

Galway Harbour Extension, Review of Marine Hydrology Issues

Date: 28-03-2025

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GALWAY, INTRODUCTION

This report is made upon request by An Bord Pleanála. It is a short review based on two recent reports [AA] and [B] (see below) on the topic “Hydrology”. Ch. 8 of the original 2014 Environmental Assessment Studies (EIS) treats this topic, but also Ch. 6 and 7 touch “Hydrology”.

The reports considered are

[A]: Galway Harbour Company: Galway Harbour Extension EIS, 2014

[AA]: Galway Harbour Company: Galway Harbour Extension: Response to An Board Pleanála, EIS Addendum Sept. 2024, Chapter 8 Water. (But also ch.6 and 7 main and addendums)

[B]: An Taisce Proposed Galway Harbour Extension in Renmore and Townparks Townlands, Galway city, Response to An Board Pleanála letter of 16 July 2024.

[C]: Galway Harbour Company: Galway Harbour Extension, Response to An Bord Pleanála, NIS Addendum September 2024.

It is important to realize that there are no material changes to the proposed design of the proposed extension compared to the design described in [A] 2014.

The reports under review are therefore mainly focused on additional updated data information.

[AA] includes updated registrations of wind and Flood data compared to [A] and further includes a discussion on Climate changes.

[B] includes even newer data than [AA] on flood (the January 2025 Éowyn storm) and also includes a discussion on Climate changes.

[C] includes new data on sediment properties and biodiversity in inter- and subtidal areas.

Structure of the review:

To put everything into perspective, the reviewer has chosen to discuss the updates topic by topic, firstly to describe the relevance, next how the problem is approached in [A] and [AA], and finally to describe/discuss content of [AA] and [B] together in each section.

Summary and conclusion:

The main report [A] is a very solid report with respect to the topic “water”. The flow pattern is modelled professionally by adequate numerical modelling, and the physics behind is explained adequately.

The reports [AA] and [B] from Galway Harbour Company yields constructive new input: [AA] first of all gives a clear comprehensive summary of earlier work, which was very helpful for the preparation of the present review - and reduced the written work considerably.

[AA] and [B] both improved the description of tidal flood: [AA] by illustrating the robustness of predicting extreme flood levels by including further updated data.

[B] pointed out how violent the January 25 Éowyn storm behaved, and that it most likely would change the coming prediction regarding extreme flooding. Still, it should be kept in mind that this is not caused or affected by the proposed extension.

The reviewer has only found two very minor issues which have not been mentioned in the reports, namely superelevation (which is quite small) and possible bend scour in the Corrib Mouth, due to the turning of the in-and outflow to Corrib River.

Contaminated sediment in the spill has not been discussed, but chemical analysis in [C] confirms that this is not an issue.

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1. Wind, Waves and Current

Motivation:

Changes in waves and current due to extension have been considered very detailed in the main report [A] because such changes in the nearshore flow pattern will cause erosion or deposition in the seabed and along the shoreline.

The risk of increased flood changes in flow patterns also increase the risk of increased flood and finally impact on the salinity distribution near the River Corrib Mouth. This latter is treated in section 4.

Waves

General:

Wind Waves are formed by wind, and their size grows with free stretch, strength and direction of wind and finally the time, the wind is acting.

Methodology: The model TOMAWAC (from TELEMAC) was applied to model the generation of waves due to winds and offshore climates and the propagation of these deepwater waves into the shallow waters in the inner Galway Bay. TOMAWAC is a third-generation spectral wave Model.

A more refined model ARTEMIS was used to model near the proposed port area and its sea defenses, and to assess the effect of the new port extension on the local wave climate

Results: [A] concludes that waves do not impact the flood risk at the adjoining areas to the extension, as also referred to in the detailed description in [AA] p.8.

Wind

General:

Wind is input to the wave generation model.

The Wind aligned with the bay (WSW) is the most exposed direction for the Bay. Because of the Aran Islands, the free stretch in this direction is limited. Therefore, wind-generated waves are limited in height. In the modelling [A], a 50-Yr storm with a strength equal to 30 m/s from all directions is applied. Most waves are from W or WSW. With this

direction, the model predicts waves up to a height of 17 m in deep water, decaying to 5-6 m behind the Aran Islands, and 2-3 m just outside Galway Harbour. This decay is partly due to refraction (turning) of the waves towards the shorelines as they migrate inwards in the bay, and partly due to wave breaking, which limits the wave height. The waves usually break when the height approaches 0.6-0.8 times the local water depth.

[AA] pp21-22 includes additional wind data from a 22 Yr Wind record, and this data modifies the predicted 50 Yr wind from 30 m/s to 31-32 m/s. This is considered in [AA] to be so small that it can be neglected.

Conclusion

It is reasonable to neglect the small increase in predicted extreme wind, since the waves break in shallow water, so the limited water depth limits their height anyway.

Current

General:

The daily current flow is mainly governed by the tide, 2 to 5 m (neap to spring). Near the Corrib mouth, the outflow from the Corrib contributes with an additional current component, see section 4.

Methodology:

[A] modelled the tidal flow pattern close to the extension area with and without the extension implemented, using the numerical flow model, Telemac.

Because the design of the proposed extension is unaltered, no new modeling work has been performed and presented in [AA].

Summary and conclusion:

The only change in [AA] compared to the original EIS [A] is an extended data series regarding the extreme wind strength. including more recent data (until 2024). This incorporation increases the 50 Yr storm applied to predict the wave climate by about 5%. [AA] find this so small, so no new numerical runs have been performed.

The reviewer agrees in this assessment also because the wave heights most likely will not increase anyway, because the waves will decrease in height due to wave breaking.

[B] do not comment on this topic.

2. Flood

Motivation:

The extension may cause a rise in water levels in its nearby surroundings. The harbour itself has a quay level equal to 4.70 m above high tide level (O.D.Malin), and an even higher tide flood level is not catastrophic as long as the quays only is used as *harbour* with its facilities, i.e. not taken special considerations to housing and other vulnerable structures.

The general increased risk of flooding nearby due to *climate changes* is not related to the extension, but nearby there may be some minor effects.

General:

The flood is just as waves and current, due to action of wind and tide. Additionally, precipitation may play a role for the water levels near the Corrib Mouth due to the runoff from Corrib River.

Methodology:

Estimates of Maximum Tidal flood levels for a 200 Yr event in [A] are based on an updated statistical analysis of 27 yrs (1982-2009) records of data from Oranmore.

Updated Results:

[AA] includes updated fluvial flow statistics (from Office Public Water OPW) including recent records 2009-2024. The updated statistics from Wolfe Bridge (crossing Corrib) now comprises 32 Yrs, and the one from Oranmore comprises 42 Yrs

By comparison between Oranmore (Away from Corrib) and the one at Wolfe Bridge placed at the mouth of Corrib you can extract the fluvial impact from Corrib on flood (it is predicted to be 15 cm, but mainly upstream of the bridge)

The above-mentioned data are supplemented with data at two other locations for a somewhat shorter span of years (p.16, [A]).

[A] and [AA] make similar analysis, the latter predicting a 4cm higher 200Yr event. [AA] mentions that data covering 42 years is quite low to predict a 200 Yr event, especially when considering climate changes.

The new prediction is 4.044m O.D. Malin with a statistical error of 0.15m, ([AA] p. 17)

Recent storms

In the analysis, [AA] also included the historical storm Eleanor (3.735m OD at Oranmore) occurring 2 January 2018, but the analysis and reporting were finished before the even more violent historic storm Éowyn 24 January 2025.

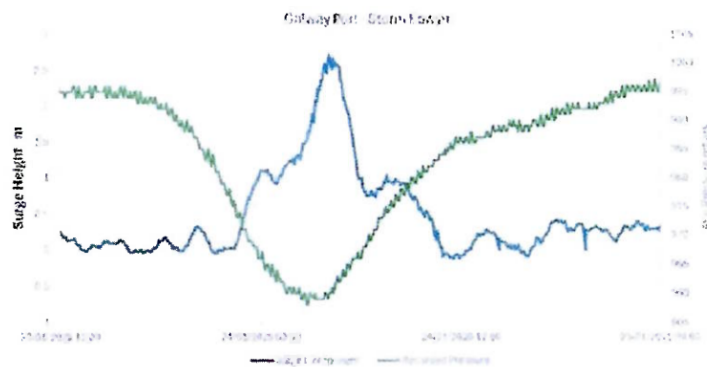
That storm is a central issue in the report by [B]:

The storm took place with medium tide, and the high tide that day was 3.9 m. The highest flood level the same day was 5.25m, recorded at Galway Port. At the time for this recording, it coincided with lower tide, and was, according to Tony Cawley, - cited in [B], about 2.6 m on the astronomical tide.



Tony Cawley • 1st
Hydrologist and Director of Hydro Environmental Ltd.
4d • 🌐

The Storm Surge recorded at Galway Port for Storm Eowyn was Historic and fortunate to have coincided with the lower neap tides and towards low water producing just over 2.5m on the astronomical tide



Storm Surge Profile

From [B]: The Cawley plot. Green is tide, blue storm surge (next to tide).

For forward predictions it is important to distinguish between tidal flow and storm induced flow: tidal flow is independent of climate changes, while stronger storms increase the magnitude of the so-called wind set-up, where the wind drag the sea water surface, so the water surface elevate near land. This increase can be even stronger if you have a local barometric low pressure.

Because it is two independent events (tide, and wind set up), you can get the worst-case scenario by adding the storm setup of 2.60 m to the high spring tides closest to January 24th instead: this occurred January 15 (5.3 m, Chart Datum) and 31 January (5.4m). So, if Éowyn instead had occurred one week later at high tide (06:14 in the morning), the water level would reach

5.4 m +2.6 m=8.0 m. or **5.0 m O.D. Malin.**

This is 30 cm above the quay level.

Impact of extension for nearby flood

[B] specifically ask (p.15) whether a storm surge like Éowyn (and even higher in the future) will cause deflection of the storm surge waters to other areas in the vicinity of the new development.

Answer: Whether the water level near a structure will increase further than the incoming storm surge depends on how fast the water level is rising, If you consider a solitary wave like a tsunami, the timescale is about 1 minute, and the water level near-a-structure (House, harbour, etc.) certainly may rise additionally. However, the timescale for a rising storm surge is much larger: the “Cawley-plot” shown above suggest a timescale for the last 1.5-meter storm surge rise to be about 1.5 hours.

In such case, the displaced-by-structure amount of water will be levelled over a much larger bay area, and any additional water level increase will be negligible, less than a few millimeters.

Near the Mouth of Corrib

The figures below show the expected impact of the extension on the flow pattern, with a high outflow from Corrib River, modelled with the 2D (depth averaged) flow model, TELEMAC.

The proposed outer western breakwater acts as a guiding wall for the river, which is been deflected to a more Southern direction. [A] explains that this concentrated flow will be beneficial for keeping the coming dredged channels clean.

However also additional scour may be introduced along the breakwater and further upstream, see next section. Also sharply curved flow may introduce additional super-elevation at the other bank (proportional to V^2 / R , V=flow velocity and R radius of curvature) and especially at the tip opposite Nimmo’s Pier, see the red arrow in the figure below. The flow becomes most curved at this point, due to the deflection by the

new Western part of the extension. However, this contribution is small, some few centimeters.

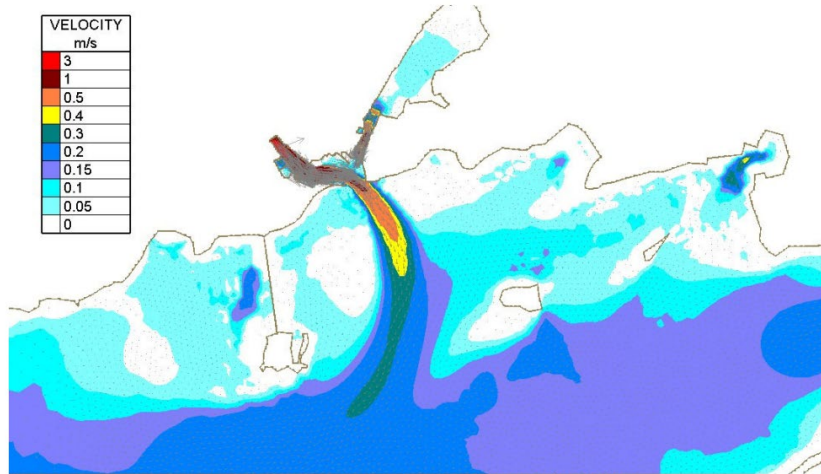


Figure 8.4.12 - Depth averaged velocities Mid-ebb Spring Tide and 100 year Corrib Flow

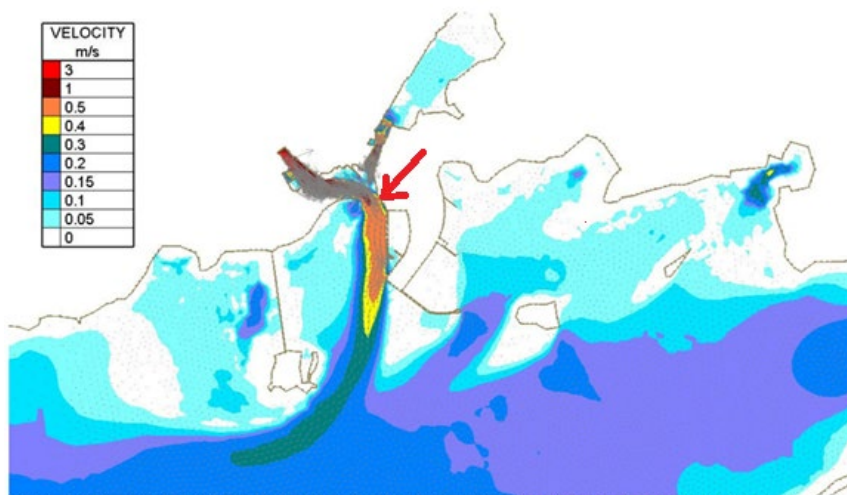


Figure 8.4.13 - Depth averaged velocities Mid-ebb Spring Tide and 100 year Corrib Flow with new development

The banks at the red arrow will be exposed to a slight superelevation due to flow in bend

Summary and conclusion:

The flood risk assessment has been discussed in detail in [AA] and to some extent also in [B].

However, it is important to realize that almost all predictions on flood risk are not generated by the extension of the harbour, but by nature itself. The extension alone do

not contribute to the rise of the water level, except at the red arrow in the River Corrib. Here the increase is of order a few centimeters at very high river flows.

The prediction of the flood risk has been improved by [AA] and [B]: [AA] demonstrates that the predicted Tidal Flooding not is sensitive to prolonging the data series behind the predictions by about 25%: the 200 Yr tidal flood level is only increased by 0.048m to 4.194m (including 15 cm statistical error).

The operational quay level is set to 4.70m O.D., so there should be room for 50 cm sea level rise.

[B] included the January 2025 Éowyn storm, which occurred at low tide with a storm surge setup about 2.75 m (i.e. filtering out the tidal component). Had it occurred at spring high tide, the water level would have raised to 5.10 m O.D., far above the 200 Yr prediction in [A] and [AA] and 40 cm above designed quay level of the extension.

3. Bathymetry, shoreline.

Shoreline.

The coastline in Galway bay is quite stable, charts from 1813 and 2013, from [A], Ch 7, p146 and 147, reproduced below



Figure 7.7.1 - Section of Admiralty Chart number 1984 showing the area from Renmore Point to Black Rock ca 1843

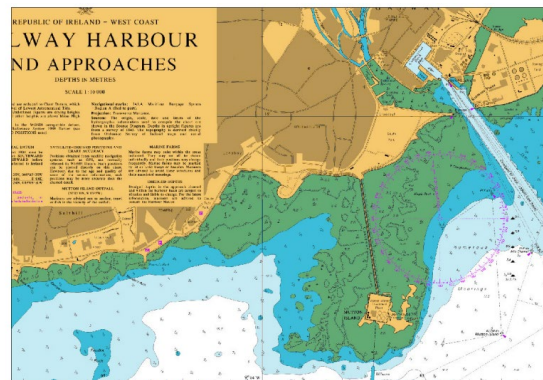


Figure 7.7.2 - Section of Admiralty Chart number 1904 showing approximately the same area in ca 2012

Shorelines 1843 and 1904.

Also, the shoreline is today well protected by a rubble mound revetment:



The coast is well protected (Firth et al: Eco-engineered rock pools: A concrete solution to biodiversity loss and urban sprawl in the marine environment [Environmental Research Letters](#) September 2016 11(9):094015

Also, the seabed is stable: From Bathymetry measurements, [A], Ch 6, Add.p3 concludes: nearly no change has occurred in a large year span, 1843-2012.

Impact from extension on erosion/deposition

Renmore/Ballyloughanecf. The proposed extension will act as a large groin for this area, - as does the Mutton causeway for the area W of the Corrib Mouth. A groin usually traps sediment in the front, and because of this trapping, erosion occurs behind. In an environment with a strong tidal environment, the functioning of groins is questionable because the flow approaches from both directions.

Mutton causeway constructed in 1999/2000 acts similarly as a groin, however, not much accretion/erosion has occurred in the vicinity of the causeway. Next to the description above, this is most likely due to very limited longshore sediment transport. A detailed flow and sediment transport description is given in [A] Ch 7.

Sometimes such a structure like the two described above will collect different kinds of debris including dead seaweed, creating smell problems. However, such trap has not really been observed behind the Mutton Causeway, most likely due to the strong tide which during falling water levels will “clean up”.

Scour near the Western part of the proposed extension.

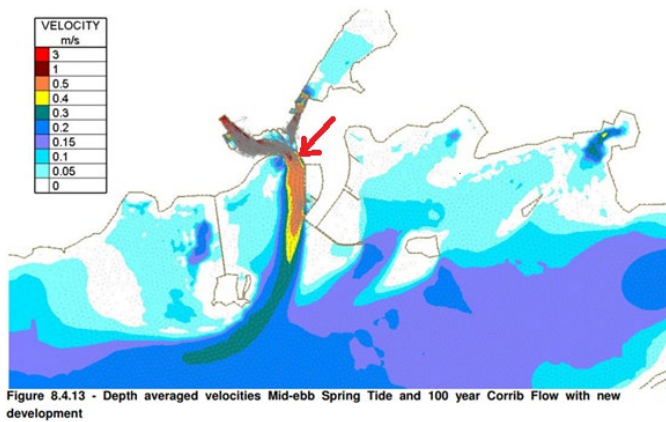
This region was touched in the previous section with respect to super-elevation in curved flow. Here, the effect was estimated to be small. However, curvature also has an impact on the bed morphology, if it consists of erodible sediments such as loose sand or silt. The reviewer has not been able to find samples taken in Corrib River near Nimmo’s pier (see also section 6 on sediment samples)

When flow becomes curved, it introduces helical motion with a flow component near the bed towards the center of the curvature, transporting sediment away from the outer banks (just like tea leaves in a cup when stirring).

This transport may create bed erosion (scour) at the outer bend, making the outer banks more vulnerable. The bank is already well protected, but the stones may tumble down.

The figure below is a flow with high flow discharge in Corrib, but the flow will be more curved in all cases, even with tidal flow alone, and the inward directed component is present for both inward- and outward flow.

This flow is not included in the numerical modelling, because the model used here is depth averaged.



The banks at the red arrow will be more exposed to bend scour.

Summary and conclusion

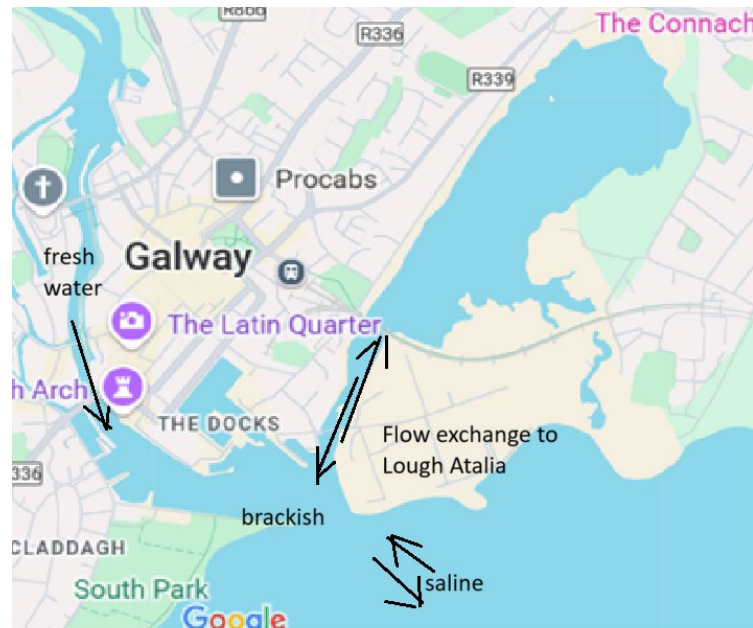
The shoreline is well protected to erosion, so the extension will not create any further problems, maybe except for problems with smelly seagrass trapped E of the extension.

In the mouth of Corrib, some bend scour may occur at the banks opposite to Nimmos pier, - if the bed is erodible. This possible scour may damage the present bank protection by undermining, but the risk is probably very small.

4. Salinity

Motivation for this study

Due to the inflow from Corrib River into the Bay through Galway Harbor, fresh water from the river is mixed with saline marine water. Salinity is important for the marine habitat



Method:

The flow is modelled using the TELEMAC, combined with a 3D model to account for buoyancy effects (more salty water at the bottom, less at the surface)

Results

Ballyloughane/Renmore experiences largest change: it becomes more saline because the freshwater flow from Corrib after the extension is prevented from flowing Eastward directly from the mouth to the bay.

Some changes occur in *Lough Atalia*, which already are exposed to large variations from fresh to salty water. The water will be slightly less salty because of the same reason as the increase in salinity at Renmore: more freshwater will remain west of the extension and flow back through the mouth into Lough Italia at next rising tide.

No new data has been collected, nor runs by the numerical models has been performed since the publication of [A] in 2014. In [A], appendix 8.1 the conditions in Lough Atalia has been detailed described, and in appendix 8.2 the, similar conditions in Lough Renmore is treated.

As described in [A] and summarized in [AA] the impact is minor and only local. [B] do not mention it.

The fauna in the Lough shows high resilience towards salinity changes, [A] p. 7-410. The numerical modelling predicts the current cumulative annual periods of 7 hours of zero PSU will increase to 18 hours at the southern part of the Lough if the extension is implemented, -without affecting their ecological functions.

Climate changes - and their interaction with the extension

The weather is changing quite rapidly (in a meteorological time scale), with stronger storms and more heavy and concentrated rainfalls.

[AA] describes a potential rise in flood flow from heavy precipitation during winter and autumn months in future scenario between 20 and 30%.

This tendency is supported by the recent occurrence of the very strong (historically strong) storm Éowyn 24 January 2025.

This may change the forecast for expected flood levels. Unfortunately, the predictions are surrounded by quite large uncertainty, just like the predictions of sea level rise (between 0.5 and 1.9 m by 2100, at present the rise is about 3 -3.5 mm annually).

The climate changes and the proposed extension may have a small interaction regarding the salinity in Lough Atalia:

Impact of proposed extension by now: smaller salinity in Lough Atalia

- Future: Heavier precipitation causes larger river flow, Corrib
- Future: even smaller salinity in Lough Atalia due to larger river flow (pushing the salt water away into the bay from the mouth)
- However this is counteracted by the sea level rise, which has the opposite effect: the salty water will move further into the river.

The resulting change will require more detailed analysis, it will most likely be negligible.

Finally, it can be mentioned that with rising sea level, overtopping of waves on Mutton Causeway will more frequent during heavy storms, thus increasing the salinity East of the causeway. However, this will not be affected by the possible extension at all.

Conclusion

The conclusion is that the changes are insignificant and do not constitute any problems.

5. Spill

Motivation:

During the capital dredging (of 1.815. mill. m^3 cbm bed sediment [A], Ch 6,Add p.6-17), some spill will occur, If the bed sediment is contaminated, it can be a problem for the local marine environment, fauna and flora. Also, vegetation and life on the bed may be covered with layers of sediment so they can't survive.

Methodology:

the further spreading of the spill from the dredger is modelled by the flow model earlier mentioned (section 4, salinity): the spill is transported with the flow, spread in the water coulomb by turbulence (eddies) and settles with its settling velocity.

As seen from the table below, most of the sediment is fine sand, very fine sand and silt with low settling velocities and therefore transported far away. Section 6 provides a more detailed description of sediment properties and chemical properties of the bed sediment.

Sediment size distribution							
Stations	Gravel (>1.5mm)	Very coarse sand (1.5mm)	Coarse sand (0.75mm)	Medium sand (0.38mm)	Fine sand (0.19mm)	Very fine sand (0.09mm)	Silt (<0.063mm)
1	0	0	0	17.65	75.29	2.3	4.77
2	0	20.19	0.36	5	21.01	22.09	31.35
3	0	0	0	28.98	65.87	0.6	4.54
4	0	2.27	0.99	4.19	23.19	24.73	44.62
5	0	18.38	0.07	17.92	53.05	4.34	6.24
6	0	0	0.7	32.69	63.44	0.33	3.47
Median	0	1.14	0.22	17.79	58.25	3.32	5.51
Maximum	0	20.19	0.99	32.69	65.87	24.73	44.62

Table 8.4.2 Sediment size distribution (percentage) at Proposed Harbour Site from AQUAFAC surface sampling (refer to Fig 8.4.1 below for sampling locations see also Soils Chapter 6)

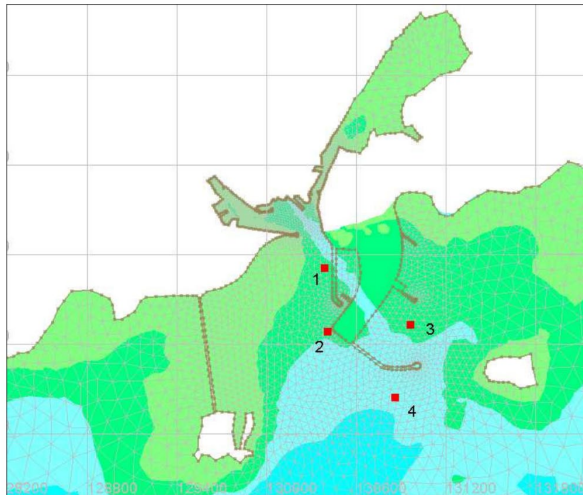


Figure 8.4.41 - Dredging locations for sediment plume simulations

(A)

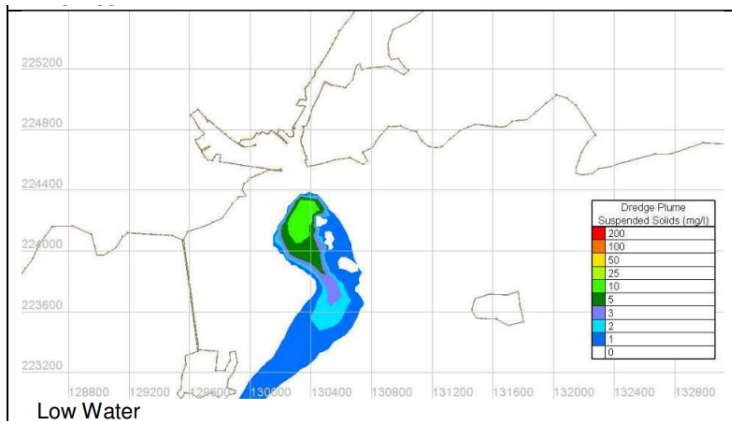


Figure 8.4.43 Fine silt suspended sediment plume simulation at dredge location 1 -

(B)

Spreading of coarse and fine sediment

As expected, the fine sediment (B) is spread much more than the coarse (A), as seen from the two snapshots above, from [A]. The spread is due to turbulence, but also to the tidal flow, which always changes strengths and direction (back and forth). Furthermore, the dredging takes place over quite a large area, which also contributes to the spreading. In [A], release of spill at 4 different dredging locations at different time in the

tidal cycle demonstrate that the spill will occur over an area at least 10 km^2 for the fine sediment, which constitute at least 60% of the spill, The coarser sediment will settle much nearer to the dredging location covering less than 10% or 1.0 km^2 of the other area, cf. the figures above.

The capital dredging of 1.815 mill. m^3 to be deposited in reservoirs is done using a Suction Hopper. Some spill occur during the operations, and [A] suggests the spill to be 850-900 m^3 /hour.

It is not fully clear where this number stems from, and there is no information on how many hours the operations take. However, a suction hopper is the dredging method with the smallest spill.

The dredging operations are described in [A], Ch 6 App p 6-19, and includes a description of spill from propeller wash and maintenance dredging of the navigation channel. Both are estimated to be minor.

Reviewer: With a spill rate about 5% (a little bit arbitrarily chosen, probably a conservative – too large- estimate) from a suction hopper, and a capital dredging of totally about 1.8 mill. m^3 , the deposited layer of fine sediment is less than 6 mm in average.

This amount is so small so it will not harm the seabed diversity, the 6 mm is less than seabed fluctuations during a storm.

However, as described in [AA], the very fine sediment will most likely be transported much further away, in so diluted concentrations so it should not be a problem for the marine environment.

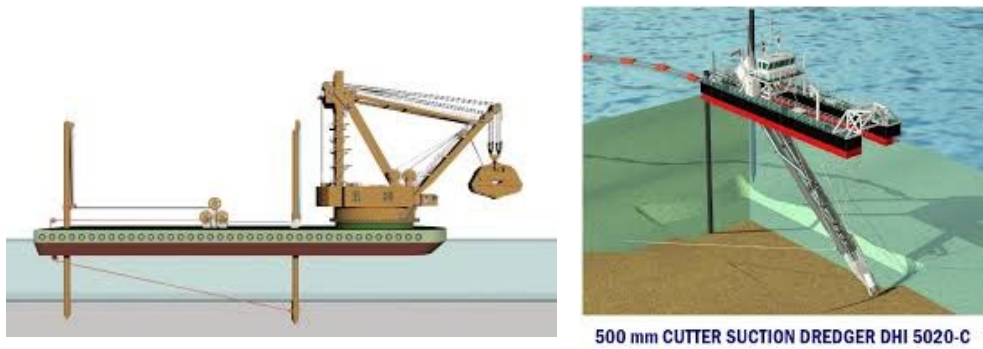
Contamination

The excavated sediment will be placed in reservoirs, so possible contamination of the sediment should not constitute any problem, while the spilled sediment could.

The bed sediment analysis from the area to be excavated shows that the contain of heavy metals is within the acceptable limit values (upper guidance level), see also the later section on 6, NIS.

[AA] and [B] do not touch anything about spill, except for some remarks p4 in [AA] regarding mitigating measures.

Mitigation: The excavation is assumed carried out using a suction hopper dredger, which does not create much spill, see the figure below. Next to choose a suction hopper, further mitigation is suggested in [AA], p 7: during ingoing tide, dredging operations are stopped to prevent the flow to transport sediment into Lough Atalia.



(Left): Grab dredger, slightly more spill than from (right): a suction dredger, where the dredged material is transported through a tube to the barge, resulting in less spill.

Summary and conclusion:

Some spill will inevitably occur during the excavation, causing a spill in the surrounding area. From the modelling in [A], it can be estimated that a layer not thicker than about 5-6 mm will be spread in a 10 km^2 large area. This layer thickness is comparable to the erosion thickness of the seabed during a large storm. It is therefore estimated that the spill will not constitute any problem for the seabed diversity.

6. Natura Impact Statement NIS, Addendum of 2024: Sediment properties

This report has extensive overlaps with chapter 7, EIS 2014, but include new data from 2023.

This section only treats the sediment data, not the biological ones

Motivation:

Sediment data are important for investigating morphological changes, coupled with the numerical flow model.

Also, it is necessary for evaluating the spreading of spills.

Methodology:

Sediment samples:

Sediment samples are taken from intertidal locations between Corrib and Renmore and shown on the map below. The Samples are taken in the bed surface, a core 18 cm in diameter and 15 cm in depth, three at each location. They were analyzed for fauna and sediment analysis: grain size distribution,

No chemical data are given for the samples shown in the figure below, but samples from Lough Atalia are. Here the concentrations of dangerous metals are very small (Titanium, Cadmium, Chrome, Copper, Lead, Manganese, Nickel). There should be no reason to expect higher concentrations of such metals at the dredging points in the bay compared to Lough Atalia, the latter being less exposed to flow action, and [A] in Ch. 7 p. 7-69 also conclude that mobilization of sediment during dredging operations will not impact water quality.

Intertidal Regionsl, Renmore



Figure 7-18: Intertidal Sampling stations 2023.

From [C] NIS, p 17.

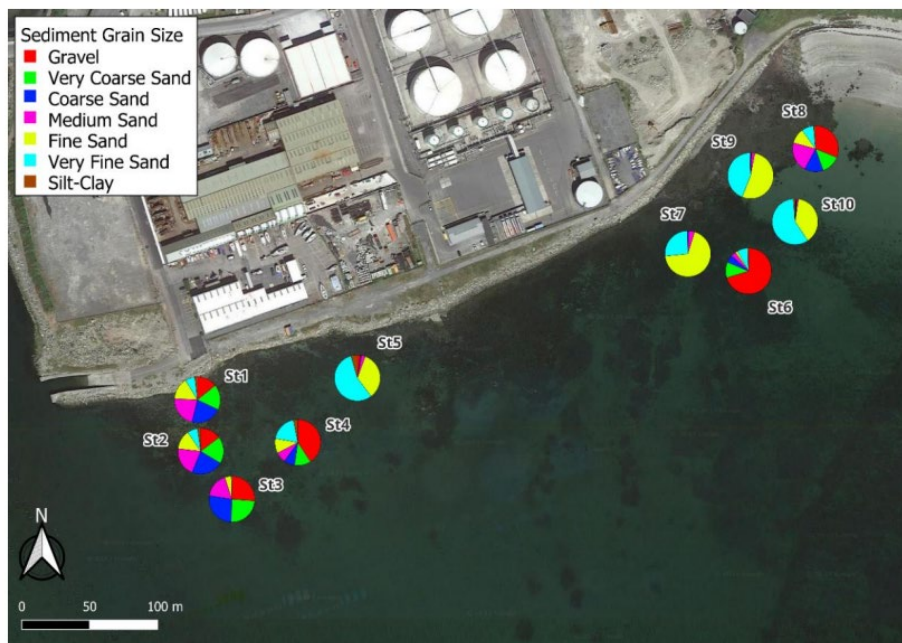


Figure 3.1: Sediment composition at the Renmore intertidal stations.

From [C], app. A, p.8.

The only comments in [C] about these samples are on grainsize distributions: the lower figure above shows the sediment composition of the 10 intertidal stations. The sediment mainly is gravelly sand: the table below lists the composition

Table 3.1: Granulometry and Organic Carbon content from Renmore intertidal samples.

Station	>8mm	Medium Gravel (4-8mm) (%)	Fine Gravel (2-4mm) (%)	Very Coarse Sand (%)	Coarse Sand (%)	Medium Sand (%)	Fine Sand (%)	Very Fine Sand (%)	Silt-Clay (%)	Folk Classification	Organic Carbon (%)
Station 1	0	5.1	9.1	17.8	21.9	21.9	15.5	6.9	1.8	Gravelly sand	3.09
Station 2	0	6.3	8.5	18.9	22.6	20.5	13.6	7.3	2.3	Gravelly sand	4.12
Station 3	0	12.1	14.1	24.3	27.1	17.5	4.4	0.5	0	Gravelly sand	5.28
Station 4	0	21.4	19.4	11.6	7.7	7.4	10.4	19.1	3.1	Sandy gravel	3.15
Station 5	0	2.1	0.1	0.2	0.6	2.7	34.1	55.8	4.5	Slightly gravelly sand	1.45
Station 6	0	48.3	22	11	5.4	3.5	1.7	7.6	0.5	Sandy gravel	3.02
Station 7	0	0	0	0.1	0.5	4.2	68.5	26.4	0.2	Sand	1.31
Station 8	0	16.1	15.1	13.4	13.3	21.4	10.8	8.6	1.4	Sandy gravel	2.8
Station 9	0	0.1	0	0.1	0.6	2.2	53	43.6	0.4	Sand	1.33
Station 10	0	0	0.4	0.4	0.6	1	38.1	58.3	1.2	Sand	1.5

NIS App, p.9. The high carbon content stems from Corrib River nearby.

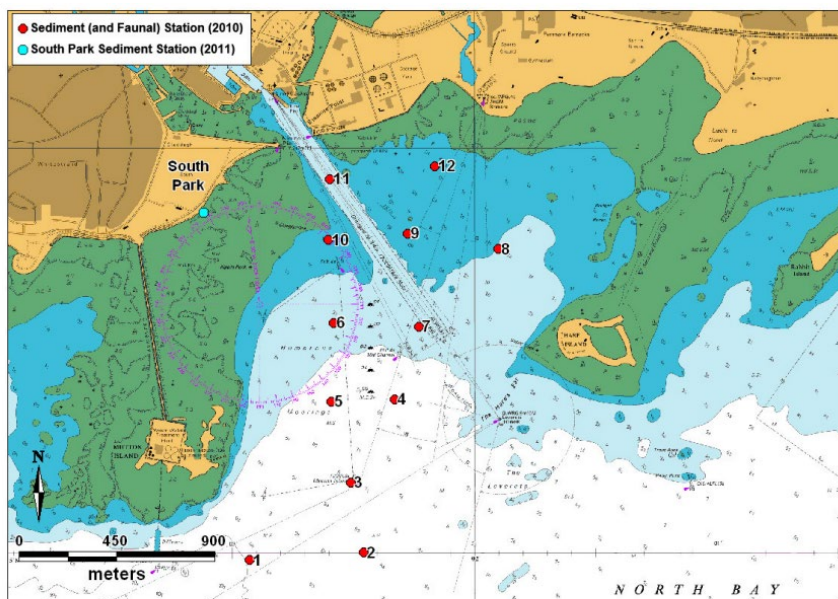


Figure 7.5.5 - Sediment and macrofauna stations sampled in 2010 and South Park sediment site sampled in May 2011

Orange: intertidal, blue: subtidal.[A] p. 7-42.

Subtidal regions:

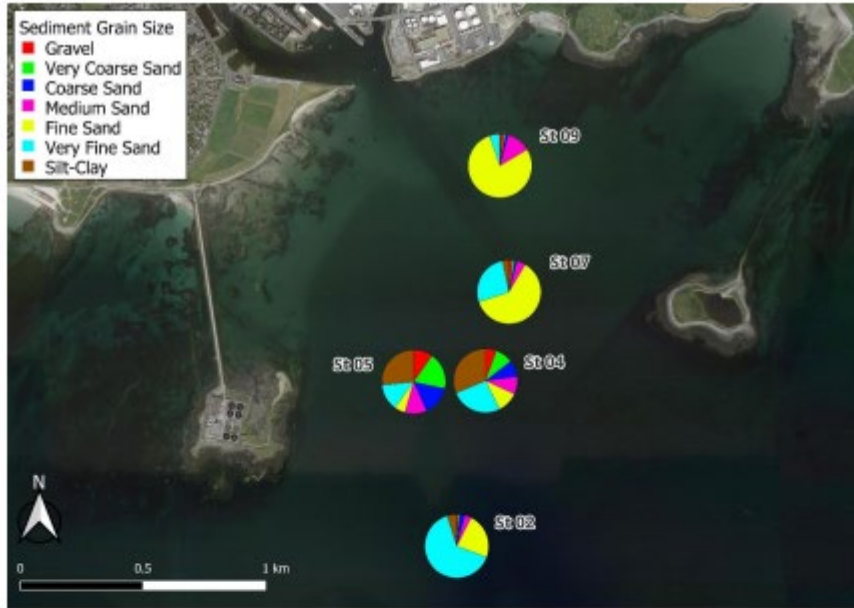


Figure 3.4: Sediment composition at Galway Bay stations.

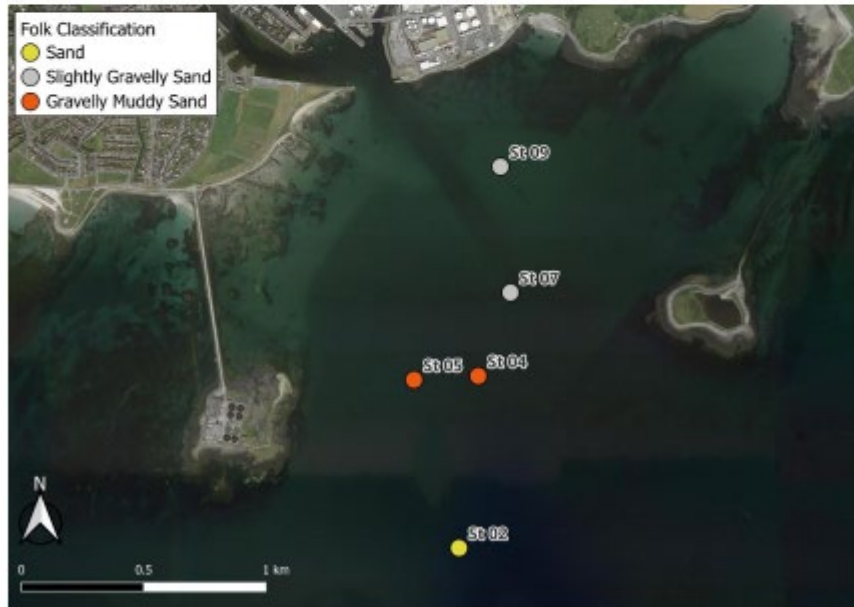


Figure 3.5: Folk classification of sediment samples.

[C] App.B, p.14.

A

In the subtidal regions, the sediment composition changes slightly between 2010 and 2023:

12 samples were taken in 2010, and in 2023, 6 of these were repeated: sts. 2-4-5-7-9-12.

Changes were observed in the following stations:

St.2: silt/clay to very fine sand

St. 7 and 9: very fine sand to fine sand

St. 12: very fine sand to cobbles.

(In the accompanying text next to the table shown above, st.10 and 8 is switched compared to the table 3.1, both in [A] and [AA]. The reviewer think, the table is correct,)

The biotopes recorded were typically for the area, p.16, NIS App.B.

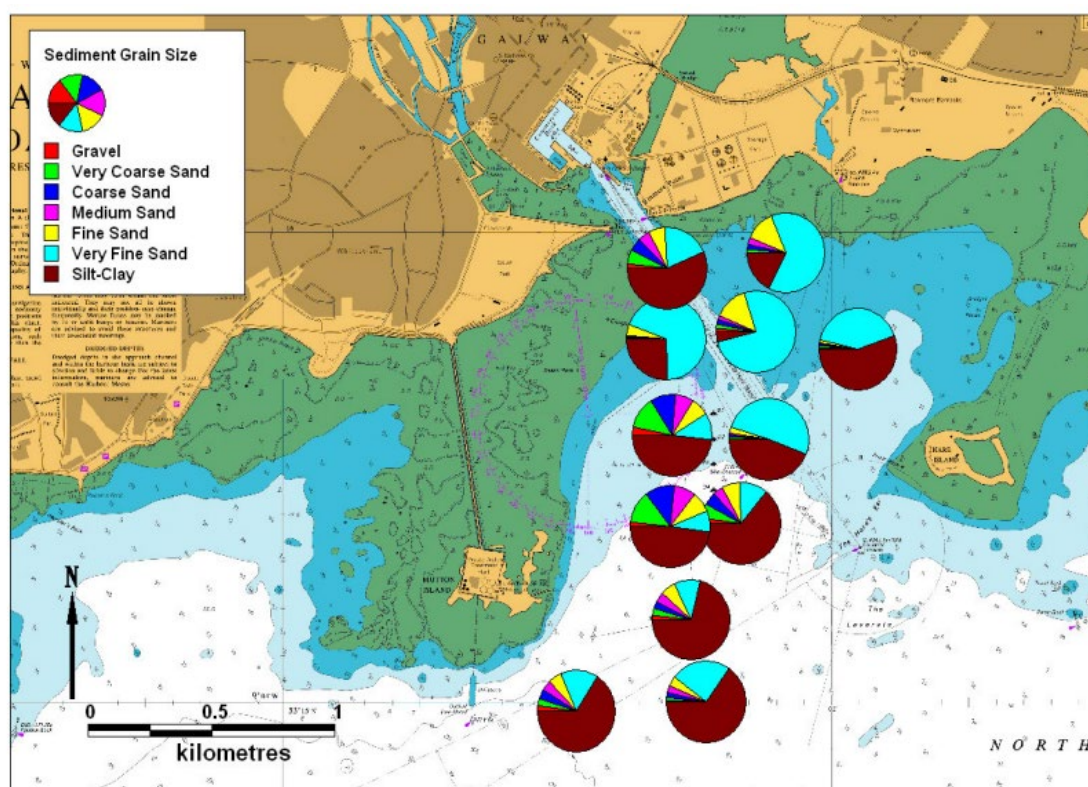


Figure 7.5.6 - Proportions of grain sizes in sediments surveyed in Galway Bay in 2010

From [A], p. 7-46.

The figures above shows samples presented in [A] The samples are analyzed for grainsize distribution and marine fauna. Sediment from outside South Park and Galway Dock also for the chemical's properties like heavy metals and pesticides.

One metal which exceeds the upper guidance level (410 mg/kg) was zinc, and that was only in Galway docks and Layby. Regarding zinc it was found to be about twice the guidance level. in the layby. In the South Park samples, it was below 20 mg/kg. Regarding lead, the concentrations in the docks were 2-5 times the upper guidance level (218 mg/kg).

In the Layby, Pesticides and organic solvents were also found to be presence, but in low concentrations, creating no problems. Oil/fats/grease was also found (11100 mg/kg) in the Layby, and below 5mg/l in the Southpark sample. In [A] p7-47, table 7.5.3, the upper guidance level is not available (n/a).

Conclusion:

Because there are only observed insignificant changes in the sediment composition, there are no reasons to modify the spill calculations described in section 5.

From the sediment samples it also can be concluded that the marine sediment has a very low degree of contamination and therefore does not create any problem related to the excavation.