TECHNICAL REPORT

03

Updated flooding and hydrology assessment

Appendix M Technical note—flood planning level

NARROMINE TO NARRABRI PROJECT

TECHNICAL NOTE

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CC	Matt Errington Kris Mitchell	Senior Environment Advisor – N2N Senior Technical Advisor – N2N
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DATE	29 July 2021	
SUBJECT	**Inland Rail N2N – Flood Planning Level (FPL) – Supporting Information**	

1 Introduction

This Technical Note (TN) is in response to the letter from Bewsher Consulting (author: Drew Bewsher) to the Department of Planning, Industry and Environment (DPIE) dated 18 March 2021. The letter summarised the review findings of the flooding and hydrology assessment for the Narromine to Narrabri (N2N) Environmental Impact Statement (EIS).

This Technical Note focuses on the comments pertaining to 'Flood Immunity / Flood Planning Level (FPL)', contained primarily in Section 1 of the aforementioned letter. For reference the comments are outlined in Section 1.1.

1.1 Bewsher Consulting review comments

1. Flood Immunity / Flood Planning Level (FPL)

1.1. The Item 9.1c of the SEARs require ARTC to "Describe and justify the proposed flood planning level (FPL) for the project including the AEP of the flood which will overtop the formation and rail" [s1.3 p10]. This hasn't been done or hasn't been done adequately

1.2. In the absence of a proper description and justification of the FPL, the reviewer suggests that the Project should be designed so that trains can continue to operate should flood waters rise to the level of the 1% AEP flood plus 0.3m freeboard or the 1% AEP flood level under climate change, whichever is higher. (The reference design presented in the EIS may already meet this standard).

1.3. The EIS states "The flood planning level for the proposal has been determined based on achieving a minimum flood immunity for the 1% AEP event with due consideration of adjacent infrastructure" [s3.2.1 p23]. However, the term "flood immunity" is not defined in Tech Report 3. The term needs to be clarified.

1.4. The term "flood planning level" (FPL) is also not defined. The NSW Floodplain Development Manual (Manual) defines FPL as the design flood level with a freeboard, usually 0.5m. The freeboard used by ARTC appears to be zero, but this needs to be clarified.

1.5. The justification provided at [s3.2.1 p23] that a 1% AEP immunity is required by the Manual is incorrect. The Manual does not mandate use of the 1% AEP event.

1.6. The EIS states that the Project "needs to achieve a high level of reliability so that it is a competitive freight transport solution. The proposed flood planning level is essential in order for the proposal to meet these requirements" [s3.2.1 p23]. Nevertheless the reviewer notes that on other sectors of the Inland Rail, flood immunity standards lower than 1% AEP have sometimes been adopted and therefore it is unclear how different flood immunity standards have been applied on different sectors and yet still achieve a "high level of reliability".

1.7. During a major flood, as water rises above the top of the formation, water will start to pass through the ballast. As the water level rises further, the propensity for water to wash away ballast will increase. Assuming significant

erosion of ballast does not occur, water may eventually rise high enough to overtop the rail itself. Thus, various critical water levels can be defined, i.e.:

(i) top of formation;

(ii) level at which ballast commences to erode;

(iii) top of rail; and two further levels,

(iv) level at which train operations are halted due to flood waters (which may be lower or higher than any of the above levels); and

(v) level at which failure of the formation commences to occur.

The EIS would benefit from a thorough description of the impact of floods on train operations and the vulnerability of the rail infrastructure to flood damage. Identifying these critical water levels should be part of such a description.

1.8. Without an assessment of the level described in 1.7(iv) above, the true impact of flooding on the reliability of the Project cannot be assessed. It may likely be in excess of 1% AEP but this can't be determined from Tech Report 3.

1.9. Further, confusion arises within Tech Report 3 when the term "overtopping" is used without referencing whether this is overtopping of the formation or the rail line, e.g. [s7.1.12 p164].

1.10. Any proper assessment of the flood risk to people and property downstream of the Project during extreme floods requires the level in 1.7(v) above to be determined. This also hasn't been done.

Summary and Conclusions

A. Flood Immunity: Further work is required to define and justify the flood immunity of the Project. The reviewer recommends that ARTC determine whether the current design allows train operations to continue when flood waters rise to a flood level equal to the higher of the 1% AEP flood level with 0.3m freeboard, or the 1% AEP climate change level. If this standard is not achieved, justification needs to be provided consistent with SEARs 9.1c and the NSW Floodplain Development Manual.

1.2 Responses

Table 1 outlines the responses to the comments summarised in Section 1.1.

Table 1 – Overview of responses to comments summarised in Section 1.1

Comment	Response
1.1	Partially responded to in this TN. • FPL justification outlined – see Section 2 (2.1 to 2.7) • description of AEP of flood overtopping formation on N2N – Refer to Technical Note 10 – Track Overtopping.
1.2	See Section 2 (2.1 – 2.7) for description and justification
1.3	See Section 2 for description and definition/clarification
1.4	See Section 2 for description and justification
1.5	Comment noted.
1.6	See Section 2 (2.1 in particular, but also 2.2 to 2.7 for further context)
1.7	Refer to Technical Note 10 – Track Overtopping.
1.8	Refer to Technical Note 10 – Track Overtopping.
1.9	Refer to Technical Note 10 – Track Overtopping.
1.10	Refer to Technical Note 10 – Track Overtopping.
A (Summary & Conclusions)	See responses to comments 1.1 to 1.10 above

2 Flood Planning Level (FPL) – Supporting Rationale

For the Inland Rail (IR) project ARTC have defined the Flood Planning Level (or flood immunity) as follows for greenfield works:

"Flood immunity and serviceability limit state AEP shall be 1% at the shoulder corner of the formation capping" (ARTC ETD-10-02 – Track and Civil Code of Practice – Section 10).

ARTC's decision to nominate this as the Flood Planning Level (FPL) took into consideration the following:

1. the need to provide an adequate level of flood immunity to minimise route disruptions, not just from an individual catchment perspective, but also from a network operations perspective
2. the need to attain a level of flood immunity that was broadly consistent with current infrastructure planning approaches and standards
3. the need to avoid excessively high levels of formation flood immunity which could increase flood risk to external receptors during extreme events (notwithstanding the fact that other engineering constraints can often dictate the rail vertical alignment in floodplain locations)
4. the need to consider cost optimisation, noting the project to be financed through government funding
5. the need to consider the potential effects of climate change over the lifetime of the proposed works
6. the need to consider hydrologic and hydraulic uncertainty
7. the need to set an FPL that facilitates management of flood risk to the floodplain/floodplain receptors, and to the rail line

A more detailed description of each of these decision elements is provided in Section 2.1 to 2.7.

2.1 Provision of adequate flood immunity

The nomination of the FPL must consider not only appropriate flood immunity at crossings, but also flood immunity from a network perspective (i.e. noting the purpose of the rail line being to transport goods over large distances, or 'links' for the purposes of this discussion). Due to the extent of the rail line, the likelihood of the 'link' being affected by flooding at some location increases due to the number of waterway crossings, the greater catchment independence over larger distances (i.e. in terms of flood response), and the greater exposure the link as a whole has to rainfall/storm events. Accordingly, nomination of a 'low' level of flood immunity could markedly increase the risk to operations through flood inundation and flood damage to the rail line when considered from a 'link' perspective. With a view to adopting an FPL that sought to reasonably balance/manage this risk, and recognising the difficulty in analysing/defining it at a network level, a 1% AEP formation flood immunity was selected. This acknowledges that the Top of Rail (ToR) is approximately 750mm above formation level, thus providing a margin in which to accommodate some flood inundation within the ballast. This acts to compensate against the 'link' effects with respect to flood immunity.

Note that ARTC can run trains with a degree of ballast inundation, and have provisions to manage this in terms of their operations. Also note that on a location-specific basis, through the application of a detailed ARTC flood risk assessment process, provision of a lower flood immunity is permissible in certain situations. This was applied on brownfield projects (P2N and N2NS), resulting in some deviation from the 1% AEP formation flood immunity FPL, but which was deemed acceptable to ARTC.

2.2 Consistency with current infrastructure planning approaches and standards

ARTC sought to achieve general consistency with respect to current infrastructure planning approaches and standards. The adoption of a 1% AEP FPL (at formation level) is deemed suitable in this regard, noting AS7637 (RISSB infrastructure Standard) states the default recommended formation flood immunity to be 1% AEP: "*Where no design criteria have been specified by the Railway Infrastructure Manager, the flood immunity for track bed height should be 1% AEP."* (Note: track bed height is the same as rail formation level).

With respect to the discussion contained in Section 1, this also supports the selection of a 1% AEP FPL for the project.

2.3 Avoidance of excessive flood immunity provision

ARTC recognises that the provision of excessive formation flood immunity would demand higher embankments and formation/track levels. While this may be beneficial in terms of safeguarding the operability of the rail line during flood events, it comes at potentially increased risk to adjacent floodplains and floodplain receptors, particularly during the occurrence of extreme flood events (which can, do, and will happen). Higher embankments and track/formation levels will increase flood afflux during rare events, and may also increase the risk of breach failure. These are not desirable outcomes from a floodplain risk management perspective.

Accordingly, such considerations exert 'downward pressure' on formation levels. ARTC has sought to balance and manage this in defining the FPL.

Firstly, following assessment of ARTC operational requirements and risk, ARTC have elected to specify the FPL of "*1% at the shoulder corner of the formation capping"* to be exclusive of freeboard, thus reducing embankment heights and formation/track levels. This acknowledges that ARTC have provisions for operating trains where a degree of ballast inundation may occur.

Secondly, as part of the standard flood modelling process being undertaken in the design of the IR rail line, a full range of flood events are typically simulated to test the effects of extreme floods – this may include, for example, the 1 in 2000 AEP event, and the Probable Maximum Flood (PMF). Where necessary, design modifications can be made to alleviate risk to receptors, as informed by the modelling outcomes.

However it should be noted that there are often other engineering constraints which may dictate the vertical alignment and minimum formation levels in floodplains e.g. track grades, civil works requirements, geotechnical requirements, interaction with other infrastructure involving (overbridge construction for example), etc.

2.4 Cost optimisation

From the discussion contained in Section 1, 2 and 3, it is evident that ARTC has multiple competing demands to balance and manage, all of which were accounted for in defining the FPL of 1% AEP (at formation). Excessively high flood immunity (as discussed in Section 2.3) was also avoided with a view to minimising construction costs, noting the expenditure of government funds on the project. Concurrently, excessively low flood immunity would create the risk of increased damage remediation costs and the subsequent economic costs that would be felt directly and indirectly through disruption to the rail line (i.e. during closure periods).

2.5 Consideration of climate change effects over project lifetime

In light of the planned project lifetime and its operational horizon ARTC also considered the potential effects of climate change in defining a suitable FPL.

A conservative philosophy would have been to apply a blanket approach of designing the rail line inclusive of climate change. However, this would exert 'upward' pressure on embankment heights formation/track levels (i.e. formation at or above 1% AEP + Climate Change Allowance), as well as project costs. The risks and issues such a decision would generate are discussed in preceding sections (i.e. including increased risk to the floodplain/floodplain receptors during rare or extreme events)

Conversely, ignoring climate change completely could jeopardise the future operations of the rail line, along with potentially creating increased risk due to impacts in the floodplain/at receptors.

Accordingly, as part of the standard flood modelling process being undertaken in the design of the rail line, the effects of climate change on (i) the rail line, and (ii) the floodplain/receptors, are assessed to help inform the suitability of the design. This is achieved through sensitivity testing of climate change scenarios.

Recognising the uncertainty over how climate change may eventuate in the decades to come, and with a view to managing the risk through prudent and appropriate design criteria, a 1% AEP FPL was deemed suitable. This provides some tolerance for potential increases in flood level associated with climate change

to be accommodated within the ballast where needed (noting ARTC have provisions for operating trains in such circumstances).

2.6 Consideration of hydrologic and hydraulic uncertainty

It is acknowledged that there are varying degrees of uncertainty in the derivation of design discharges. Similarly, there is also uncertainty associated with the derivation of design flood levels (which may be implicitly related to the hydrologic analysis, but also to the definition of parameters/inputs within the hydraulic model).

Acknowledging that uncertainty may lead to some underestimation or overestimation of flood discharges/levels, a balanced approach to FPL selection is needed that can accommodate a degree of tolerance.

Broadly speaking, sensitivity testing is part of the flood modelling process to provide an understanding of model response to such uncertainty – for example, the climate change testing generally provides an appreciation of flood level response to variation in discharge.

With a view to balancing risks associated with uncertainty, so as to avoid over- and under-design, the selection of a 1% AEP FPL (at formation, and exclusive of freeboard) was deemed suitable. As stated in earlier sections, this avoids the design and construction of higher embankments and track/formation levels, but still provides some tolerance for any potential increases in flood level to be accommodated within the ballast (noting ARTC have provisions for operating trains in such circumstances).

2.7 Management of flood risk to floodplain/receptors and rail line

It is evident through the discussions in Section 2.1 to 2.6, that ARTC have sought to balance several competing demands, which concurrently exert both ‘upward’ or ‘downward’ pressure in terms of the selection of a suitable FPL.

ARTC are highly cognisant of the need to minimise risk to the floodplain and floodplain receptors, and this has been a key consideration in the selection of the project FPL. Simultaneously, there is a need to balance the operational requirements of the infrastructure, noting the significant government funding that is being invested in the project and the economic outturn it aims to generate.

Accordingly, and as per the content of this document, ARTC have elected to define the FPL as “*1% at the shoulder corner of the formation capping”.* This excludes the provision of freeboard as being a requirement, with a view to minimising embankment and track/formation heights, and recognising that ARTC have provisions for operating trains where a degree of ballast inundation may occur.

Again, it should be noted that greater flood immunity (above the FPL) may be achieved in floodplain locations due to other engineering constraints dictating the vertical alignment and minimum formation levels.

3 Conclusion

This Technical Note has aimed to address comments contained in the letter from Bewsher Consulting dated 18 March 2021. The letter summarised the review findings of the flooding and hydrology assessment for the Narromine to Narrabri (N2N) Environmental Impact Statement (EIS), noting this Technical Note to have focused on providing responses to comments relating to 'Flood Immunity / Flood Planning Level (FPL)', in Section 1 of the aforementioned letter.

It is expected that the content of this Technical Note serves to respond to review comments raised in the letter from Bewsher Consulting, where relevant (i.e. noting the Service provider JGHD to be best placed to inform on project specific enquiries). However, if there are any further questions relating to the responses provided, ARTC and its Technical Advisor will be happy to assist in closing any such queries out.

Revision History

REVISION	DATE ISSUED	TO	DESCRIPTION
A	27/07/2021	Rob Walker	Inland Rail N2N – Flood Planning Level (FPL) – Supporting Information
0	28/07/2021	Rob Walker	Final
1	29/07/2021	Rob Walker	Final