Memorandum

TO: Stephen O'Donoghue – Department of Planning, Industry and Environment
FROM: Erin Askew - WMAwater
DATE: 18 February 2020
SUBJECT: Vickery Coal Extension Project – Further Peer Review of Flood Assessment
PROJECT NUMBER: 118088

1. OVERVIEW

The Vickery Coal Project is located 25km north of Gunnedah, NSW. The open cut coal mining operation has an existing footprint and associated aspects approval but has not commenced development. Whitehaven Coal Limited is seeking approval for an extension to the approved mining footprint and associated aspects via the Vickery Coal Extension Project (referred to as the Extension Project). In addition, the Extension Project includes construction and operation of a rail spur. The Project is located within the Namoi River Floodplain, although the majority of the mine works are located beyond the floodplain, the proposed rail spur crosses the floodplain. The Environmental Impact Statement (EIS) has considered the impacts of the Extension Project on flood behaviour via the *Vickery Extension Project – Flood Assessment, August 2018 WRM Water and Environment* (the Flood Assessment*).* The EIS was placed on Public Exhibition in October 2018.

The Project's location within the Namoi River floodplain has meant that flooding has been identified as an issue of concern. In order to inform its assessment, the Department of Planning, Industry and Environment has engaged WMAwater as an independent expert to undertake a Peer Review of the Flood Assessment. The review aims to consider the appropriateness of the methodology applied and the outcomes of the assessment undertaken.

An initial Peer Review of the Flood Assessment was undertaken in November 2018. Subsequent to the initial Peer Review a meeting was held in June 2019 with the proponent and the proponent's flood assessment specialist (WRM) to discuss the items raised in the initial peer review.

The Independent Planning Commission (IPC) prepared an issues report in April 2019. Several aspects were identified, including flooding, requiring detailed consideration. The IPC considered as part of its assessment, the relevant peer reviews, in addition to the Proponent's preliminary response to submissions.

The proponent has now prepared the *Vickery Extension Project Environmental Impact Statement – Response to Flood Assessment Peer Review Comments, August 2019,* which provides clarification and responses to some aspects raised in the initial review.

It is noted that the design has changed since the preparation of the *Vickery Extension Project – Flood Assessment, August 2018* and the initial peer review (November 2018). A key aspect of this change in relation to the rail spur is the removal of some embankment sections and complete elevation of the rail spur on pylon-like structures above the 1% AEP flood level west of the Namoi River. This revision is likely to

change the flood behaviour reported in the *Vickery Extension Project – Flood Assessment, August 2018.* In the proponent's response both the work presented in the *Vickery Extension Project – Flood Assessment, August 2018* and new formally un reported assessment have been referenced.

The majority of aspects identified in the initial peer review (November 2018) have been closed off with the following significant aspects remaining open:

- Discussion of impacts against all FMP criteria,
- Climate change assessment.

A number of conditions relating to these aspects have been provided for the project. Addressing these conditions in future design and assessment stages will likely close off these aspects.

The attached table outlines a review of the responses provided and identifies any issues that remain outstanding and how they may be addressed.

A number of other minor aspects identified as part of the initial peer review were not addressed as part of the Proponent's response (August 2019) including:

- Confirmation of the appropriateness of the grid resolution,
- Confirmation of the appropriateness of the method applied to allow for the 22m^3/s flow rate when the LiDAR was flown,
- Justification for the discrepancy between modelled and recorded flood levels for historical events.

It is noted that the above minor aspects are unlikely to alter the key outcomes of the assessment.

New aspects arising from the provided response:

- Figure 10 would benefit from the inclusion of the open cut area to confirm that the PMF event will not enter this area.

2. CONCLUSION

Overall, the assessment has demonstrated that the proposed rail spur in its current refined design is unlikely to result in substantial flood impacts that cannot be managed through the later design stages. It should be noted that some aspects of the methodology, while generally undertaken in accordance with industry best practice, are not reported to the standard that would be expected for a project of this significance. These aspects are however not likely to change the overall outcome of this assessment. It is noted that the final design will be required to appropriately demonstrate its compliance with the *Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019* criteria for the required events and undertake an appropriate assessment of the impacts of climate change, as required by the project conditions.

ID No.	Nov 2018 Peer Review Recommendation	Proponent Response	Peer Review Response
1	WMA Water states that: *"… Table 2.1 also requires that the impacts on other properties, assets and infrastructure are identified. This aspect would benefit from more explicit discussion in the form of tables etc."*	The flood impacts of the Project have been detailed at each location in Section 6 of the Flood Assessment. Tabulation of the results is not provided as it would summarise the results and provide less discussion of the impact than the detailed description provided in the Flood Assessment. Notwithstanding, the revised rail configuration has reduced the predicted flood impacts such that there would be negligible impacts on private properties, assets or infrastructure.	The impacts of the proposed development are documented via mapping in *Vickery Extension Project – Flood Assessment, August 2018* and the impacts of the revised rail spur design are shown on Figure 1 of *Flood Assessment Peer Review Comments, August 2019*. While both documents indicate that the impacts of the proposed rail spur on flood behaviour are relatively minor, the standard of reporting is not what would typically be expected for works of this scale. Further reporting to demonstrate that the final design is consistent with the objectives of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 is required as part of the conditions of approval and will likely address this comment.
2	WMA Water states that: *"the community has observed coincident events, including the interaction of Coxs and Rangira Creeks with Namoi River flooding. The Flood Assessment would benefit from further discussion of this aspect and possibly the assessment of impacts during a coincident event to demonstrate the impacts of the proposed works under a different assumption."*	The catchment area of the Namoi River to the Project is approximately 18,000 square kilometres (km²) with an estimated 1% Average Exceedance Probability (AEP) peak discharge of 9,147 cubic metres per second (m^3/s). By comparison, the catchment area of Stratford Creek that drains to the proposed rail spur is 105 km2 with an estimated 1% AEP peak discharge of 221 m^3/s. When these peaks coincide, the peak discharge at the Project site would be 9,368 m^3/s, slightly larger than the 1% AEP peak discharge from the Namoi River only. The relative sizes of the catchments mean that different storm mechanisms would produce peak discharges in each catchment. For instance, a long duration, region wide storm event would produce the flood peak from the Namoi and this event would not peak at the Project site for days after the peak rainfall. For the local catchments, an intense short-duration storm would produce the flood peak, which would peak at the Project site within approximately 6 hours of the peak rainfall. In other words, the likelihood of the regional and local flood-producing events with the same AEP peaking at the Project site at the same time is very low. Notwithstanding, the model was rerun with and without the rail configuration for two scenarios (WRM, 2019): • 1% AEP flood peak from the local catchments (Stratford Creek and Collygra Creek) occurring independently of the Namoi River; and • 1% AEP flood peak from the local catchments (Stratford Creek and Collygra Creek) coinciding with the Namoi River flood peaks by offsetting the local catchment flood peaks by 80 hours.	The Proponent's response does not specifically reference Coxs or Rangira Creeks. These systems were discussed at the meeting in June 2019 and the Proponent undertook to investigate them. The provided response does demonstrate that the smaller tributary systems are unlikely to impact on the flood behaviour of the Namoi River in the vicinity of the rail spur and that the rail spur in its current design is unlikely to impact on the flood behaviour within the smaller tributary systems.

		For both scenarios, the revised rail configuration was adopted, which includes elevated sections of rail on piers (or similar) to the west of the Namoi River and minor sections of embankment to the east of the Namoi River. Figure 1 shows the 1% AEP flood level impacts of the proposed rail for the scenario where local creeks flood coincident with the Namoi River. The difference in flood level impacts compared to the scenario where the local creeks flood independently from the Namoi River is imperceptible given that the Namoi River flows are significantly larger than the Collygra Creek and Stratford Creek flows. Further clarification: The modelling originally undertaken for the EIS Flood Assessment applied an 80 hour offset between the local and regional events. Therefore, the 80 hour offset was applied to ensure the local and regional flood peaks coincided for the additional modelling scenario.	
3	WMA Water states that: *"a gap in flood mapping is shown on Figures 5.5 – 5.7 downstream of the Namoi Tributaries model, the reasoning for this gap in flood information may not be clear ……This should be clarified, alternatively, the downstream boundary for the Namoi Tributaries models could be relocated to the Namoi River channel. It is acknowledged that this area is downstream of all proposed works and inclusion of this data is unlikely to affect the assessment of the Extension Project impacts."*	Figures 5.5 to 5.7 of the Flood Assessment show the predicted extent of flooding from the Namoi River model and the Namoi Tributaries model. The description of, including the extent, of these models are described in Section 5 in the Flood Assessment. The gap in the flood mapping described by WMA Water (2018) is due to the Namoi Tributaries model not extending all the way to the Namoi River. It does not infer that there is no flooding in this area, only that it was not modelled for the Project. The adopted Namoi Tributaries model extent is considered to be sufficient to demonstrate the extent and depth of flooding from the northern tributaries with respect to the northernmost extent of the Project mining area. It was not considered necessary to extend the model to the Namoi River.	The Proponent's response provides a reasonable explanation. A note clarifying this aspect could be added to future mapping.
4	WMA Water states that: "*Section 4.1 and 4.2 discusses an overview of the methodology. These sections refer to the calibration of the models with some aspects discussed here and the results of the calibration discussed later in Section 5.3.* *The Flood Assessment would benefit from linking these sections together or providing further clarification in the earlier sections. As the Flood Assessment stands, it gives the impression that the TUFLOW model was calibrated to results from the existing MIKE-*	WMA Water's comments regarding the structure of the Flood Assessment are noted. Section 4 of the Flood Assessment outlines the methodology used to derive peak discharges for the historical and design events. Section 5 of the Flood Assessment describes the development and calibration of the hydraulic model including discussion that the Mike 11 model obtained from the NSW Office of Environment and Heritage (OEH) has been used to derive the distribution of flow across the floodplain.	The Proponent's response is reasonable.

	11 model. It is acknowledged that this is not the case following a review of Section 5.3, however calibration to previous model results would not typically be the most appropriate method, rather calibration to known flood information, as has been done, would be appropriate."	WMA Water (2018) acknowledges that this methodology is appropriate: *"… calibration to known flood information, as has been done, would be appropriate."*	
5	WMA Water states that: *"Section 4.2 discusses inflow discharges extracted from the existing MIKE-11 model and the variable proportions of discharge across the floodplain flow paths. Clarification on how these flow splits were determined and their appropriateness for use for design events is required."*	As discussed in Section 4.2.1 of the Flood Assessment, the MIKE 11 model was used to determine the peak flows for the historical events as well as the distribution of flows between the main channel and the eastern and western floodplains. The development and configuration of this model is described in the *Carroll to Boggabri Floodplain Management Plan September 2006* and *Carroll to Boggabri Flood Study* prepared by SMEC (2003) for the Department of Land and Water Conservation. The configuration of the MIKE 11 model layout from Gunnedah to Boggabri is reproduced in Figure 2 below. The model is characterised by a series of branches representing the main flow paths. The dominant flow paths in the Gunnedah to Boggabri reach consist of the Namoi River main channel as well as eastern and western floodplain branches. Given this model also extends upstream to both Carroll and Breeza, it was considered to provide the best representation of the distribution of flow at the upstream boundary of the model extent and was adopted for this purpose.	The Proponent's response provides reasonable justification for the method adopted.
6	WMA Water states that: *"The use of FFA to determine design discharges at Gunnedah is the most appropriate method for this location. The discussion in Section 4.2.2 requires further details in order to determine that the method has been applied in accordance with best practice. Additional details include what assumptions were made for events between 1955 and 1968, is there any benefit to including the period from 2015 – 2018, are there other events prior to 1955 that may influence the results, how was the fit achieved, was software such as FLIKE used, what is the likely variability around the discharge estimates for the 1955 event, given that the current rating curve is applied?* *A table showing the peak flood heights and assumed discharge would also benefit the reader.* *Labels identifying key historical events on Figure 4.3 would also be beneficial.* *The Flood Assessment states that the results are consistent with previous assessments but does not provide details, other than to say the*	The Flood Frequency Assessment (FFA) was undertaken by fitting a Log Pearson Type III distribution by the method of moments. This methodology is consistent with the procedures in *Australian Rainfall and Runoff: A Guide to Flood Estimation* (IEAust, 1987) (ARR 1987). As stated, the adopted peak discharge for the 1955 event was obtained from the Gunnedah rating curve and was the same as the 1955 peak adopted by SMEC (1999) and SMEC (2003). The methodology recommended in ARR (1987) has been used to incorporate the 1955 event as an historical event and is based on the assumption that the data in the recorded period (1968 to 2015) are also representative of historical data outside the recorded period. The FFA methodology has since been superseded by subsequent updates of ARR 1987 in 2016 and 2019. The annual series FFA was recalculated using the Bayesian approach within the Flike software recommended in ARR 2019 (Ball et al., 2019). The data was extended to include the years 2015 to 2018 and the 1955 flood was assumed to be the largest recorded flood since 1892 for this analysis. The updated analysis estimated the 1% AEP flood quantile to be 7,163 m^3/s, using a Log Normal distribution to produce the best fit to the available data. The expected AEP of 7,163 m^3/s is 1.15% and the revised 1% AEP value is some 20% lower than the	The Proponent's response indicates use of a technique (method of moments) that has not been a recommended technique for over 15 years. The use of the software FLIKE as indicated is now industry best practice. A review of the provided FLIKE file indicates that the data has been applied appropriately. It is likely that the flow rate being applied from the earlier work is overly conservative. Applying higher flow rates may mask impacts. It is however acknowledged that given the current design of the rail spur, impacts during the lower flow rate 1% AEP are likely to be minor and not significantly change the outcome of the assessment.

	predicted magnitude of previous events was similar. *Additional details would assist the reader and give credibility to the study."*	previous estimate. On this basis, the 1% AEP used in the Flood Assessment is considered to be conservatively high, which is reasonable given that the 1955 flood was the largest since 1892 (SMEC, 2003). Further clarification: The FLIKE input file associated with the analysis is attached. Note that FLIKE analysis was undertaken (at the request of WMA Water) to show that the adopted 1% AEP Namoi River discharge of 9,141 m^3/s was conservative. This is important as it means the height and extent of the 1 in 100 year flood regime are also conservative. Therefore, use of the model to achieve the commitment to elevate the rail above the 1 in 100 year flood level will also be conservative. The 1% AEP peak discharge used for the assessment is consistent with previous studies at Gunnedah and the Carroll Boggabri Floodplain Management Study. It (9,141 m^3/s) is clearly conservative given the highest post Keepit Dam discharge is 2,650 m^3/s and Keepit Dam was not constructed at the time of the highest flood peak in 1955. Further flood frequency analysis using FLIKE is not considered warranted.	
7	WMA Water states that: *"The method to determine the extreme flood event is reasonable and appropriate for this catchment. The discussion provided in Section 4.2.3 is somewhat misleading, as the limitation on use of FFA to determine the PMF is not unique to the Namoi River catchment. There would not be a stream gauge anywhere in Australia that would have a record length suitable for determining the PMF. The text tends to indicate limitations with the data for this catchment and creates uncertainty, when the method used is completely appropriate "*	See response to IPC Recommendation 3 in Attachment B below for further discussion of the Probable Maximum Flood (PMF).	The intent of the comment was to seek clarity on the discussion regarding the PMF used in the report. The response provided relates to the method used only. No further action required.
8	WMA Water states that: *"The catchment delineation on Figure 4.4 appears reasonable from the information available on the figure. It is noted that catchments UG01 – UG03 do not appear to be used in the hydraulic modelling. This could be clarified in the text."*	The XP-RAFTS model configuration includes the Collygra Creek (CC), Deadmans Gully (DMG), Stratford Creek (VC), Driggle Draggle Creek (DD) and Bollol Creek (BC) catchments. Catchments UG01 to UG03 were not included in the XP-RAFTS model as they are located significantly further downstream of the Project. A revision of Figure 4.4 from the Flood Assessment which does not show these catchments is provided below (Figure 3).	The Proponent's response and provided figure appropriately addresses this comment.

9	WMA Water states that: *"Regional Flood Frequency Estimation (RFFE) is a tool developed as part of the research undertaken to support ARR2016……Given the uncertainty and limitations around the design estimates in RFFE, it is not appropriate to calibrate a runoff routing model to these estimates. It is assumed that the parameters in XP-RAFTS have not been adjusted to provide a closer calibration match to RFFE."*	The parameters in XP-RAFTS were determined from the available topographic and ground condition data. As described in Section 4.1 of the Flood Assessment, the Regional Flood Frequency Estimation (RFFE) estimates were only used to validate the model results. WMA Water (2018) states: *The use of RFFE is a reasonable approach for validating the order of magnitude of design discharge estimates for the Namoi River Tributary catchments from XP-RAFTS.*	The Proponent's response confirms that the method used is reasonable.
10	WMA Water states that: "*Section 4.3.3 notes that the storage exponent 'X' of 0.25 has been adopted, a suggested starting value is typically 0.75. Justification for the use of 0.25 should be provided."*	The Muskingum method (applied for the Project) is a widely used flood routing technique. ARR 2019 states "*In most natural streams, X is approximately 0.2 but can vary from 0 to 0.3*". It is not clear why WMA Water has suggested a value of 0.75 as it cannot be greater than 0.5. Note that design discharges are not overly sensitive to X when varying between 0.2 and 0.3.	The parameter 'X' would more appropriately be referred to as a coefficient rather than an exponent. With the provided response clarification, an appropriate value has been used.
11	WMA Water states that*: "In reference to Table 4.2, clarification is required as to why the PERN 'n' value adopted for BC01 and BC02 differs from the remainder of the sub-catchments."*	BC01 and BC02 are located in forested areas along the eastern fringes of the catchment and therefore the 'n' value adopted differs from the other subcatchments, which are located in cleared agricultural land.	The Proponent's response is reasonable and justifies the method used.
12	WMA Water states that: *"The methods described in Section 4.3.4 Paragraph 2 are appropriate for determining the Probable Maximum Precipitation however further details of the calculations are required in order to confirm the application of the methods. Resulting values do appear to be reasonable and of the scale that would be expected."*	Both the Generalised Short Duration Method (GSDM) and Generalised Tropical Storm Method (Revised) (GTSM-R) parameters used in the Flood Assessment are in accordance with the Bureau of Meteorology's (2003) *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method* and (2005) *Guidebook to the Estimation of Probable Maximum Precipitation: Generalised Tropical Storm Method*. The GSDM rainfalls were calculated assuming a 100% smooth catchment with an elevation adjustment factor of 1 and a moisture adjustment factor of 0.775. The GTSM-R rainfalls were calculated using the coastal summer rainfalls, TAF = 1, DAF = 0.8358 and EPW = 78.3137. For both methods, the calculated rainfall was applied to each sub area. The adopted methodology is considered to provide a reasonable estimate of the PMF from the local catchments.	The Proponent's response shows that the parameters applied are appropriate.
13	WMA Water states that*: "In reference to Table 4.3, it is assumed that a range of durations have been assessed to determine the peak discharge and that appropriate durations have been selected for the smaller tributaries included in the Namoi River model. The critical durations for each design discharge and the method used*	The XP-RAFTS model of the smaller tributaries was run for a range of durations from 3 to 72 hours. The critical duration varied between catchments but was generally around 18 hours for the 1% AEP event.	The Proponent's response shows that an appropriate assessment of different storm durations has been undertaken.

	to determine should be documented."		
14	WMA Water states that: *"The 2000 ALS data used in the 2003 Carrol to Boggabri Flood Study, has been shown to contain a 'tilt' across each aerial scan sweep. Given these issues it would be useful to see the areas where the various other more recent topographic datasets are applied and an indication of how well each dataset ties in to the surrounding data sets."*	Figure 4 shows the locations where the 2000 airborne laser survey (ALS) data was updated with more recent survey used in the 2003 study. All other areas used the 2000 ALS data. The flood model areas in the immediate vicinity of the proposed mine infrastructure have been updated with the most recent data. The updated survey extends some 5 km upstream of the proposed rail spur, which is sufficient to remove the potential impact of the 'tilt' in the 2000 ALS data.	From a review of the provided map it is determined that the updated survey appears to cover the majority of the area assessed and therefore the 'tilt' in the data is of minor significance.
15	WMA Water states that: *"Figures 5.1 and 5.2 show the TUFLOW model configurations. The configurations shown appear to be reasonable. In regard to inflow boundaries, it is assumed that inflows CC10 and DMG13 include all catchment discharge (CC01 – CC09 and DMG12 – DMG13) to that point and that the discharge is not representative of the local catchments for which the labels apply. The same query exists for VC02 and VC09 for catchments VC04, VC06, VC01 and VC03 (Figure 5.1) and BC03 and DD04 for catchments BC01, BC02, DD01 – DD03 and DD07 (Figure 5.2).* *…* *Additional details would also benefit the reader in clarifying which systems have been included in the modelling. A later comment in Section 5.3 Paragraph 4 gives the reader the impression that some of these other smaller systems (noted by landholders) are not accounted for and included in the modelling. Collygra and Deadmans Creeks are included in the Namoi River model and could also be identified in Table 5.2."*	The inflow boundaries located near the extent of the hydraulic model include all flows generated upstream of that point. The downstream inflow boundaries represent the local inflows from each subcatchment within the hydraulic model. This is a standard approach to ensure all local catchment flows are considered. The inflow boundaries for Collygra Creek and Deadmans Gully represent whole of catchment flows as there is only one inflow. For the calibration events, the local catchments were not modelled, as stated in Table 5.2 of the Flood Assessment. The local catchments were included in the design event modelling.	The Proponent's response describes a reasonable method.
16	WMA Water states that: "*Figure 5.1 would also benefit from adding labels to the included culverts so that they can be cross checked with Table 5.3."*	Figure 5.1 of the Flood Assessment is reproduced as Figure 5 below, incorporating labels of the culverts.	The provided updated mapping addresses this comment.
17	WMA Water states that: *"It is noted in Section 5.2.3, that Manning's 'n' surface roughness values were adjusted to achieve a calibration fit, some additional clarification is required to indicate how much the values were adjusted.*	Data was available for two events to calibrate the model; the 1998 event and the 1955 event. The 1998 event, which experienced only minor overbank flows, was used to derive the Manning's 'n' values for the channel and riparian area. The	The Proponent's response is reasonable, however appropriate testing and validation of assumptions would be expected to be undertaken during a flood assessment for a project of this scale.

	Additionally, is it reasonable to assume the low vegetation cover value adopted for crops is representative of the conditions in both 1955 and 1998. *Should a higher Manning's 'n' value for cropping be applied to design events, would the impacts of the Extension Project be substantially different. A sensitivity assessment where Manning's 'n' values are adjusted would typically be undertaken to demonstrate the sensitivity of the modelling outcomes to these assumptions."*	channel Manning's 'n' was adjusted from 0.06 to the adopted 0.03 and overbank from 0.08 to the adopted 0.06. The overbank crop areas were not sensitive to Manning's 'n' for this event, given the shallow depth of flows. The 1955 flood was much larger and used to calibrate the overbank crop areas. The model generally overpredicted flood levels for this event, even though very low Manning's 'n' were adopted for the overbank crop area. Higher Manning's 'n' values, assuming higher vegetation cover, would have produced a poorer model calibration. Overall, it suggested that the model would provide conservative estimates of design flood levels. Sensitivity testing of overbank (crop) Manning's 'n' was not considered warranted given the minimal impact that was predicted for the low Manning's 'n' scenario. The use of a higher Manning's 'n' value would increase flood levels, however, would likely reduce flood impacts due to the minor reduction in floodplain velocities. Further clarification: Figure provided.	A map showing the distribution of the applied Manning's 'n' surface roughness has also been provided by the Proponent. The application appears appropriate.
18	WMA Water states that: *"Section 5.2.4 discusses the development of the design event hydrographs based on the 1984 event extracted from the existing MIKE-11 model, this appears to be a reasonable approach. The text should discuss if any validation of the event hydrograph was undertaken prior to adopting from the MIKE-11 model."*	WMA Water's (2018) comment that the development of the design event hydrographs is a reasonable approach is noted. No validation of the event hydrograph was undertaken as there was no more appropriate or alternative method to determine a suitable distribution of flow between the main channel and eastern and western overbanks.	The Proponent's response is reasonable.
19	WMA Water states that: *"Section 5.2.5 describes the inclusion of additional hydraulic features such as culverts and banks. The described method appears appropriate but some further clarification on which structures were modelled in 1D and which in 2D, in addition to how the levees and banks were included in the modelling should be provided"*	All structures were modelled in 1D with the exception of HW1. Instabilities were encountered at this structure when the model was run in CPU, and as such, was replaced with a 2D opening. This structure is almost 30 metres (m) wide, equivalent to two cells and as such suitable to model within 2D. This assumption is inconsequential to the peak flood levels or impacts of the project. Further clarification: Floodplain banks and levees were modelled as a 2D_shape (ridge) with elevations derived by extracting elevations from the available lidar data.	The described method is appropriate for the inclusion of culverts and structures. Further clarification has confirmed that an appropriate method has also been applied for the floodplain banks and levees.
20	WMA Water states that: "*Section 6.2.2 aims to describe the various components of the proposed rail spur, culverts, bridges, embankments in relation to the Draft FMP zones. It is difficult for the reader to determine the locations and sizing of the assumed*	The conceptual Project rail spur was designed to achieve the objectives of the *Draft Floodplain Management Plan for the Upper Namoi Valley Floodplain 2016* (Draft FMP) and included sections of embankment within Whitehaven-owned land (Plate 1). The embankments (indicated in yellow on Plate 1) were modelled as a blocked obstruction. Elevated components	The Proponent's response indicates that the rail spur structure has been modelled using appropriate methods. It is noted that the rail spur design has been refined since the initial review.

	structures. A map showing what assumptions have been made in the TUFLOW model in terms of structure sizing and placement, additionally including the FMP Zones, would greatly assist in clarifying this for the reader. *In addition, the method to represent these structures within the TUFLOW model has not been described and can therefore not be reviewed for appropriateness. It is however understood from discussions with the proponent's flood assessment specialist consultant that layered flow constrictions have been applied, which would be an appropriate method for representing these structures within TUFLOW. The method used should be documented in the Flood Assessment, including any assumptions that have been made."*	of the conceptual rail spur were modelled as a layered flow constriction (i.e. 5% to 9% obstruction below the superstructure. Initial modelling of the conceptual rail spur design indicates negligible changes to flood levels, velocities and distributions on privately-owned land. Further design development of the conceptual rail spur alignment following submission of the Project EIS determined that the Project rail spur would be completely elevated on pylon-like structures west of the Namoi River (i.e. the revised rail configuration). At the point where the elevated rail spur joins the Werris Creek Mungindi Railway (i.e. the Main Line) embankment there will be a short transition zone. The superstructure of the rail spur would be elevated above the 1 in 100 year flood level. Sections of embankments within Whitehaven-owned land to the east of the Namoi River would remain.	A comparison of the model results to the objectives of the FMP has not been provided. It is noted that Whitehaven have committed to providing an assessment against the FMP criteria when the design is finalised. Further reporting to demonstrate that the final design is consistent with the objectives of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 is required as part of the conditions of approval. Reporting against the specific criteria outlined in the plan such as percentage change in velocity, change of drainage times, flow diversion on individual landholders, will likely address this comment.
21	WMA Water states that: "*Section 6.2.4 references Figure 2.2, this figure does not exist within the Flood Assessment. This section also discusses the impacts of the Extension Project Borefield and Pipeline, it is not clear if the statement of impacts is based on modelling or opinion. This should be clarified."*	Section 6.2.4 should instead reference Figure 1.2 of the Flood Assessment (reproduced as Figure 6 below for reference), which demonstrates the location of the Project borefield with respect to Driggle Draggle Creek. The Project borefield pipeline would only be approximately 0.1 m above the ground and on that basis was not included in the modelling.	Based on the Proponent's response it is understood that the comments made regarding the impact of the borefield pipeline are based on opinion as opposed to modelling outcomes. Given the scale of the borefield pipeline and its location, this is considered to be a reasonable response.
22	WMA Water states that: *"The impacts of the Extension Project within the Namoi Tributary catchments of Stratford and South Creeks are described in Section 6.3. The discussion does not provide a comparison to all the components of the Draft FMP criteria that would apply to Zone C, including drainage times, flow redistribution and percentage changes to velocity. Further analysis and discussion should be provided."*	The proposed rail spur construction would not impound water and therefore is not predicted to impact on flood drainage times. Details on the flow redistribution is provided in Section 6.4.3 of the Flood Assessment. The final detailed rail spur design would be designed to satisfy the relevant drainage time, flow redistribution and percentage change to velocity criteria specified in the Draft FMP (now superseded by the *Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019* [2019 FMP]). Whitehaven will provide DPIE and OEH with the final detailed rail spur design and updated flood assessment results to confirm compliance with the objectives of the 2019 FMP.	It is noted that Whitehaven have committed to providing an appropriate assessment against the FMP criteria when the design is finalised. Further reporting to demonstrate that the final design is consistent with the objectives of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 is required as part of the conditions of approval. Reporting against the specific criteria outlined in the plan such as percentage change in velocity, change of drainage times, flow diversion on individual landholders, will likely address this comment.
23	WMA Water states that: "*Section 6.4 goes on to compare the impacts of the Extension Project Rail Spur against only some of the Draft FMP criteria. The Draft FMP velocity criteria is related to a percentage change in velocity and not an absolute change, the Flood Assessment does not show the velocity changes in terms of percentage."*	The 2019 FMP criteria relevant to changes in flood velocity increase the flood velocity by more than 50%. Section 6.4.2 of the Flood Assessment states that the flood velocity under the rail spur would be approximately 20% higher than existing conditions. This was determined by comparing the predicted change in flood velocity due to the Project rail spur (Figures 6.11 to 6.13 of the Flood Assessment) with the existing velocities (Figures 5.9 to 5.11 of the Flood Assessment).	The provided mapping does not show the change in velocity as a percentage and therefore the statement that the change is in velocity is approximately 20% cannot be confirmed. The compliance to the velocity criteria has not been appropriately justified.

		The flood model results predicted an increase in velocity between 0.2 m/s and 0.5 m/s at the ends of embankment sections of the Project rail spur (Figure 6.13 of Appendix C of the EIS, reproduced below as Figure 7). Note that Whitehaven has now committed to elevating all sections of the Project rail spur west of the Namoi River on piers and/or pylons. The predicted increases to flood velocities in localised areas would comply with the velocity impact requirement set out in the 2019 FMP, and would be constrained to Whitehaven-owned land. Appropriate erosion and sediment control measures will be implemented at locations of increased velocity, where required.	It is acknowledged that the refined design is likely to further reduce the impacts on flood behaviour and Whitehaven have committed to addressing the FMP criteria when the final design has been determined. Reporting/mapping of the percentage change in velocity will address this objective of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 and is required as part of the conditions of approval.
24	*"In addition, the Draft FMP assessment criteria for flow redistribution is based on an overall and individual adjacent landholder criteria. Section 6.4.3 describes flow redistribution on an overall floodplain basis and does not quantify the change to individual properties. This information would be key to adjacent landholders and should be provided."*	The impact of the Project rail spur on peak flow distribution for the 5% AEP flood event was assessed in Section 6.4.3 of the Flood Assessment. The peak flow distribution impacts for the 5% AEP flood event and the 1% AEP flood event are detailed in Tables 1 and 2, respectively. The location of each Peak Flow ID is shown on Figure 6.1 of the Flood Assessment (reproduced below as Figure 8). These locations represent the flow distribution locations that could be assessed in the *Carroll to Boggabri Floodplain Management Plan* and generally represents property locations. The results show that the distribution of flow across the floodplain is not significantly altered by the Project rail spur for both the 5% and 1% AEP events (i.e. less than 5% and would result in a consequential effect to neighbouring properties or the environment). Accordingly, there would be negligible redistribution of flood flows at adjacent private property boundaries. The reduction in the embankments for the revised rail configuration would further reduce the change in distribution. Notwithstanding, Whitehaven will provide DPIE and OEH with the final detailed rail spur design and updated flood assessment results to confirm compliance with the objectives of the 2019 FMP.	It is noted that Whitehaven have committed to providing an appropriate assessment against the FMP criteria when the design is finalised. In relation to the flow redistribution the FMP requires redistribution to be measured on adjacent landholders. It is acknowledged that the proposed rail spur is likely to result in minor redistribution of flows, this should however be appropriately demonstrated when the final design is available. Reporting/mapping of the change in flow distribution on adjacent individual landholders will address this objective of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 and is required as part of the conditions of approval.
25	WMA Water states that: *"It is noted that the Flood Assessment indicates that the 5% AEP design event is representative of a large flood under the Draft FMP, it appears that for this section of the Namoi River catchment, that the 1984 event remains as the large design flood. It is acknowledged that they are of a similar magnitude however this should be clarified within the Flood Assessment."*	Consistent with the 2019 FMP, the 'large design flood' was developed based on the 1998, 1971 and 1984 floods, which are all considered representative of the 5% AEP flood event. Section 2.2.1 of the Project Flood Assessment states (bold for emphasis): ***These rules and the management zones have been developed by assessing*** *the flooding characteristics of a small flood represented by a 20% AEP design flood event or the 1992 historical flood and a number of* ***large flood events represented by three historical floods (1998, 1971 and 1984) as well as the 5% AEP design flood event.***	The Proponent's response is reasonable.

26	WMA Water states that*: "Section 6.4.1 states that the impacts are generally confined to Whitehaven owned land, this statement should be explicitly clarified, with the exceptions identified."*	One privately-owned residence (No. 15) was predicted in the EIS to experience a negligible increase (i.e. approximately 1 centimetre) in flood levels during the 1% AEP flood event. This impact would be eliminated by the revised rail configuration. The only other residence predicted to experience an increase in flood level for the 1% AEP as a result of the Project rail spur (Residence No. 5). Residence No. 5 is Whitehaven-owned and located in a high hazard flood area, with flood levels exceeding 1 m for the 1% AEP flood under existing conditions (i.e. without the Project rail spur). Residence No. 5 is not occupied and access to and from this property is not available during a 1% AEP flood event under existing conditions. Consideration of safe wading depths at residences and property access ways is not considered to be necessary due to the negligible change in flood depths and velocities predicted for the Project.	The Proponent's response provides the requested clarification.
27	WMA Water states that: "*The colour scheme used on Figures 6.2 – 6.10 is difficult for the reader to follow, particularly through the flood level reduction categories where a number of colours are very similar."*	Please see Figure 9 below for a simplified view of changes in flood levels under the 1% AEP flood event for the conceptual rail spur design. Note that Whitehaven has now committed to elevating all sections of the Project rail spur west of the Namoi River on piers and/or pylons.	The refined figure provided addresses this comment.
28	WMA Water states that: "*Section 6.4.4 states that the Extension Project does not impact on drainage times. Changes to drainage time is a criteria to be assessed under the Draft FMP. Hydrographs at various locations across the floodplain should be provided to support the statement made."*	Section 6.4.4 of the Project Flood Assessment states that the detailed rail spur design would be designed to satisfy the relevant drainage time criteria specified in the Draft FMP (now superseded by the 2019 FMP). Notwithstanding, as the revised rail design proposes to elevate the spur on piers west of the Namoi River and would not impound water, there would be no impacts to drainage times. Whitehaven will provide DPIE and OEH with the final detailed rail spur design and updated flood assessment results to confirm compliance with the objectives of the 2019 FMP.	It is acknowledged that the FMP criteria will be addressed when the final design has been determined. Reporting supported by pre and post development hydrographs at various locations will address this objective of the Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019 and is required as part of the conditions of approval.
29	WMA Water states that: "*Section 6.4.5 discusses the cumulative impacts of the development and existing infrastructure. Cumulative assessment typically considers future development in addition to the proposed and existing development. The assessment described in this section does not appear appropriate.* *The assessment should ensure that currently approved but possibly not yet constructed floodplain works and developments are included in the assessment."*	The TUFLOW model has been developed using the best available topography sources to capture existing developments. The topography data across the model extent is sourced from an ALS in 2000, and has been supplemented with more detailed data in the vicinity of the Project, including LiDAR survey data and a more detailed ALS, conducted in 2011 and 2015, respectively (Section 5.2.2 of the Flood Assessment). As the flood model has been developed using ALS and LiDAR data, it includes the floodplain infrastructure that was present at the time of the surveys. As the model includes both existing built infrastructure as well as proposed Project infrastructure, it is considered to represent all proposed and existing development. Whitehaven knows of no approved/proposed but	Given there is no approved or proposed but unconstructed infrastructure, the Proponent's response is reasonable.

		unconstructed infrastructure in the area that would affect the outcomes of the flood modelling. Further, given that the Project rail spur and the revised rail design show negligible flood impacts, any cumulative impact assessment against pre-development conditions will only show the impacts associated with the existing infrastructure.	
30	WMA Water states that*: "Section 6.5 sets out a discussion and reasoning behind not assessing the impacts of the Extension Project under a future climate scenario. While the points raised are somewhat reasonable, the SEARS (Table 2.1) sets out this requirement. Additionally, the uncertain nature of climate change and longevity of the Project make understanding the sensitivity of the impacts of the Extension Project in these uncertain future climate conditions essential."*	The Secretary's Environmental Assessment Requirements (SEARs) for the Project required that flood modelling be conducted for the 20% AEP, 5% AEP and 1% AEP flood events (Attachment 1 of the EIS). An 'extreme' flood event equivalent to three times the 1% AEP flood event (assumed to be the PMF event) was also modelled. Assessment of an 'extreme' flood event of a magnitude of 0.1% AEP (as suggested in some public submissions) is not considered to be warranted because the Project mining area is not predicted to be inundated by the 'extreme' flood event (i.e. three times 1% AEP). Consistent with the rainfall predictions in the Surface Water Assessment (Advisian, 2018), the magnitude of any changes in rainfall intensities due to climate change over the Project life (25 years) are not expected to significantly change the 1% AEP and PMF events that have been assessed and therefore the predicted changes in flood levels and velocities due to the Project would not be significantly affected. Comparison of the differences in flood levels for the 5% and 1% AEP flood events is less than 0.5 m in the Namoi River itself, and accordingly, any minor change in peak discharge above the 1% AEP design event due to climate change over the 25-year Project life would not materially change the modelled 1% AEP flood levels. During detailed design, freeboard considerations for the Project rail spur above the 1% AEP flood level would be sufficient to account for any changes in peak discharge due to climate change.	It would be prudent and considered best practice for a project of this scale and lifecycle to consider the impacts of climate change. Noting that this requirement is listed in the agency requirements and recommendations. In addition, it is not appropriate for climate change to form a component of any freeboard applied to the project. A sensitivity assessment of the impacts of the project under future climatic conditions is required as part of the conditions of approval.