

STRATEGIC INFRASTRUCTURE DEVELOPMENT
APPLICATION TO AN BORD PLEANÁLA
(REG NO. PL04.PA0045)

ORAL HEARING

RESOURCE RECOVERY CENTRE, RINGASKIDDY, COUNTY CORK

WITNESS STATEMENT OF KEN LEAHY

FLOOD RISK ASSESSMENT AND MANAGEMENT (FRAM)

1. Qualifications and Experience

My name is Ken Leahy. I hold an Honours degree (B.E.) in Civil and Environmental Engineering, University College Cork (1998). I was also awarded a Post Graduate Diploma (with Distinction) in Construction Law and Contract Administration from Trinity College Dublin (2004).

I am a Chartered Engineer and Chartered member of both Engineers Ireland (IEI) and the Institute of Civil Engineers (ICE).

I was co-author of a technical paper entitled 'Design and Implementation of Mallow Flood Relief Scheme' which was presented to Engineers Ireland Cork Region in 2009 and for which I was awarded the 'MacDonald Engineering Excellence Award' from Engineers Ireland, as well as authoring a number of articles on flood risk management topics for various publications including the 'Engineer's Journal'

I have worked full-time in the areas of civil infrastructure design, drainage design and flood risk assessment and management for the last 17 years.

I am the leader of Arup's flood risk assessment and management (FRAM) consultancy service in Ireland. I have been the project manager for the successfully completed Mallow Flood Relief Scheme for the last 10 years. I am currently Project Manager for the Lower Lee (Cork City) Flood Relief Scheme, which will be the largest flood relief scheme ever to be implemented in Ireland and from which I possess a thorough understanding of flood risk in and around the greater Cork Harbour area.

I am also currently Project Director for a number of other major Flood Relief Schemes Including King's island in Limerick and Glashaboy (Glanmire) in Cork.

As well as managing and designing major flood relief schemes, I have been the lead author of numerous strategic and site specific flood risk assessments.

I am an Industry Expert guest lecturer for the Advanced Hydrological and Flood Control Module of Cork Institute of Technology's MEng (Civil Engineering) programme and have also occasionally guest lectured at University College Cork.

2. Role in the Project

My role in the project related to the area of flood risk management, specifically leading the preparation of the Flood Risk Assessment including:

- advising on an appropriate flood risk management strategy for the site,
- advising on appropriate minimum site levels and finished floor levels,
- advising on the strategy for the public road upgrade, including drainage and road levels
- advising on the potential impacts of climate change
- Interfacing with my colleagues on the flood risk interface with drainage design, hydrogeology, and coastal erosion.
- Approving the final Flood Risk Assessment Report.

I was assisted with the above by a number of other flood risk management professionals within my team.

2.1 Conclusion of Flood Risk Assessment

The conclusions of the flood risk assessment can be summarised as follows:

- Part of the site has previously suffered from pluvial flooding.
- Groundwater and fluvial flood risk at the site are negligible.
- The site is located in Flood Zone C as it is outside the 1 in 1000 year design tidal floodplain.
- The minimum design flood defence level of the proposed development was calculated as 3.8m OD Malin.
- Conservatively however, it is proposed to raise the footprint of the entire site to the proposed site flood defence level of 4.55m OD.
- In addition, it is proposed that the buildings will have a minimum floor level of 5mOD. This will provide an extremely high level of protection.
- It is proposed to upgrade the L2445 to address the risk of flooding of the road. The upgrade works will include raising a 185m section of the road to a maximum height of 3.45m OD. This is approximately 1.0m above the existing road level. This will elevate the road above the 200 year design tidal water level plus an allowance for climate change. This will offer a high level of protection to the road from tidal flooding and ensure that access and egress routes are maintained during extreme flood events.
- A new dedicated surface water drainage and attenuation system will also be installed as part of the upgrade works to collect, convey and attenuate the runoff from the road before connecting back into the existing drainage to discharge to the foreshore.
- These measures are sufficient to ensure that the risk of flooding of the site and its access road is extremely low.
- It is considered that the proposed resource recovery centre at Ringaskiddy should be classified as a “Highly Vulnerable Development” as per the vulnerability classification. As the site is classified as Flood Zone C, a Justification

Test is not required for the proposed development and it is necessary only to undertake mitigation measures for any residual risks as set out in the FRA.

3. Submissions and Responses

In preparing this witness statement, I have considered each of the observations submitted to An Bord Pleanála by various parties in relation to flood risk and/or the Flood Risk Assessment for the Ringaskiddy Resource Recovery Centre. I have addressed each of the key issues below.

(Note: All levels quoted in this statement refer to Ordnance Datum Malin Head. Many submissions refer to Chart Datum. To convert to chart datum, 2.58m should be added to all figures quoted in this report)

Reference to the 'Guidelines' in my statement below refer to the Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published by the DEHLG and OPW in 2009 which forms the statutory basis for the assessment. The Guidelines are issued under Section 28 of the Planning and Development Act 2000.

Issue #1: Determination of Flood Zone Designation and Justification Test

Submission: Noonan Linehan Carroll Coffey (NLCC) on behalf of Mary O' Leary and CHASE
In its submission on the application, NLCC refer to reports prepared by SM Bennet & Co. On page 14 of the submission, Joe Noonan asserts that the site '*plainly falls within Flood Zone A*' and that the '*site is flooded literally every day from high tide*'. Mr. Noonan goes on to suggest that it is not necessary to go to the Justification Test but if one was to do so, the application would fail the Justification Test.

Submission: Maime Bowen

In her submission, Miss Bowen asserts that the site flooding in 2004, 2009, 2010 and 2015, makes it Flood Zone A.

Response:

Reading Miss Bowen's submission, Mr. Noonan's submission and SM Bennet's report, it is evident that there is a misunderstanding on their part in terms of the designation of Flood Zones and the application of a Justification Test.

In terms of Flood Zone Designation, the approach to be adopted is set out in 2.23, 2.24 and 2.25 of the Guidelines. Flood Zone Designation is a function of the risk of flooding from rivers and/or the sea. Groundwater flooding and/or pluvial flooding is not considered when designating flood zones. (That is not to say that the risk of pluvial and groundwater flooding need not be considered in an FRA, but simply that they do not factor in flood zone designation).

All of the current relevant studies (including the ICPSS, the Lee CFRAMS and the SFRA

undertaken as part of the Carrigaline LAP on behalf of Cork County Council) agree that neither the road nor the site are at risk of direct flooding from the sea in the 1 in 1000 year event as illustrated by the mapping produced and publically available from these studies.

Furthermore, the flood maps prepared as part of the Lee CFRAMS do not show the site at risk of flooding in a 1 in 1000 year tidal event even when allowing for a 550mm increase in sea level due to climate change

The flood zone maps prepared on behalf of Cork County Council as part of the SFRA for the Carrigaline Area Plan (and reproduced in the plan) do not show the site in either Flood Zone A or B, i.e. CCC agree that the site is located in Flood Zone C.

Arup in preparing the FRA reviewed a topographical survey of the area and established that a tide level of at least 3.25mOD would be required for the sea to overtop existing ground levels at the eastern end of the existing road and site. This is circa 400mm above the predicted 1 in 1000 year level. It is noteworthy that there is no record of any tidal level in excess of 3mOD in Ringaskiddy.

It is acknowledged that pluvial flooding has occurred on the road and in the field to the west of the Indaver site, south of the road, and that this pluvial flooding is exacerbated by high tides. However, this is not direct flooding from the sea and therefore is not considered in flood zone designation.

Mr. Noonan's assertion that the 'site literally floods every day from high tide', has not and cannot be substantiated and has no merit.

Whilst a Justification Test is not required due to the site being in Flood Zone C, if it were, Mr. Noonan's points that the development could be located elsewhere and so a Justification Test would fail on this ground is incorrect. This is a development application and so the applicable Justification Test is that at Box 5.1 of the Guidelines which in terms of strategy planning, requires simply that the proposed development is compatible with the site zoning in the applicable development plan which has been informed by the Guidelines. The proposed development is compatible with the current site zoning which was designated by CCC in the Carrigaline LAP which was prepared taking account of the Flood Risk Management Guidelines and included an SFRA.

Submission: Section 10.6 of submission Cork County Council

In its submission on the application, CCC suggests that the Lee CFRAMS preliminary flood extent maps indicates a 1 in 10 chance of tidal flooding occurring in the vicinity of the site noting major tidal flooding events occurred at 10 year intervals in 1994, 2004 and 2014.

Response:

It is not clear what map is referred to but the suggestion that there is a risk of tidal flooding in the 1 in 10 year event is incorrect. We have reviewed the final version of the relevant Lee CFRAM map (Map No. M9/RA/EXT/CURS/006 dated 21 June 2012) which shows no flood risk on the site even for the 1 in 1000 year event. Furthermore, we have reviewed the Lee CFRAMS Mid-Range Future Scenario map (Map No. M9/RA/EXT/MRFS/006) which allows for 550mm increase in sea level for climate change) and which similarly shows no flood risk in the 1 in 1000 year scenario (allowing for climate change). We have independently

reviewed the topography in the area and can confirm that the low point in the topography at the coast is the walkway from the car park to the beach and which has a low point of circa 3.25mOD. The tidal level would have to exceed this level before direct tidal flooding would occur. The reference to the events of 1994, 2004 and 2014 as major tidal events is correct. There was very significant direct tidal flooding in Cork City during these events. However, the flooding which occurred on the road adjoining the Indaver site was as a result of pluvial flooding where the rainfall which fell could not escape because the surface water drainage outfall was 'tide-locked'. The pluvial flooding was significant as the duration for which the outfall was tide-locked was worsened because of the high tide. However, the area did not flood directly from the sea, which is the criteria required to establish the flood zone designation.

Flood Zone Designation is addressed in full in Sections 2, 4, and 8 of the Indaver Flood Risk Assessment.

Issue #2: Potential Climate Change Impacts

Submission: NLCC on behalf of CHASE

In its submission on the application, Mr. Noonan refers to a report by SM Bennet. Mr. Bennet in this report states that Professor Sweeney (NUI Maynooth) predicts surge of 2.5m to 3m above Spring Tide, referring to a paper from Oxford, 1989 and noting that this would create flooding at the site, which would be worsened by sea level change predictions.

Submission: Submission by An Taisce

An Taisce notes various data sources on climate change impacts.

Submission: Numerous Others

A number of submissions make similar references to the risk of flooding being increased by climate change.

Response:

We would note that details of the original Oxford paper referred to by Mr. Bennet, have not been provided and therefore it is unclear what area this surge prediction applies to and if in fact it has any relevance to Cork Harbour. Furthermore, it is unclear whether these surge predictions were for the present or future conditions. In any event, this paper is over 25 years old and is therefore superseded by better and more current data/analysis such as the Cork Harbour hydrodynamic modelling undertaken as part of both the ICPSS and Lee CFRAM studies as well as sea level rise predictions from OPW and the Environment Agency in the UK.

Climate Change is addressed in a number of locations in the Flood Risk Assessment and in particular in Section 6.2 which references the current OPW guidance which is the applicable guidance for developments in Ireland.

It is acknowledged that climate change predictions are by their nature very uncertain and therefore a conservative approach should be adopted when assessing suitable floor levels for new developments. This approach has been adopted in the case of this application in adopting a conservatively high level for development taking full account of OPW's current guidelines on climate change as well as international best practice.

Issue #3: Return Period of Tidal Event giving rise to Flood Level of 5mOD

Submission: Cork County Council

In its submission on the application, CCC requests clarification on what return period event would give rise to a tide level matching the building floor levels of 5mOD.

Response:

As can be seen in Section 4.2 of the Flood Risk Assessment, the predicted tide level ranges from 2.28mOD for a 1 in 2 year tide to 2.88mOD for a 1 in 1000 year tide. This is a very narrow range of only circa 600mm. As the building floor levels are over 2m higher than the 1 in 1000 year level, it is clear that the risk of a tide level reaching the building floor level is minuscule. Whilst it is not normal to quote predicted levels beyond the 1 in 1000 year event, it can theoretically be statistically evaluated. To address the query, we have extrapolated the growth curves from both the ICPSS and the Lee CFRAMS. This analysis confirms that such an event (in present value terms) would have a return period of circa 5 trillion years or has an AEP of circa $2 \times 10^{-11} \%$!

It is probably better to look at this level as simply being over 2m above the existing 1 in 1000 year flood level, i.e. it has been set conservatively high.

Issue #4: Inclusion of Maximum Astronomical Tide and Storm Surge in evaluation of Design flood level

Submission: Appendix A of submission by Cork County Council

In its submission on the application, CCC seeks confirmation that the design level of 2.73mOD provides for the maximum astronomical tide and storm surge.

Response:

The figure referred to of 2.73mOD is the design tide level for the 1 in 200 year (or 0.5% AEP) Event. This is based on the more conservative estimate of the Irish Coastal Protection Strategy Study (ICPSS) and the Lee CFRAMS Study. Both studies included detailed assessment of maximum sea levels for various return periods taking account of all relevant factors such as the astronomical tide level and surge contributors such as the range of atmospheric pressure, range of possible wind direction, fetch, etc. The predicted 1 in 200 year tide level was arrived at following a statistical assessment of the probability of the worst combination of these factors. It is noteworthy that both studies arrive at very similar levels. In short, the levels quoted from both the ICPSS and Lee CFRAMS include for both astronomical tide and surge.

Issue #5: Justification for contention that there is no fluvial flood risk

Submission: Appendix A of submission Cork County Council

In its submission on the application, CCC requests justification for the contention that there is no risk of fluvial flooding at the site or significant watercourse in the vicinity of the site including the distance to and details of the nearest significant watercourse.

Response:

The nearest identified watercourse (based both on EPA mapping of watercourses and OPW's mapping of watercourses) is the Glounatouig Stream which discharges at Rafeen Creek some 4 km to the west-northwest of the Indaver site. There is no risk of the Indaver site flooding from the Glounatouig Stream because of both its remoteness from the subject site and the elevation of the intervening topography.

Issue #6: Reasons for selecting the maximum road design level on the L2545 relative to the minimum site flood defence level.

Submission: Appendix A of submission Cork County Council

In its submission on the application, CCC requests the applicant to explain the reasons for selecting the maximum road design level on the L2545 relative to the minimum site flood defence level identified in the Flood Risk Assessment.

Response:

The criteria/constraints for the design of the revised road included the following:

- Achieving compliance with maximum allowable vertical alignment gradients
- Working within the portion of public road owned by the applicant
- Tying into existing entrances and the existing road at each end
- Ensuring that the design could incorporate an appropriate drainage design
- Reducing the risk of flooding to acceptable levels.

The first four points will be addressed by other witnesses. I will address the last point.

The requirements for appropriately managing the flood risk to the major buildings (and associated processes and equipment) is very different to the requirements for managing the flood risk to the road for the following reasons:

- The consequences of flooding of the buildings would be significantly more serious than the road flooding. The flooding mechanism is tidal and therefore if flooding were to occur, it would only be for the short duration at the peak of the flood. Whilst this would create a nuisance for road users and potential impact access/egress for a short time, it would not have a long term impact in terms of damage/cost. Flooding of a building even for a short time would clearly be more problematic. For this reason, it is not necessary to apply the same extremely conservative approach to setting the

road levels as that adopted for the site and floor levels.

- By its nature, once constructed, it will not be possible (or at least not reasonably possible) to adapt the buildings in the future if the impacts of climate change arose and were significant. However, by its nature, the road can easily be raised further in the future, in line with sea level rise, to the extent to which it might occur. This point is correctly made by Conal Courtney (Senior Executive Engineer of Cork County Council) on page 2 of his report to CCC's planners.

Setting the high point of the road at a minimum level of 3.35mOD (3.45m at centreline) ensures that the section of roadway west of the high point, including the Indaver entrance, is protected against the 1 in 200year event including an allowance of 550m for climate change (or freeboard in the shorter term) and ensures safe access and egress to the Indaver site. This is a high standard of protection which is appropriate to the current risk and strikes an appropriate balance between all of the current constraints.

We have considered the option of raising the high point of the road further to a level of 3.8mOD as suggested by CCC and can confirm that this is technically feasible, and would further reduce flood risk to the road. However, we do not consider that this is necessary as the currently proposed level of 3.35mOD already provides a very high level of protection.

Issue #7: Extent of Site Raising

Submission: Appendix C of submission Cork County Council

In its submission on the application, CCC's senior engineer in the Coastal Management and Flood Section notes that the proposal includes for raising the footprint of the entire site to be raised to 4.55mOD and requests that this area be defined on the site layout map.

Response:

A revised site layout map with the area of raising annotated has been provided as requested.

Issue #8: Alleged Failure to properly address ground of refusal on previous ABP Decision

Submission: Submission by An Taisce

In its submission on the application, An Taisce asserts that the current application does not address the grounds of refusal of a previous application and amongst other things that flooding issues was a fundamental impediment to site suitability and access, claiming that there is inadequate evidence that the proposed works will resolve the issue of flood impact on vehicular access to the site.

Response:

The FRA submitted with the application comprehensively outlines the flood risk issues at the site and adjoining road and sets out clearly the measures proposed to address these

measures. See FRA and Response to Issue No. 6 above for further details.

Issue #9: Area Prone to flooding and allegedly flooded during Storm Frank

Submission: Submission by various individuals including:

Various submissions have noted that the site has previously flooded and did so during Storm Frank

Response:

It has been acknowledged that the site has previously suffered from pluvial flooding worsened by high tides. The tide level during Storm Frank was only 2.09mOD as recorded at Ringaskiddy and was therefore about 1.2m below the level that would result in direct tidal flooding of the road. It is evident therefore that the flooding arose due to the extreme rainfall and is pluvial in nature.

A photograph provided by Maime Bowen in her submission taken on 2 January 2016, a few days after Storm Frank shows the road flooded but the area to the east of the road dry. This reflects the fact that the flooding was pluvial in nature and demonstrates the lack of existing storm water drainage, an issue which will be rectified by the proposed road/drainage upgrade.

In summary, the risk of pluvial flooding has been assessed, is understood and the proposals include appropriate measures to manage this risk.

Issue #10: Assertion that measures proposed in FRA will cause more problems than it will sort on the northern boundary and does nothing to alleviate flooding on the rest of the site

Submission: Submission by CHASE

In its submission on the application, CHASE assert that the proposed measures will cause more problems that they will sort and does nothing to alleviating flooding of the rest of the site.

Submission: Submission by Lorna Bogue

In her submission on the application, amongst other issues, Lorna Bogue appears to infer concerns over the management of runoff from the site.

Response:

It is unclear why CHASE consider the proposed solution will cause more problems than it will sort. The proposed raising of the road will reduce the risk of it flooding directly from the tide and the proposed attenuation will reduce the risk of pluvial flooding of the road and the site as it will provide the required attenuation capacity in a safe underground storage area, rather than at present where this attenuation is provided on the road and in the field to the south of the road. The significant number of additional gullies will also provide a major improvement on the management of runoff versus the existing roadway which has minimal formal drainage.

Management of flood risk on the rest of the site is dealt with by raising ground and building floor levels to a suitably conservative level above predicted extreme tidal levels and by incorporating a robust drainage and attenuation system to deal with runoff across the site.

Issue #11: Tidal Influence on Groundwater Levels

Submission: Submission by An Taisce

An Taisce claims the impact of sea level rise on the water table is inadequately addressed and that there is an inflow of seawater to groundwater.

Submission: Submission by NLCC on behalf of CHASE

In its submission, NLCC refers to a report by Mr. Bennet which notes that groundwater levels are influenced by tidal levels and that therefore there is a risk of groundwater flooding. Mr. Bennet notes that during a site visit in late January 2016, there was evidence of ponding of water on the site which he considers may have been due to groundwater including possible springs.

Response:

Groundwater flood risk is addressed in Section 5.4 of the FRA. The FRA acknowledges that groundwater levels on the site will likely be influenced by tidal levels.

However, the impact of tidal variation on the water table level is very small. Monitoring of groundwater levels over a tidal cycle has been undertaken on a limited number of boreholes which shows that fluctuation in groundwater levels around the tidal cycle is very small, circa 0.1m to 0.2m. Groundwater levels recorded during the site investigations have been reviewed and confirm that the groundwater flood risk is low.

Any risk of groundwater flooding will be decreased further by raising the levels of the site and be managed by an appropriately designed site drainage system.

The ponding of water on site in January 2016 is an example of pluvial flooding. As circa 3 times the normal rainfall fell in Cork in Dec 2015, soils were saturated and rainfall infiltration was very low meaning that some surface water would pond in local depressions in the topography. This risk has been considered in the design of an appropriate surface water drainage system for the site.

The hydrogeology of the site will be addressed in more detail by my colleague, Joanna O' Brien.

4. CONDITIONS RECOMMENDED BY CORK COUNTY COUNCIL

Cork County Council has recommended the attachment of a number of indicative conditions which are contained in its Report received by the Board on 13 April 2016.

The following are relevant in terms of flood risk:

Suggested Condition 18

'Details of a proposed maintenance plan for the final outfall line/point for surface water sewer shall be submitted to the Planning Authority for approval in writing. In this regard the flap valve at the end of the existing concrete outfall pipe should be replaced and other measures taken to prevent sand and pebbles at the discharge location from blocking the free movement of the valve.'

Applicant Response

It is agreed that the proper functioning and maintenance of this non-return valve is critical to the flood defence plan for the local road way. However, as this is located outside of Indaver's land holding and benefits the wider area, it is considered that the responsibility for maintaining (and/or any upgrading/replacement) of the existing non-return valve should rest with CCC.

However, as an alternative to the above, Indaver would be prepared to install a new (and additional) non-return valve in a new chamber upstream on the drainage line, to be located in the car park at the eastern end of the road. This is on Indaver's lands, would provide a secondary line of defence should the flap valve on the existing outfall fail, and would have a lower risk of damage due to be housed in a sealed chamber. It would therefore add redundancy to the existing system.

5. Conclusion

The proposed development is located within an area designated as Flood Zone C and therefore in flood risk terms, is considered appropriate for development of the nature proposed, subject to the incorporation of an appropriate flood risk management strategy in the design of the development

The design of the proposed development has been developed to ensure that there is negligible flood risk to the site itself, by elevating the site and finished floor levels to conservatively high levels, and by installing a site wide drainage system which will adequately cater for and manage the risk of pluvial and groundwater flood risk, even when combined with a high tidal scenario.

The proposed development will not increase flood risk in the surrounding area and in fact, in line with the objective of the Guidelines, will actually significantly reduce the flood risk to the existing public road which will significantly reduce the likelihood and impact of potential road flooding for the surrounding businesses as well as ensuring safe access and egress to the Indavar site and other nearby sites. The development of the solutions to manage flood risk on the road has been developed in consultation with the relevant technical staff in Cork County Council.

In summary, I wish to emphasise that due consideration has been given to the assessment of potential flood risk at the site and in the development of proposals to mitigate flood risk in a sustainable way, in compliance with the statutory guidelines entitled 'The Planning System and Flood Risk Management'.