

Appendix 1 – Flooding Comments

References of Study	<p>Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand Project Report prepared for: Element Environment, on behalf of Dunmore Sand & Soil Pty Limited Report Prepared by southeast engineering+environmental Revision: F Date:19/06/2019 Project No. :451</p> <p>Flood and Coastal Study Stage 2 Report Minnamurra River Boardwalk Report prepared for: Kiama Municipal Council Report Prepared by Cardno Version Number: Version 01 Job Reference: 8141801101 Date:08/02/2019</p>																														
Date	09/08/2019																														
Water engineering assessment	Tyson Perry																														
Peer Review	Prabin Kayastha																														
Comment # 1 from SCC	The largest flood event modelled was the 1% Annual Exceedance Probability (AEP) event and not the Probable Maximum Flood (PMF) event. Section A5 of the NSW Floodplain Development manual states: “more explicit recognition that floods rarer than those used for design of mitigation works and control of development will and need to be considered in managing flood risk. The full range of flood sizes, up to and including the PMF event must be undertaken with particular emphasis on danger to personal safety and critical infrastructure”.																														
Response from consultant on 25/06/2019	The consultant had provided results of PMF event along with other rainfall events in Table 3.2. Moreover, the consultant had provided flood maps in the Appendix A of the report version Rev F dated 19/06/2019.																														
Recommendation From SCC on 02/07/2019	<p>It would be better to show the following flooding maps for the existing scenario and post–development scenario with proposed car park, spillway and other infrastructures for different rainfall events.</p> <table border="1"> <thead> <tr> <th>Events</th> <th>Velocity</th> <th>Depth</th> <th>Water level</th> <th>Velocity x depth</th> <th>Hazard</th> </tr> </thead> <tbody> <tr> <td>5 yr ARI</td> <td>√</td> <td>√</td> <td>√</td> <td></td> <td>√</td> </tr> <tr> <td>20 yr ARI</td> <td>√</td> <td>√</td> <td>√</td> <td></td> <td>√</td> </tr> <tr> <td>100 yr ARI</td> <td>√</td> <td>√</td> <td>√</td> <td>√</td> <td>√</td> </tr> <tr> <td>PMF</td> <td>√</td> <td>√</td> <td>√</td> <td></td> <td>√</td> </tr> </tbody> </table>	Events	Velocity	Depth	Water level	Velocity x depth	Hazard	5 yr ARI	√	√	√		√	20 yr ARI	√	√	√		√	100 yr ARI	√	√	√	√	√	PMF	√	√	√		√
Events	Velocity	Depth	Water level	Velocity x depth	Hazard																										
5 yr ARI	√	√	√		√																										
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100 yr ARI	√	√	√	√	√																										
PMF	√	√	√		√																										

	Furthermore, the flood impact mapping for different rainfall events such as 5yr ARI event, 20 yr ARI event, 100 yr ARI event and PMF event can be shown for the post-development scenario.
Response from consultant on 23/07/2019	An additional figure is provided to illustrate the location of the car park. Additional figures are also provided to address the post development scenarios.
Recommendation From SCC on 09/08/2019	Hydraulic hazard maps in the PMF events are still missing. Satisfied for all provided storm events.
Comment # 2 from SCC	The required vehicle stability assessment cannot be undertaken due to lack of information. All car parks in flood-affected areas are to comply with Book 6, Chapter 7, Section 7.2.4. Vehicle Stability in “Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019”.
Response from consultant on 25/06/2019	The consultant stated that the car park at Stage 5B is located above the PMF flood level.
Recommendation From SCC on 02/07/2019	As mentioned in comment # 1, it would be better to show the car parking in the flood map in the post development scenario for the different rainfall events such as 5yr ARI event, 20 yr ARI event, 100 yr ARI event and PMF event. The extent of car parking in the flood map will confirm the statement provided by the consultant.
Response from consultant on 23/07/2019	An additional figure has been provided to illustrate the location of the parking area.
Recommendation From SCC on 09/08/2019	It is not clearly illustrated from the flood maps provided that the car parking is above the PMF flood level (due to titles on maps blocking some flood mapping). However, consultants have stated that the car park will be above the PMF level which is satisfactory. If concept design changes in the future and the levels of the car park are below the PMF level, car parks should comply with Book 6, Chapter 7, Section 7.2.4. Vehicle Stability in “Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019”.
	Moreover, in the existing condition, car park, spillways and detention basins are not required. If needed to show these structures in the existing condition, please mention the proposed car park, proposed spillway and proposed detention basins in the legend.
Comment # 3 from SCC	No information on the potential for vehicles to cause a nuisance during a PMF event is available. In this regard, vehicles in car parking areas affected by flooding must not cause a nuisance in the PMF event by being caught in floodwaters and becoming moving objects. Vehicle bollards or similar method of containment should be investigated where flood velocity and depth exceeds vehicle stability limits.

Response from consultant on 25/06/2019	The consultant stated that the car park at Stage 5B is located above the PMF flood level.
Recommendation From SCC on 02/07/2019	As mentioned in comment # 1, it would be better to show the car parking in the flood map in the post development scenario for the different rainfall events such as 5yr ARI event, 20 yr ARI event, 100 yr ARI event and PMF event. The extent of car parking in the flood map will confirm the statement provided by the consultant.
Response from consultant on 23/07/2019	An additional figure has been provided to illustrate the location of the parking area.
Recommendation From SCC on 09/08/2019	<p>It is not clearly illustrated from the flood maps provided that the car parking is above the PMF flood level (due to titles on maps blocking some flood mapping). However, consultants have stated that the car park will be above the PMF level which is satisfactory. If concept design changes in the future and the levels of the car park are below the PMF level, vehicles in car parking areas affected by flooding must not cause a nuisance in the PMF event by being caught in floodwaters and becoming moving objects. As such, vehicle bollards or similar method of containment should be investigated where flood velocity and depth exceeds vehicle stability limits.</p> <p>Moreover, in the existing condition, car park, spillways and detention basins are not required. If needed to show these structures in the existing condition, please mention the proposed car park, proposed spillway and proposed detention basins in the legend.</p>
Comment # 4 from SCC	Only events up to and including the 1% AEP flood event has been modelled to support the basin/embankment sizing and functions of both stages. The spillway must be designed to safely pass in a PMF flood event.
Response from consultant on 25/06/2019	The consultant stated that the spillway will accommodate the 100 yr ARI and PMF events.
Recommendation From SCC on 02/07/2019	As mentioned in comment # 1, it would be better to show the spillway in the flood map in the post development scenario for the different rainfall events. The extent of spillway in the flood map will confirm the statement provided by the consultant.
Response from consultant on 23/07/2019	An additional figure has been provided to illustrate the location of the spillway.
Recommendation From SCC on 09/08/2019	<p>Location of spillway noted. Spillway is to be designed to safely accommodate the 100yr ARI and PMF events.</p> <p>Moreover, in the existing condition, car park, spillways and detention basins are not required. If needed to show these structures in the existing condition, please mention the proposed car park, proposed spillway and proposed detention basins in the legend.</p>

Comment # 5 from SCC	Limited information regarding the 'flood protection bund' and armoured spillway has been provided. There is a potential risk of the embankment at Stage 5A to fail thus creating a risk to the public and infrastructure downstream. An 'embankment break' risk assessment for stages 5A and 5B be undertaken for all events up to and including the PMF flood event. These risks must be considered and managed.
Response from consultant on 25/06/2019	The consultant stated that "Spillway design will be undertaken to accommodate 100 year ARI and PMF flood depths and velocities. Water levels within bunded areas will generally be similar to adjacent water levels though ground water or flood flow overtopping impacts. Periods of difference in water level between dredge ponds and outer environment will be limited as ponds will be emptied to allow for dredge operations to resume. The bund freeboard is based on limiting the risk of inflows into the basins, as such freeboard guidelines used for the design of flood/stormwater retention structures to provide protection in residential areas is not necessarily applicable."
Recommendation From SCC on 02/07/2019	Shellharbour City Council's Subdivision Drainage Design Code details that there should be no increase in flooding in downstream and there should be no increase in flood levels upstream.
Response from consultant on 23/07/2019	The proposal does not seek to establish a sub division. The subdivision drainage design code was developed to guide the design and construction of subdivisions in the Shellharbour Local Government Area. The proposal upon completion of rehabilitation activities, will result in no increase in flooding in downstream and upstream flood levels. Impacts during the course of extraction are contained within the site for Stage 5B, with 16 mm increase over Riverside Drive in the 5 year ARI event, and smaller increase in other events. Refer to sections 3 and 4 of the Surface Water Assessment for more detail and page 36, Section 5.4.9 of the RTS document.
Recommendation From SCC on 09/08/2019	Even though the proposal does not seek to establish a sub division, the condition stating "there should be no increase in flooding in downstream and there should be no increase in flood levels upstream" is valid. The flood impact maps show there is slight increase in flood level due to the proposed development which is also mentioned in Section 5.1 of the report. Are there any flood modelling results to support the statement that the proposal upon completion of rehabilitation activities will result in no increase in flooding in downstream and upstream flood levels? The proposed embankments in Stage 5A are approximately 3.7m AHD on the Eastern face according to 'Appendix G – Revised surface water assessment June 2019' and confirmed using the proposed terrain files (.asc) provided by the applicant. The flood level heights inside the Stage 5A embankment (from the flood model results provided by the applicant) are as follows:

		5yr ARI	Existing	2.6m AHD
			Proposed	3.7m AHD
		20yr ARI	Existing	2.9m AHD
			Proposed	3.7m AHD
		100yr ARI	Existing	3.4m AHD
			Proposed	3.7m AHD
		PMF	Existing	4.4m AHD
			Proposed	4.4m AHD
		<p>For Stage 5A, it has been stated within ‘Appendix G – Revised surface water assessment June 2019’ that “An armoured spillway 100mm lower than the bund height (3.6m AHD)” will be provided. Given that the spillway is the only specified outlet to discharge water from inside the embankment, it is reasonable to predict that static water levels within the Stage 5A embankment will be 3.6m AHD. Due to this additional water, approximately 40,000m³ of water will be stored within the embankments of stage 5A. Note: approximate calculation = [(3.6m AHD for spillway height – 1.6m AHD as existing RL at proposed embankments – 0.4m if fill within embankment area) x 26000m² area]</p> <p>Due to the large increase of water storage onsite contained within raised embankments, there is a potential risk of the embankment failure at Stage 5A, thus creating a risk to the public and infrastructure downstream. Risks from embankment failure must be considered and appropriately managed for all events up to and including the PMF to ensure safety of all properties and personnel downstream (namely passing traffic on Riverside Drive).</p> <p>As such, an ‘embankment break’ risk assessment is recommended to be undertaken to ensure that all risks (including potential erosion) have been considered and appropriately managed. It is also recommended that, since water is being stored i.e. retarding water, consultant seeks advice from the NSW Dam Safety Committee (DSC) as to whether the embankment has the potential to be classified as a prescribed dam under the Dam Safety Act 1978.</p>		
		Comment # 6 from SCC	Documentation states that a freeboard of 100mm has been provided for the Stage 5A bund which is not in line with Councils Subdivision Design Code. Additional freeboard (as a factor of safety) for embankment heights should be considered. Shellharbour City Councils Subdivision Drainage Design Code details that detention basins (i.e. embankments that hold water) shall have a freeboard of not less than 500 mm above the 1% AEP flood level.	
		Response from consultant on 25/06/2019	The maximum 100 yr ARI level for Stage A and Stage B are respectively 3.42m AHD and 4.12 m AHD as shown in Table 3.2. The flood protection bund and spillway levels for Stage A are 3.7m AHD and 3.6m AHD respectively as shown in Figure 4.2. Furthermore, the flood protection bund and spillway levels for Stage B are 4.1m AHD and 3.9m AHD respectively as shown in Figure 4.3.	

Recommendation From SCC on 02/07/2019	Shellharbour City Council's Subdivision Drainage Design Code details that detention basins (i.e. embankments which holds water) shall have a freeboard of not less than 500 mm above the 1 in 100-year flood level.
Response from consultant on 23/07/2019	<p>The proposal does not seek to establish a sub division. The subdivision drainage design code was developed to guide the design and construction of subdivisions in the Shellharbour Local Government Area.</p> <p>The proposal upon completion of rehabilitation activities, will result in no increase in flooding in downstream and upstream flood levels. Impacts during the course of extraction are contained within the site for Stage 5B, with 16 mm increase over Riverside Drive in the 5 year ARI event, and smaller increase in other events.</p> <p>Refer to sections 3 and 4 of the Surface Water Assessment for more detail and page 36, Section 5.4.9 of the RTS document.</p>
Recommendation From SCC on 09/08/2019	<p>A freeboard in any sense is applied for any potential inaccuracies in modelling and for risk management purposes regardless as of the development type. However, it is noted the "Spillway design will be undertaken to accommodate 100 year ARI and PMF flood depths and velocities" and therefore the proposed freeboard of a minimum of 100mm is suitable.</p> <p>The consultant can provide the detail design of basins in the detail designed stage.</p>
Comment # 7 from SCC	Losses are based on ARR 2016 (ARR Data Hub) with IL= 61mm & CL = 4.3mm/h. There is more up to date information available and the study has not demonstrated that the hierarchical process outlined in the data hub (at http://data.arr-software.org/nsw_specific) has been followed. ARR Data hub states that "If default continuing losses from the ARR data hub are to be used these should only be used with a multiplier of 0.4 applied". This has not been demonstrated to have occurred within the model. Losses should be revised to reflect the most up to date ARR guidance at http://data.arr-software.org/nsw_specific . Subsequent remodelling will be required with the new losses.
Response from consultant on 25/06/2019	The data for losses in the study are was provided in the Appendix A of previous version of report i.e. Rev E dated 19/02/2019. However, the data was omitted in the current version of report.
Recommendation From SCC on 02/07/2019	The consultant can provide the losses assumed in this study as per the previous comments provided by the SCC.
Response from consultant on 23/07/2019	No response was provided.
Recommendation From SCC on 09/08/2019	The consultant can provide the losses assumed in this study either in the main body of the report or in the Appendix part. The flood report prepared by Cardno showed the losses assumed in Section 3.4.3 Adopted Hydrological Parameters for Design Storm (page 9).
Comment # 8 from SCC	There is no evidence that blockage scenarios have been adopted in flood modelling to support the assessment. Investigation of blockage of hydraulic structures in line with guidance from Book 6, Chapter 6:

	Blockage of Hydraulic Structures in “Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019” should be undertaken.
Response from consultant on 25/06/2019	The model assumes 100% blockage at Riverside Drive.
Recommendation From SCC on 02/07/2019	In the report, there is not any evidence of adoption of blockage scenario. Please also mention about blockage scenario adopted in this study in the report.
Response from consultant on 23/07/2019	As detailed in the RTS, on page 36 Section 5.4.9, the model assumes 100% blockage at Riverside Drive.
Recommendation From SCC on 09/08/2019	The consultant stated in the RTS that the model assumes 100% blockage at Riverside Drive. However, there is no evidence of blockage scenario in the report prepared by the consultant. The consultant should clearly specify applied blockage factors by providing details in the main body or as an appendix to the report.
Comment # 9 from SCC	The Manning’s n value of 0.025 for pastures is outside the range specified for open pervious areas in ARR. Revision of the manning’s value for the pasture land use type is required to ensure it is within the range provided in Book 6, Chapter 2: Open Channel Hydraulics in “Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia), 2019”. The latest edition of ARR suggests between 0.03-0.12 for open pervious areas (with varying degrees of vegetation)
Response from consultant on 25/06/2019	The previous version of the report mention about Manning’s n in the Appendix A. However, the information of Manning’s n was omitted in the current version of report.
Recommendation From SCC on 02/07/2019	Please provide the table and map for the Manning’s n used in this study area.
Response from consultant on 23/07/2019	Manning’s roughness detailed is provided in Section 4.1.4, on page 12 of the attached Cardno report.
Recommendation From SCC on 09/08/2019	The consultant can provide the Manning’s roughness (n) assumed in this study either in the main body of the report or in the Appendix part.
Comment # 10 from SCC	Invert levels of culverts beneath the Princes Highway, Riverside Drive and Fig Hill Lane were estimated (not exact RLs), based on surrounding levels and Rocklow Creek water levels. Inverts of pipes/culverts must be obtained from the RMS WAE plans or survey to further improve model accuracy.
Response from consultant on 25/06/2019	In this report also, the invert levels are approximated.

Recommendation From SCC on 02/07/2019	Inverts of pipes/culverts must be obtained from the RMS WAE plans or survey to further improve model accuracy.
Response from consultant on 23/07/2019	Section 3.4, page 16, of the Surface water assessment details the invert levels of culverts.
Recommendation From SCC on 09/08/2019	In section 3.4, page 16, of the report there is approximation of the invert level. Hence, the consultant is recommended to obtain the inverts of pipes/culverts from the RMS WAE plans or survey to further improve model accuracy.
Conclusions on 02/07/2019	Research undertaken by NSW OEH has indicated that there are significant reductions in AR&R2016 IFD Design rainfall in the Shellharbour area. In response to this, Council will only be accepting Flood estimation techniques that are based on AR&R1987 IFDs and methods until such time that calibrated/validated catchment specific flood studies have been adopted by Council that identify the flood estimation techniques that are appropriate for the catchment. As the Rocklow creek has not yet been through this process, Council will not accept the results of the report if it is based on AR&R2016 Design Rainfall and methods extracted straight from the AR&R Data Hub. Furthermore, the consultant needs to address the comments using AR&R 1987 IFDs and flood estimation methods.
Response from consultant on 23/07/2019	See attached Cardno report, which details that the ARR 1987 technique has been utilised in the flood model, see page 9 of the report. The same model has been used to determine the findings in our surface water assessment.
Recommendation From SCC on 09/08/2019	As most of the comments are of minor revision, the consultant is recommended to provide the revised and updated version of flood report showing all flood maps and addressing the issues raised in aforementioned Comments 1 to 10.