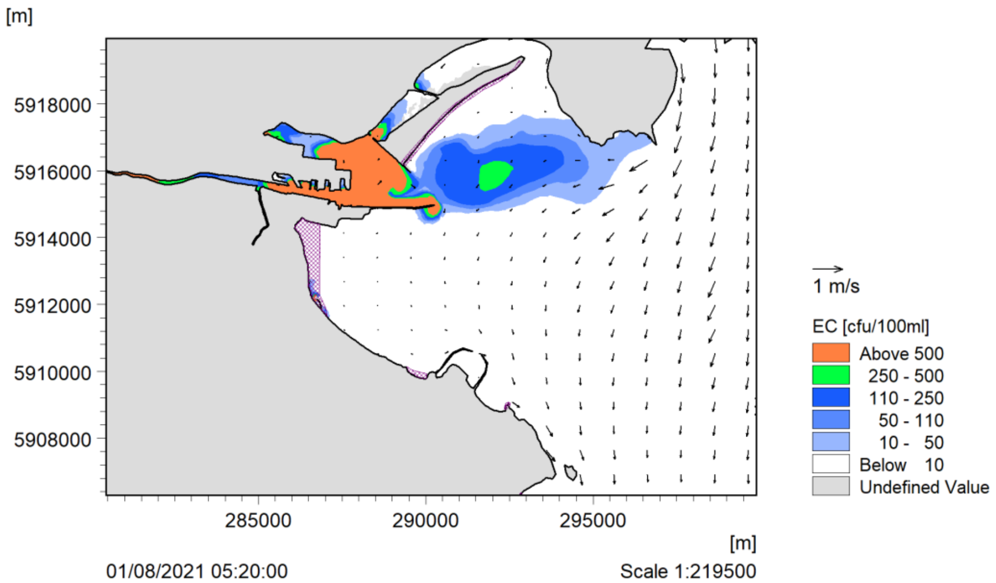
1 Hour before event ends (ebbing tide)



EC 3

Storm Tank Scenario

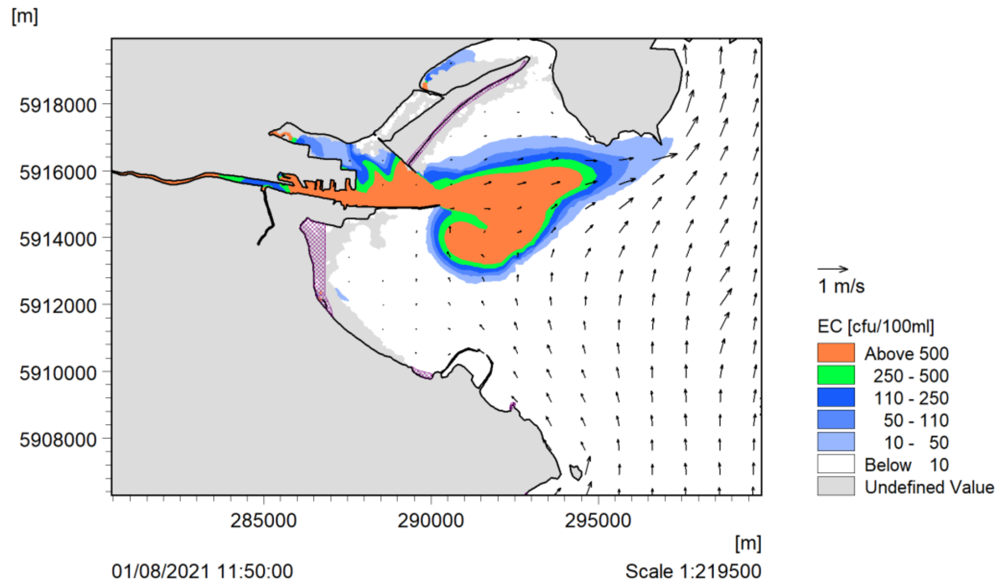
LW after mass discharge event



EC 4

Storm Tank Scenario

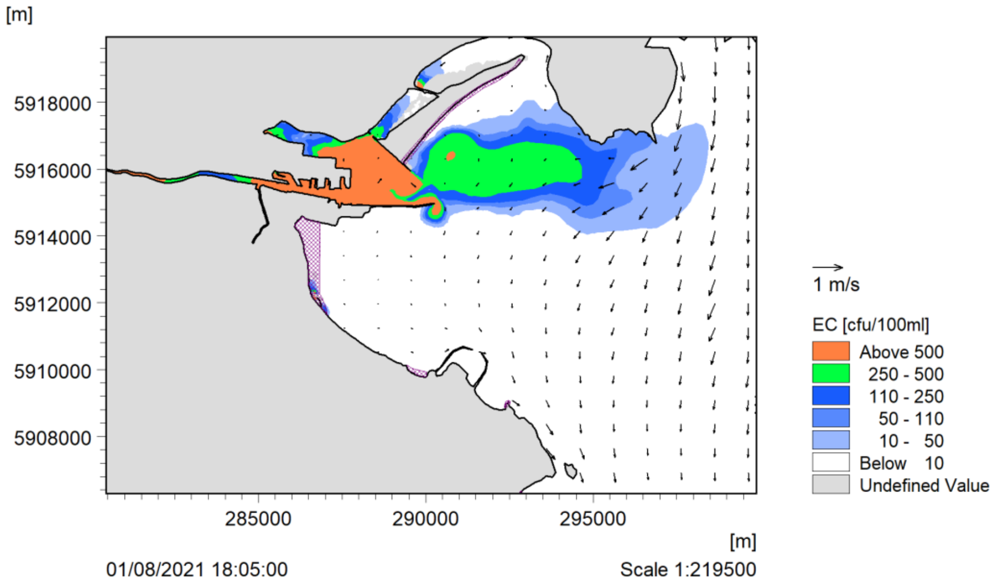
Subsequent HW, after mass discharge event.



EC 5

Storm Tank Scenario

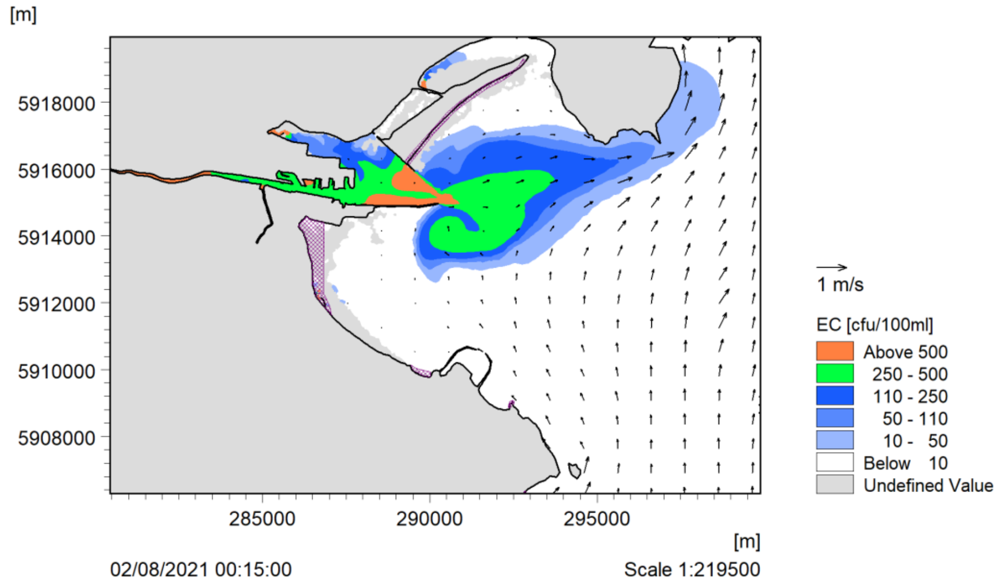
Second LW after mass discharge event.



EC 6

Storm Tank Scenario

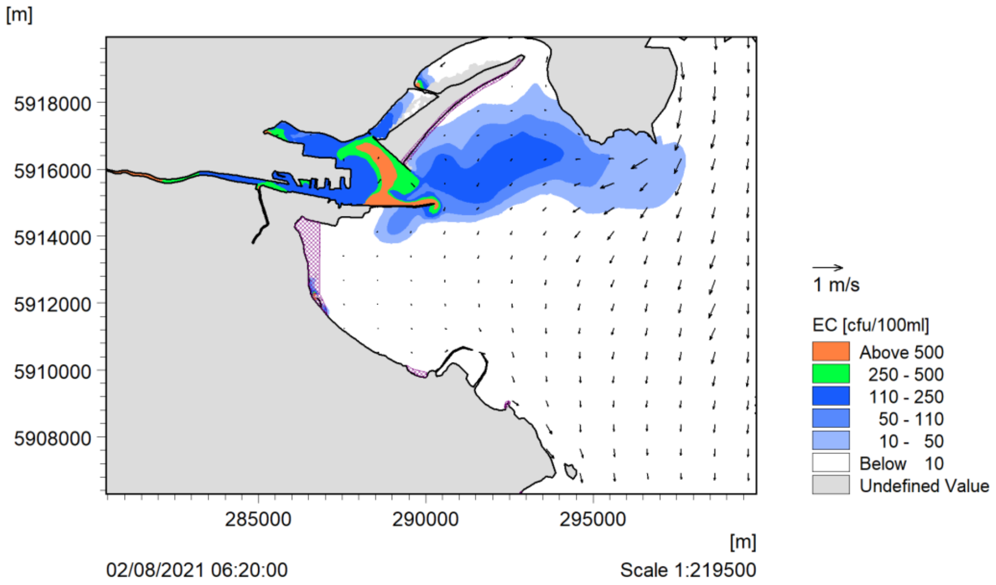
Second HW after mass discharge event



EC 7

Storm Tank Scenario

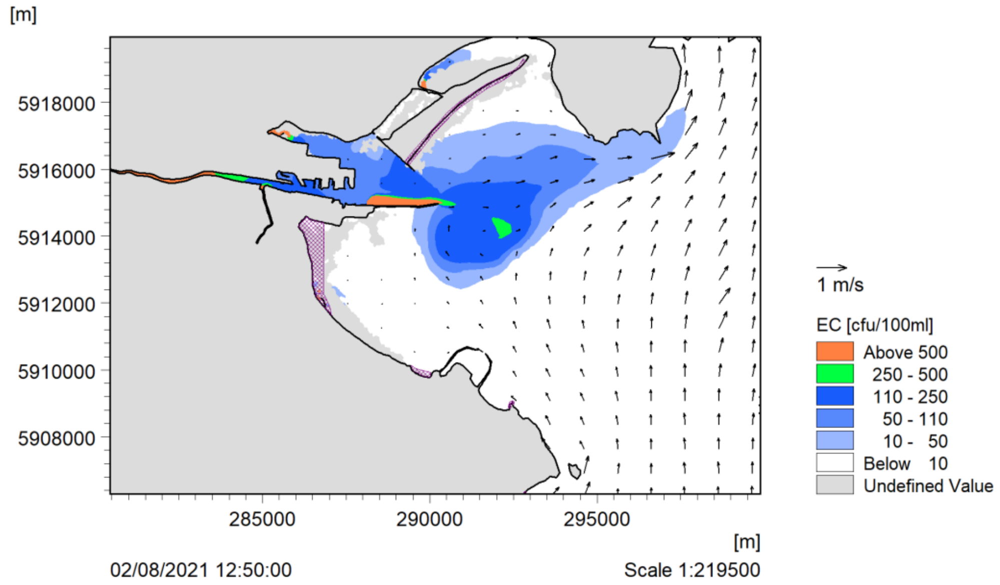
Third LW after mass discharge event



EC 8

Storm Tank Scenario

Third HW after mass discharge event

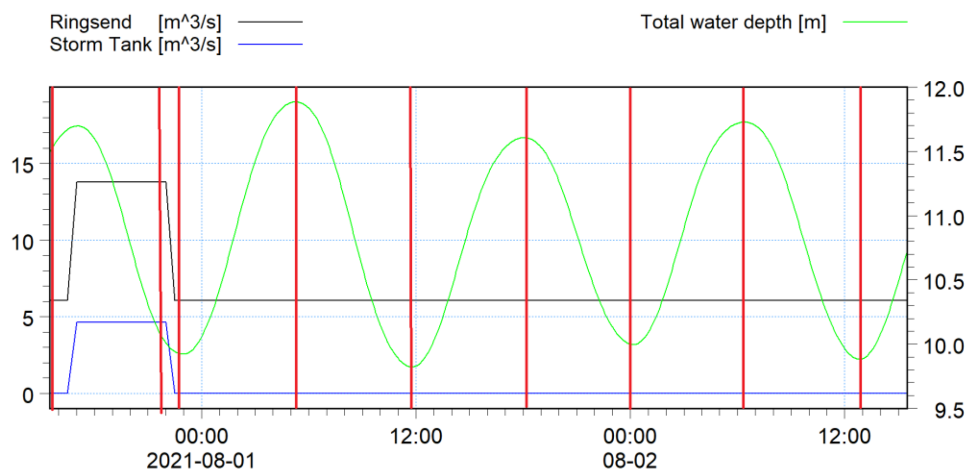


EC 9

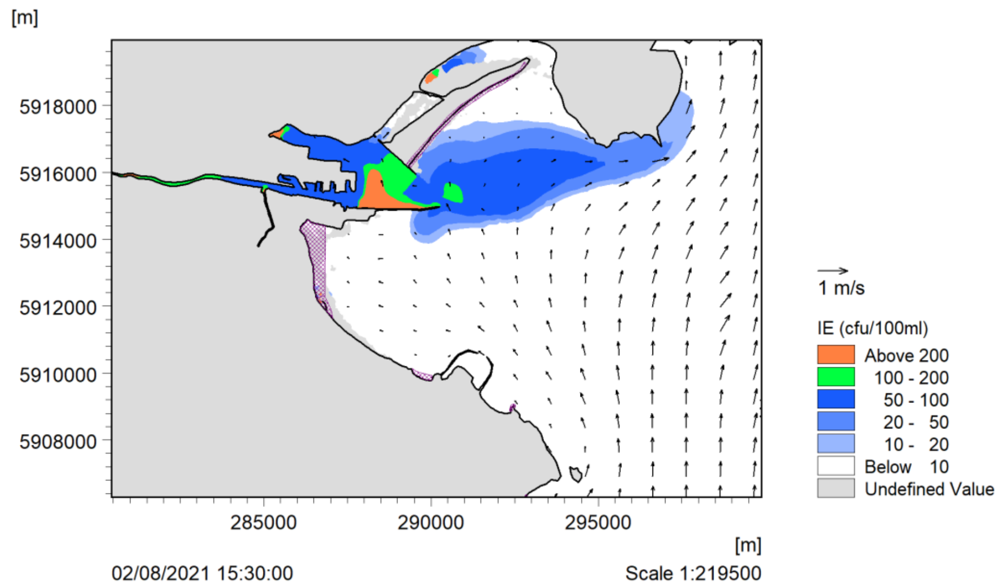
Storm Tank Scenario

Fourth LW after mass discharge event

C.2 STORM TANK SCENARIO – IE



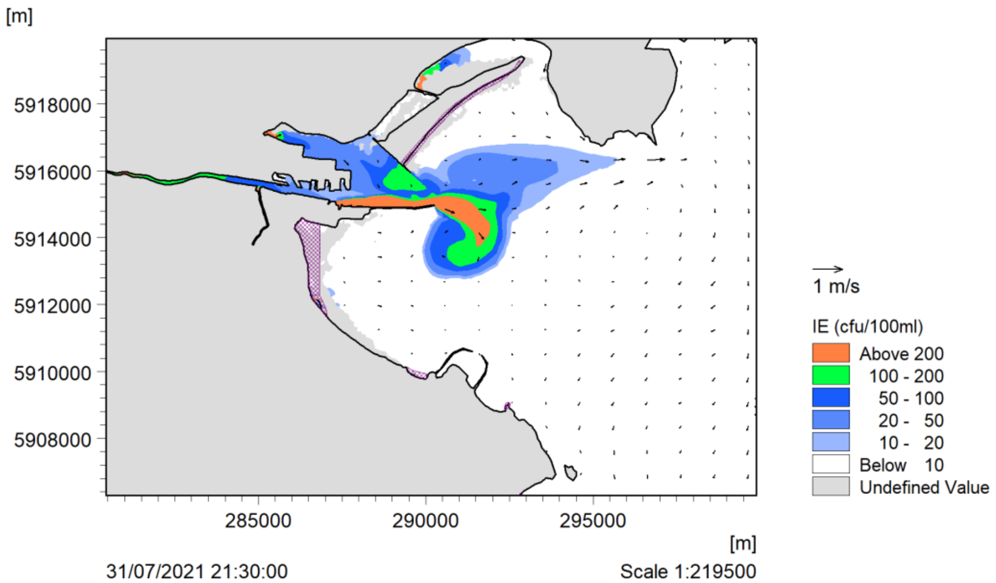
Time Series of modelled discharge rates and water level within Dublin Bay. Red vertical line indicates timing of subsequent plan plots of modelled concentrations.



IE 1

Storm Tank Scenario

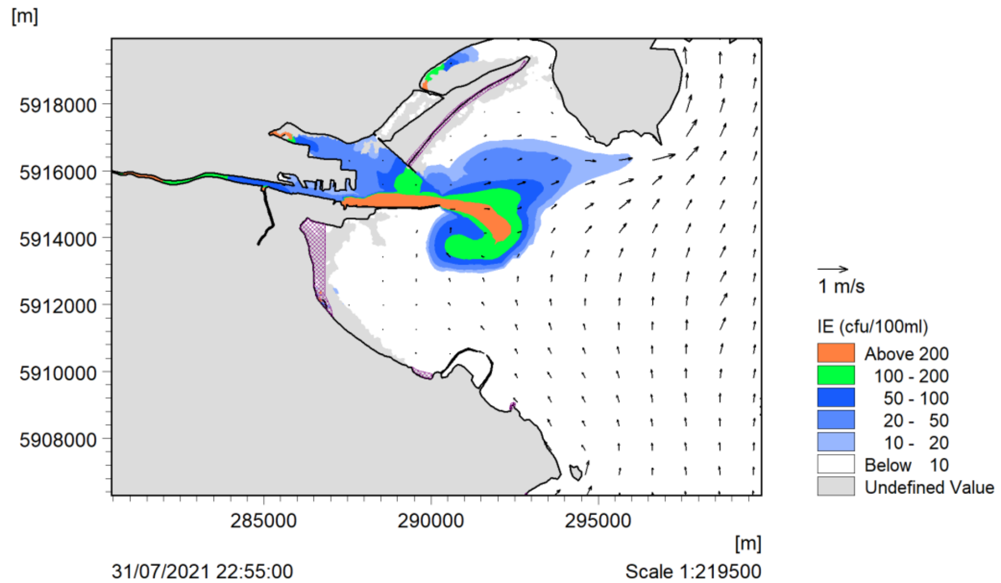
1 Hour before event start (flooding tide)



IE 2

Storm Tank Scenario

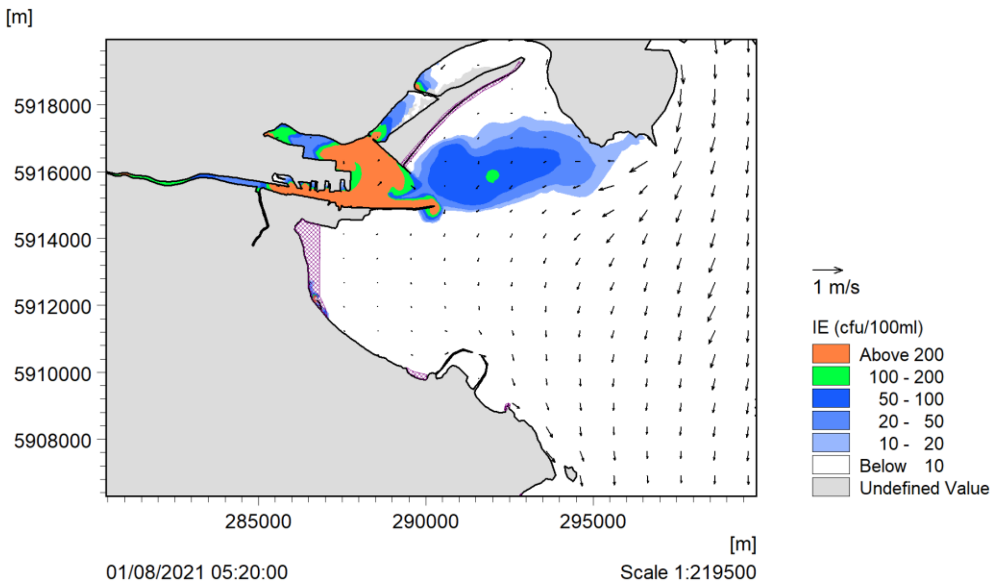
1 Hour before event ends (ebbing tide)



IE 3

Storm Tank Scenario

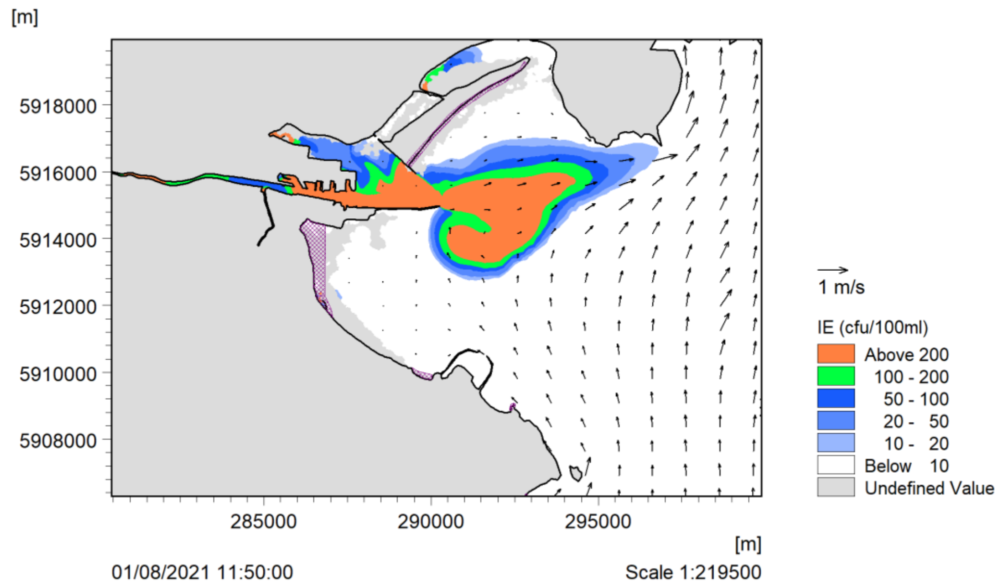
LW after mass discharge event



IE 4

Storm Tank Scenario

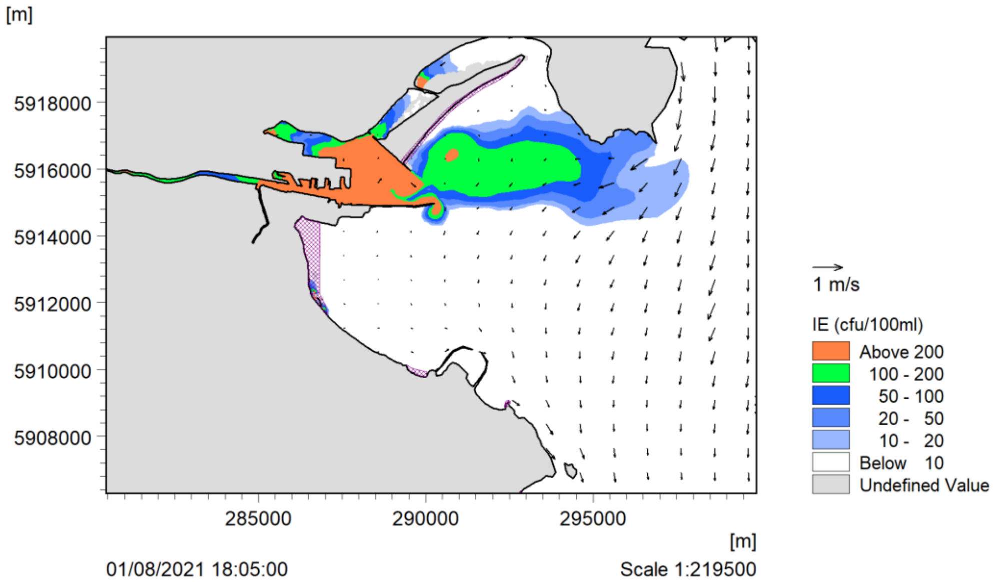
Subsequent HW, after mass discharge event.



IE 5

Storm Tank Scenario

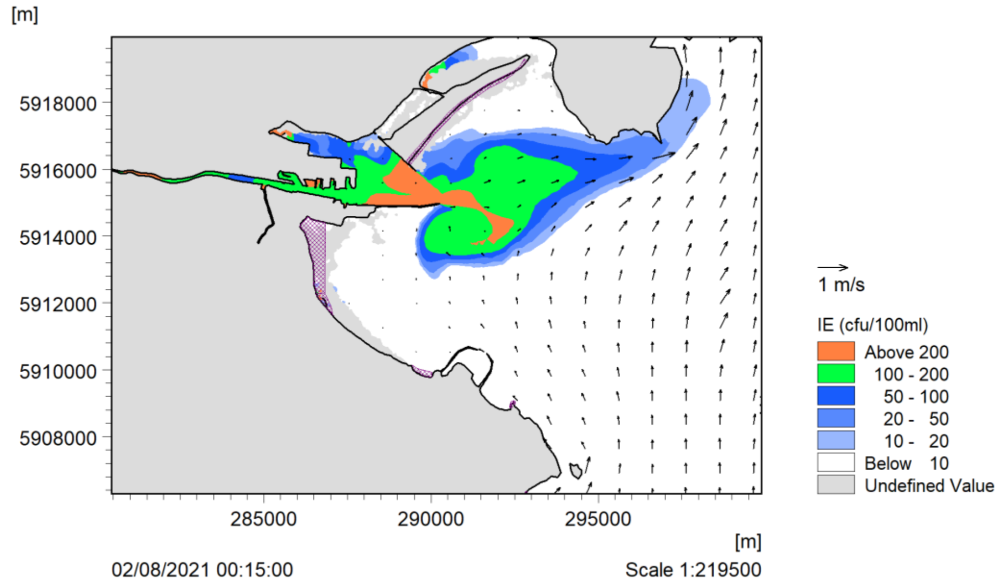
Second LW after mass discharge event.



IE 6

Storm Tank Scenario

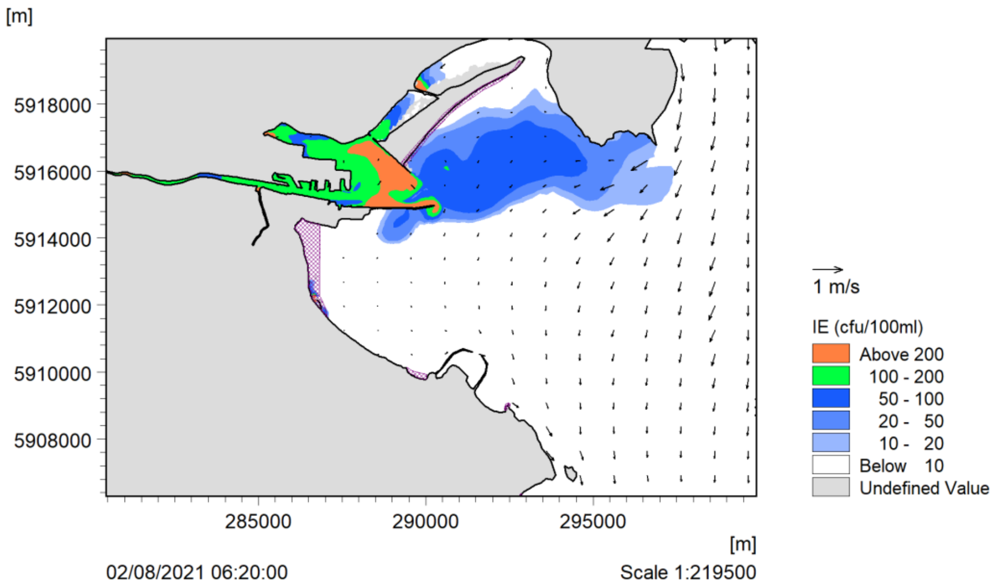
Second HW after mass discharge event



IE 7

Storm Tank Scenario

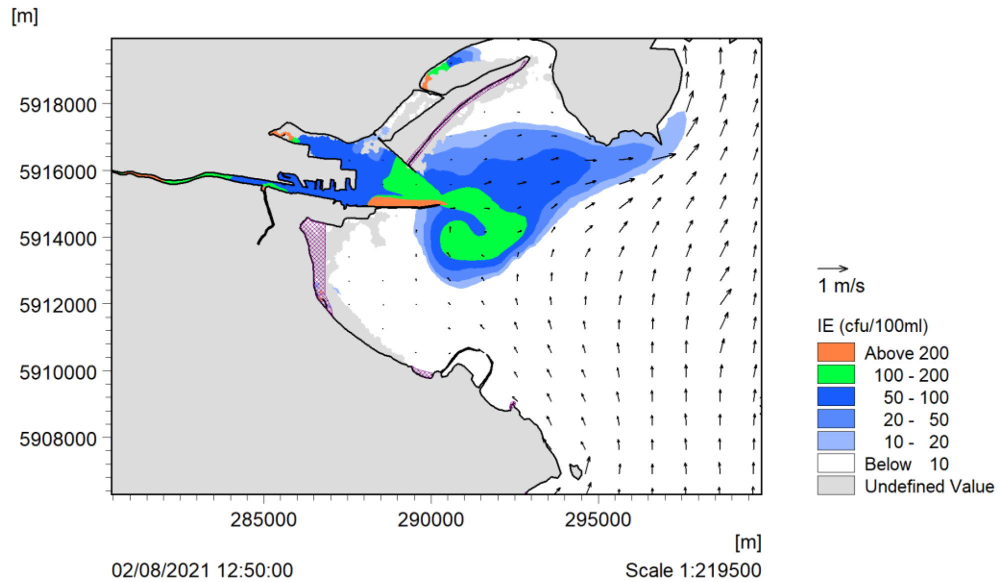
Third LW after mass discharge event



IE 8

Storm Tank Scenario

Third HW after mass discharge event



IE 9

Storm Tank Scenario

Fourth LW after mass discharge event

Memo

To: EPA OES
From: Uisce Éireann Asset Strategy
Date: 21/12/2023
Re: Modelling of ESB Channel Structure in Greater Dublin Area Agglomeration WWDL Application

Introduction

The primary discharge from the Ringsend WwTP outfalls to the Lower Liffey Estuary via the ESB Cooling Water Channel (CWC) for the Poolbeg Power Station. The CWC is a sheet-piled structure and is currently in a state of disrepair. As a result, flows in the CWC from both the power station and the WwTP do not spill to the Lower Liffey Estuary over the weir as originally intended.

The purpose of this memo is to provide context to the EPA on how Uisce Éireann has considered the effect of the CWC in the water quality modelling studies carried out as part of both the planning application and WWDL application.

Licensing and Modelling History

Previously a WWDL for the Greater Dublin Area Agglomeration was granted in 2010 in response to an application from Dublin City Council in 2007.

At that time a modelling study was undertaken using the 3D MIKE3 numerical water quality model which had been originally developed for the Ringsend Waste to Energy Project (EPA Waste Licence Reg. No. WO232-01). The model was updated for the purposes of the WWDL application and submitted to the EPA for review. The outcome of this process was the issue of the WWDL with ELVs as per below.

SCHEDULE A: Discharges

A.1 Primary Waste Water Discharge

Primary Discharge Point Code: SW1Dublin

Name of Receiving Waters: Liffey Estuary Lower (IE_EA_090_0300)

Discharge Location: 321073E, 233814N

Monitoring Location: 320355E, 233396N (Outlet sampling point)

Parameter	Emission Limit Value
pH	6 - 9
Toxicity	5 TU
Faecal coliforms	100,000MPN/100ml Note 1
	mg/l
CBOD	25
COD	125
Suspended Solids	35
Total Nitrogen	10
Total Phosphorus (as P)	1

Note 1: Limit shall apply from 1 May through to 31 August annually.

Figure 1 – D0034-01 ELVs as per WWDL licence as issued in 2010

In 2017 Irish Water submitted an EIAR in support of the planning application for the upgrade of the wastewater treatment works at Ringsend. This was accompanied by a new water quality modelling study based on a new calibrated and validated 3D dispersion model also developed in MIKE3 software. The modelling study was carried out by JB Barry & the Danish Hydraulic Institute (DHI) and herein is referred to as the “2017 EIAR study”.

In 2023 a WWDL Review was submitted by Uisce Éireann to the EPA. This was accompanied by an updated modelling study. In this study an updated 3D dispersion model was used to account for improvements in available water quality data and refinements to the previous model made as part of works delivered by Uisce Éireann and the Dublin Bay Bathing Water Taskforce. Herein this is referred to as the "2023 WWDL Study”.

Cooling Water Channel and Outfall Arrangement

The CWC within the Lower Liffey Estuary is a combination of sheet-piled wall structure (currently in a state of disrepair) and a curved concrete weir.

Figure 2 – Plan view of CWC

There are some gaps/holes in the wall which allow flows to leave the channel. As a result, flows in the CWC from both the power station and the WwTP do not spill to the Lower Liffey Estuary over the weir as originally intended.

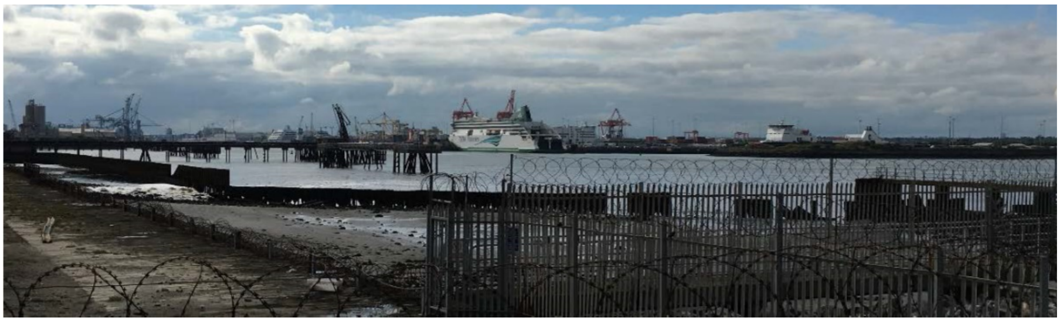


Figure 3 – Broken sheet pile wall structure

Figure 4 – Curved CWC outfall weir structure

As part of the Ringsend WwTP Upgrade Project, Uisce Éireann has an agreement in place with ESB to repair the CWC structure to ensure all discharges from both power station and WWTP operations discharge to the Lower Liffey Estuary over the curved weir. This agreement was originally in place between Dublin City Council and ESB.

Uisce Éireann is currently drafting tender documents for these works, with construction envisaged to commence in 2025 and be complete in 2026.

Representation of the CWC structure in numerical modelling studies

The CWC was represented in a similar manner for both the 2017 EIAR Study and the 2023 WWDL Study. The difference between the two was that for the final simulations the 2017 EIAR Study modelled the weir in its existing state whereas the 2023 WWDL Study modelled the weir in its repaired state.

The representation of the CWC structure in both models was documented in Section 5.4.7 of the Volume 3B Water Quality Modelling Report for the EIAR prepared as part of the original planning application. Additional information is provided below for ease of reference.

In order to appropriately schematise the CWC in the model, the physical structure was dis-aggregated into multiple components within the model.

The western (intact) section of the sheet-pile wall was represented as a physical land boundary, precluding and flow transfer through the structure.

The transfer of flows via the damaged sections of sheet-pile wall and the curved weir was represented by using four unique structures in the model. These are labelled in Figure 5 below. Each of the four structures was schematised using the broad crested weir equation to simulate the approximate conveyance through the irregular weir structure.

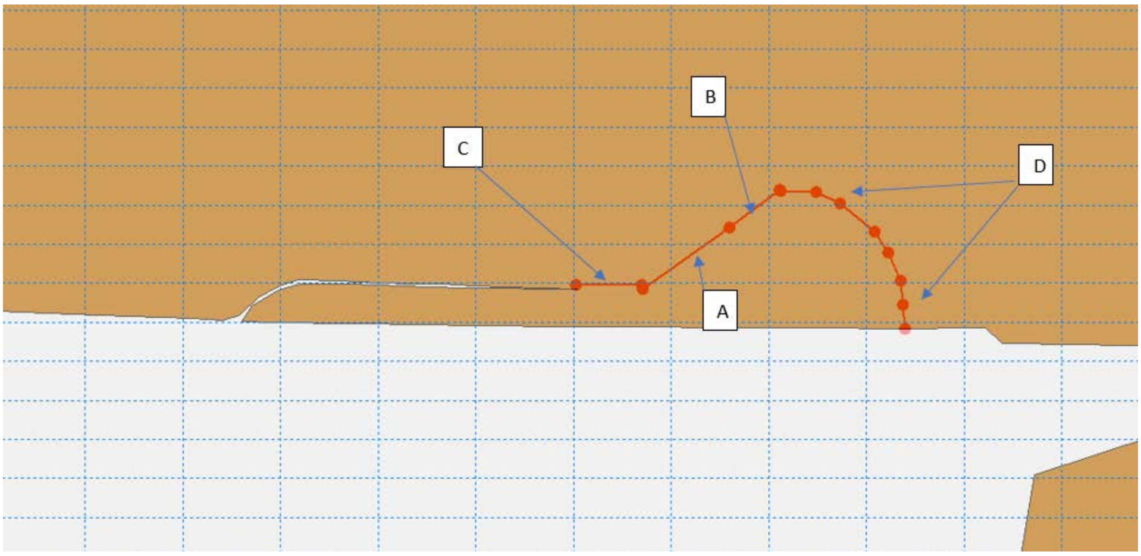


Figure 5 – Representation of CWC structure in model

Invert levels and weir widths were applied to each section to appropriately represent flow paths from the CWC to the Lower Liffey Estuary for the purposes of understanding impacts on the water quality of the receiving waters. Values used were based on a site investigation in August 2016 by JB Barry/DHI undertaken at low tide.

The preferential flow mechanisms through the CWC structure were modelled via Section C (immediately beside the WWTP outfall) which was attributed an invert level of -1mOD and with a width of 12m, and through Section B which was also attributed an invert level of -1mOD and a width of 30m. These weirs were used to simulate missing sections of the sheet-pile wall.

Section A represented the mostly intact section of sheet-pile wall in between Section B and Section C, and was modelled as a weir of invert +1mOD and width of 50m.

Finally - section D represented the curved weir structure and was modelled with an invert of 0mOD and a length of 100m.

Figure 6 shows the model mesh resolution in the area of the weir. Each of the model elements in the area of the CWC are in order of 15m-25m in length so the schematisation of the four weir structures is commensurate with the model resolution in this area. This schematisation of the CWC is appropriate for the purpose of the model which is to assess the fate of pollutants from Ringsend WWTP and to understand the impact on water quality in the receiving waters.

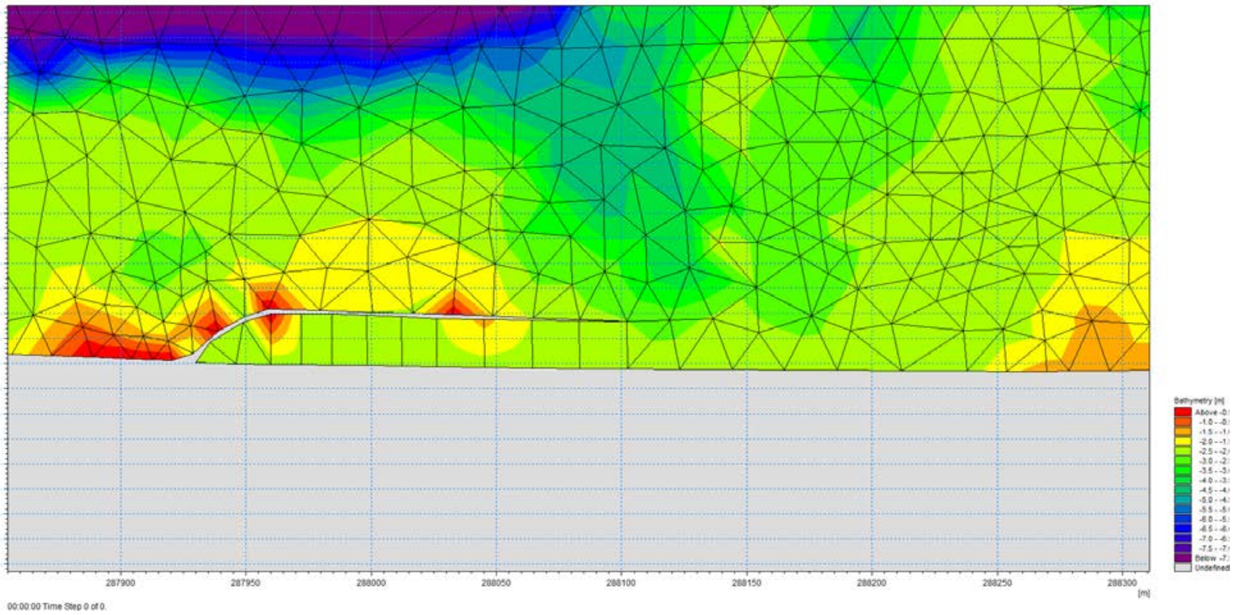


Figure 6 – Model mesh resolution in vicinity of CWC

The only difference between the 2017 EIAR study and the 2023 WWDL study was that for the 2023 study the crest heights of modelled sheet-pile structures A, B and C weir were increased to an arbitrarily high level of +50mOD in order to force flows to discharge via the curved weir (Section D).

Sensitivity analyses on CWC repair

Two sets of unique sensitivity analyses have been carried out to demonstrate the influence of the CWC on receiving water quality. These are set out below.

2017 EIAR Study

As part of the 2017 EIAR Study an investigation into the effect of the repair of the weir on the local hydrodynamics was carried out using particle tracking analyses.

This involved a particle tracking exercise where particles were released into two models, one with the CWC in the existing state, and one with the CWC in a repaired state. These were presented in Section 7.2.4.2 in Volume 3B Water Quality Modelling Report of the EIAR and are reproduced in Figure 7 below for ease of reference.

The particle tracking exercise simulated conservative tracer particles released to the CWC at via the Ringsend WWTP outfall.

Particle tracking involves simulating the release of neutrally buoyant particles in the water column. These particles are advected by the general currents and dispersed randomly by sub-grid scale linked to the dispersion rate in the model. Particles released at the same time and same place may therefore slowly separate and follow different paths.

Each particle track shows the particle position over a 48-hour period from time of release. Blue tracks show particle movement with the CWC repaired. Orange tracks show particle movement with the CWC in its current state.

The four plots were set up to show the effect of the CWC repair on advection of particles across different tidal conditions:

- The top left panel shows 48-hour tracks for particles released hourly on day 3 under spring tide conditions
- The top right panel shows 48-hour tracks for particles released hourly on day 5
- The bottom left panel shows 48-hour tracks for particles released hourly on day 11 (neap tide conditions)
- The bottom right panel shows 48-hour tracks for particles released hourly on day 13

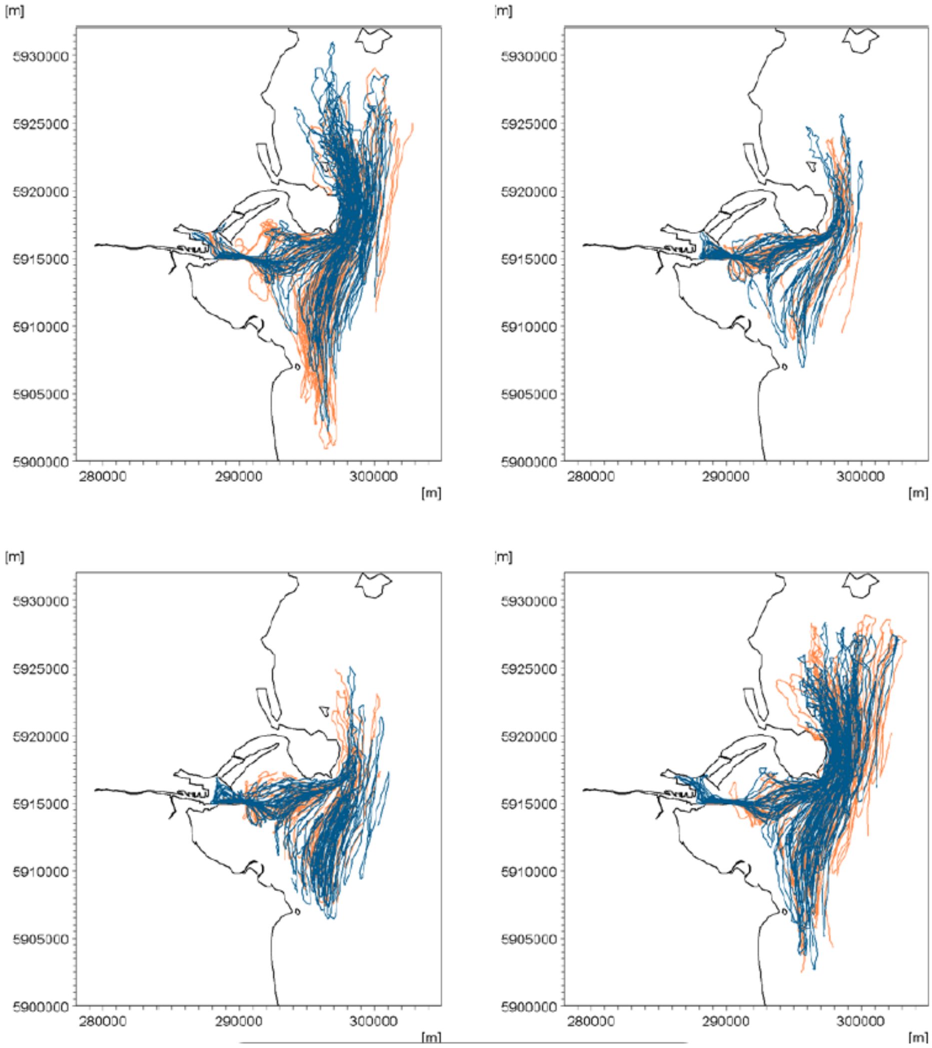


Figure 7 – Particle tracking runs with CWC in current state (orange) and repaired state (blue)

The plots all showed similar patterns of advection (particle movement) irrespective of the state of the CWC.

In terms of impacts of key receptors such as Designated Bathing Waters at Dollymount and Sandymount, the particle tracking demonstrated that there was no significant effect, irrespective of whether the CWC channel was repaired.

The particle tracks did show with the CWC repaired, there was a greater propensity for particles to drift north towards the Tolka Estuary. This was described in Section 8.1 of Volume 3B Water Quality Modelling Report of the EIAR as follows:

> *"Post remediation, the flow over the easterly end of the weir leads to a slight change in the position of the surface water flows, which is sufficient to lead to a small increase in water from the vicinity or Ringsend into the lower Tolka."*

2023 WWDL Study

Following a meeting between Uisce Éireann and the EPA OES Wastewater Licensing Team, additional modelling simulations were carried out by Uisce Éireann to directly demonstrate the limited influence of the CWC on the water quality of receiving waters.

Two EQS parameters were assessed including:

- Summer 95%ile *E. coli* concentrations to demonstrate any potential impacts on Designated Bathing Waters
- Winter median DIN concentrations to assess potential for any impacts on nutrient sensitive receiving waters

For each parameter two simulations were run, one with the weir in its existing damaged state and a second simulation with the weir repaired. The results of these are presented in Figure 8 and 9 below.

The outcomes of both sets of sensitivity analyses show that the CWC arrangement has little effect on overall water quality concentrations in receiving waters.

Figure 8 demonstrates that there are some local changes in median DIN concentration in the immediate vicinity of the discharge in the Lower Liffey Estuary however these are very small in magnitude and are not sufficient to cause a change in classification of any of the WFD supporting quality elements.

For 95%ile *E. coli* concentrations, the delta plot in Figure 9 also shows some local changes in bacterial concentrations in the immediate vicinity of the discharge and a slight reorientation in plume trajectory towards the Tolka Estuary. Overall, the plot demonstrates a net improvement in bacterial concentrations in Dublin Bay however there is no discernible change at the designated bathing waters.

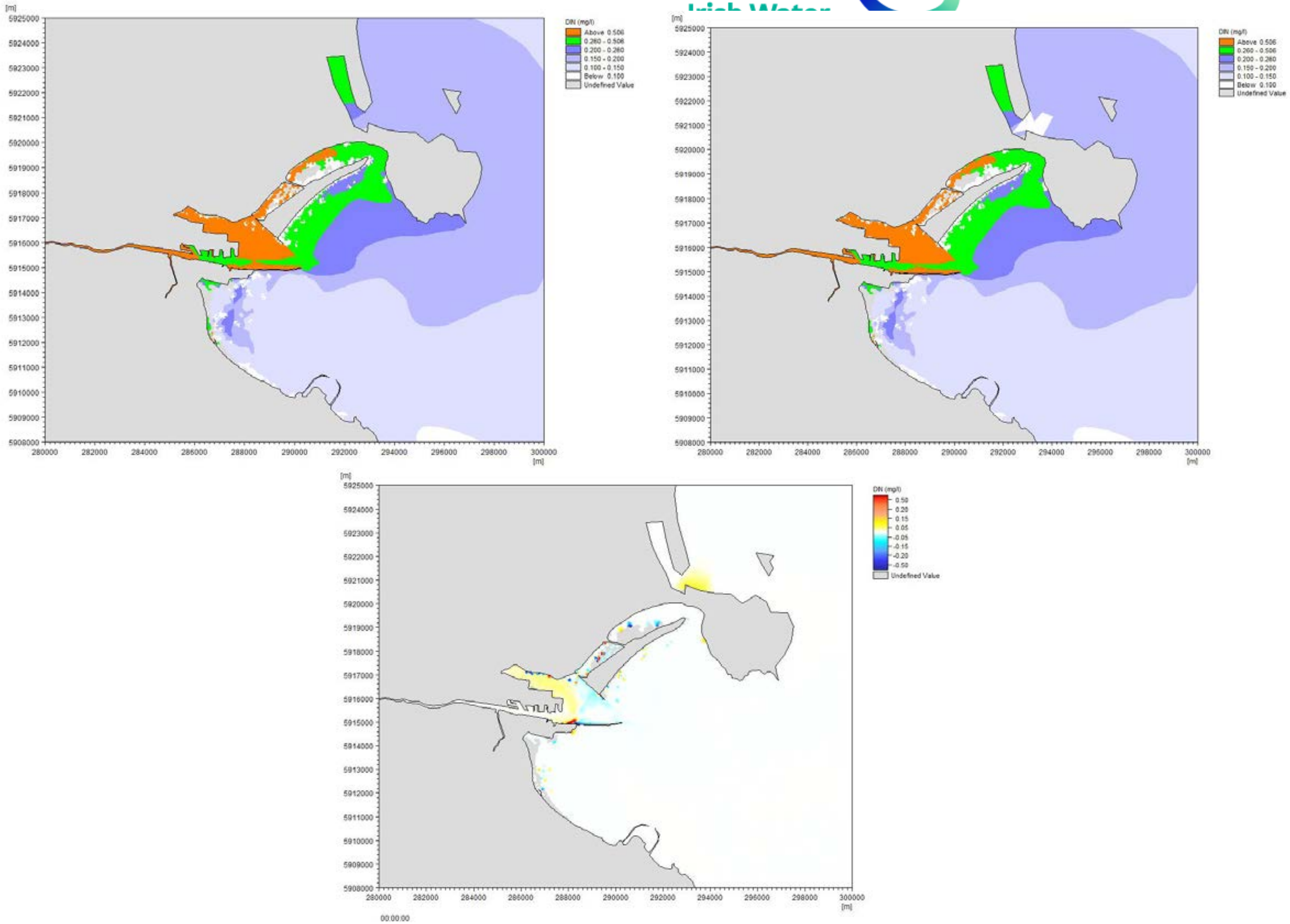


Figure 8 – Median Winter [DIN] (mg/l) with weir broken (top left) repaired (top right) and delta change plot (bottom)

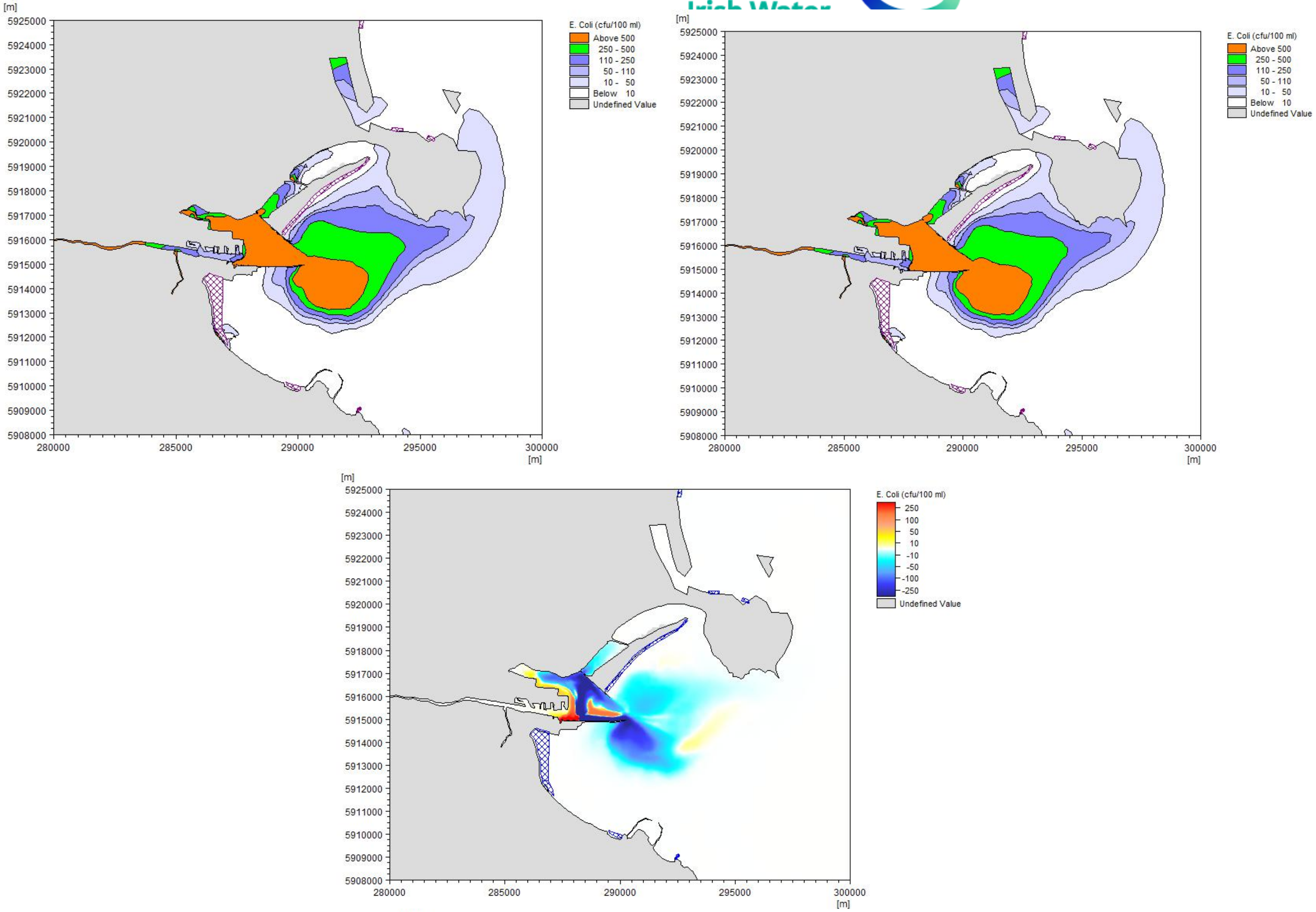


Figure 9 – Summer *E. coli* (MPN/100ml) with weir broken (top left) repaired (top right) and delta change plot (bottom)

Conclusion

Having considered the findings of the 2017 EIAR particle tracking modelling sensitivity analyses as well as the additional sensitivity analyses carried out as part of the 2023 WWDL Study for winter DIN and summer *E. coli*, Uisce Éireann is satisfied that the repair of the CWC alone will have no material change on the designated bathing area nor in the achievement of WFD objectives for the receiving waterbodies.

The findings of the sensitivity analyses confirmed that the CWC arrangement is not a dominant factor in receiving water quality and that dilution (due to tidal exchange) and the net advection of pollutants out into Dublin Bay remain the governing factors on the fate of pollutants from Ringsend WWTP.

Both CWC scenarios (current state & repaired) have been modelled and included in the overall submission for the WWDL Review.

The 2017 EIAR study included an assessment of the proposed discharge with the CWC in its current state whilst the 2023 WWDL modelling study included the weir in its future repaired state.

Uisce Éireann are of the opinion that for the purposes of the WWDL Review it was appropriate to model the CWC with the weir repaired for reasons set out below:

- The state of the CWC has no impact on WFD classification or Protected Areas.
- The repair of the CWC results in only very minor, localised changes to the immediate mixing plume.
- An Uisce Éireann project is on track to repair the weir with works due for completion in 2026.
- Modelling the repaired weir avoids the need for a future WWDL Review in 2026.