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## Appendix H – Review of hydrologic models for the Yanco modernisation project

# HYDROLOGICAL MODEL REVIEW CHECKLIST

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*To be completed by the SDLAM Project Team*

Project Title	Review of hydrologic models for the Yanco modernisation project
Subject of Review	RFS022 - Hydrological models for Yanco Creek
Project Manager/Client	Matt Kendall
Date Review required by:	16 <sup>th</sup> July 2021
How are model data / report files to be provided?	Via OneDrive link with file summary document
Any other comments or particular requirements	<p>Primary purpose to calculate water savings and environmental equivalent outcomes. Hydraulic models will provide input into the hydrologic model.</p> <p>Talk through model documentation / details. Preliminary documentation to be provided initially.</p> <p>Inform the development of baseflow targets and a flow operations plan.</p> <p>Calculate <b>changes</b> in operational water savings from infrastructure options and changed use of irrigational escapes relative to a base case scenario.</p> <p>Calculate changes in EWRs as a result of changes in infrastructure and flow operations.</p> <p>Is the Yanco model suitably interoperable with the Murrumbidgee model? The Yanco model will be run as a component of the Murrumbidgee models to evaluate the SLDAM projects.</p>

*To be completed by the Review Panel Member*

Review Organisation	Alluvium Consulting Australia	Reviewer's Experience & Qualifications (relevant to the task)	B App Sc (Chem) QUT 1989, FMSSANZ, National Lead Water Modelling
Reviewer(s)	Tony Weber		
Data received and dates	Emails received 6/9/21 and 11/10/21 with models and build	Date of review completion:	Initial 16/12/21 – Final 8/3/22

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	reports, discussions held on 26 November 2021. Revised reports sent through 14/2/22 including updated report, comments on annotated original report.		
Review version (i.e. Hold Point Number and subversion)	1	Previous Reviews of this Report/Model	None
<b>REVIEW OUTCOME</b>			
Is the model suitable for its intended use?	Given the updated modelling reporting and discussions held with modellers, the Yanco model appears suitable for its intended use		
Any comment on above	The model as viewed and as described in the Yanco SDLAM Hydrological Model Build Report: Draft provide a useful overview of the model development process but raised a number of questions that were discussed at a meeting on 26 November. This highlighted possible improvements in the modelling and reporting that should address those questions and ensure the model is suitable for its intended use. These were completed and revised reports received which indicate the model is now sufficiently well described for the intended use.		

<b>MODEL REVIEW METADATA</b>	
Project Title:	YancoAcceleration_20210720.rsproj and Yanco SDLAM Hydrological Model Build Report: Draft
Completed By (Organisation):	NSW Department of Planning, Industry and Environment
Modeller(s):	Rachel Blakers, Alice Brown
Comments on Study Objectives:	The primary purpose of the Yanco System model is to allow the estimation of changes in water savings and environmental metrics associated with the Yanco SDLAM Projects.

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Comments of Specific Aims of Review:	The review aimed to evaluate the model and model build documentation supplied to determine the suitability of use of the model for application in SDLAM project assessments
Model and data files used in the Review	YancoAcceleration_20210720.rsproj
Documents used in the Review	<ul style="list-style-type: none"> <li>• Yanco SDLAM Hydrological Model Build Report: Draft and updated draft</li> <li>• Hydrological modelling for preliminary options assessment: Draft Report</li> <li>• Headwater Flow Calibration Report Murrumbidgee Valley – Gauging Station 410091 Billabong Creek @ Walbundrie</li> <li>• Yanco project public information session slide pack</li> </ul>
Applicable Standards or Guidance to the Review	<ul style="list-style-type: none"> <li>• Project Brief (name)</li> <li>• Hydrological model manual (version)</li> <li>• Australian Rainfall &amp; Runoff 2019</li> <li>• eWater Source - Australian Modelling Practice (<a href="https://wiki.ewater.org.au/display/SC/Australian+Modelling+Practice">https://wiki.ewater.org.au/display/SC/Australian+Modelling+Practice</a>)</li> </ul>
<p>Colour coding to be used to highlight specific issues identified in the review.</p> <p><b>Green</b> – suggestion for compliance with good practice but if undertaken is unlikely to change the model outcomes.</p> <p><b>Amber</b> – non-standard method or method not following project specifications but unlikely to have impacted on model results.</p> <p><b>Red</b> – omission that could make the model/report findings subject to challenge and which requires correction/further work.</p>	

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## Review of model conceptualisation

<b>MODEL SCHEMATISATION</b> (refer to Conceptualisation report requirements in modelling objectives)		
<b>Item Reviewed</b>		<b>Comments</b>
<b>General Model Schematisation</b>		
MS1	Has the modeller correctly identified the question(s)/problem(s) and the objective of the model?	Yes, this is clearly outlined in Section 1.2 of the Model Build Report
MS2	Has the modelling team adequately defined the study area and its characteristics? Are all the key system components, processes and linkages included?	I believe this is the case, though the Yanco system is very complex and there is likely some uncertainty of cross-connectivity in certain areas. The major components of the Yanco, Colombo, Billabong and Forest Creeks are included in addition to the Yanco Offtake on the Murrumbidgee, irrigation diversions and irrigation escapes, and a range of control structures.
MS3	Is the general schematisation of the model appropriate? Is this a suitable approach to fulfil the model purpose and requirements?	Yes, the model is at the appropriate scale for evaluating proposed SDLAM options (as outlined in the Yanco public submission slide pack) and contains sufficient resolution and configurations to allow the options to be assessed.
MS4	Which software package has been used? Which version? If this is not the most up-to-date version, is the reason for this justified? Is this package suitable for meeting the model purpose and requirements?	The model was developed in the Source modelling framework, and appears to be constructed in Version 5.5 which was likely to be the current version during development. Further updates have occurred since then but I am unsure if this would make any material difference to the model operation. Current advice is the model has been moved to Version 5.10
MS5	Has the appropriate data been referenced and / or sourced for use in the study? Are they up to date and of sufficient quality to achieve modelling objectives?	Yes, appropriate forcing data has been with a considerable degree of quality assessment to verify and improve (e.g. infill) data where there may be limitations.
MS6	Does the model utilise information from existing models? Is this information appropriate for use? Does it represent appropriate	Yes, the Murrumbidgee IQQM model and other hydraulic models (e.g. Sobek) have been used to inform the development of this model. The modelling is of a sufficient standard to inform the Yanco model and when incorporated back into the full Murrumbidgee Source model it will be appropriate for use

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	scenarios in the context of the study objectives?	
MS7	Has the modelling team adequately demonstrated the validity of the model in various flow conditions for use in the study?	<p>The rainfall runoff calibration results of the model appear robust across most of the flow range except low flows, noting that this is just for the upper reaches of Billabong Creek (Headwater catchment 410091). There also appears to be a slight mismatch in flow timing between observed flows and calibrated model results.</p> <p>For the flow calibration, it is noted that a number of changes in operating rules occurred during the calibration period which can influence the ability to obtain satisfactory (or better) calibration results. I also note that considerable effort has been undertaken to verify and improve the gauged data where possible, though the degree to which gauge provided the most “weight” for calibration purposes and which ones were used more for verification purposes has been discussed and agreed to. The flows calibration is taken on a reach by reach basis, with adjustments made to different model elements and unaccounted for differences incorporated as transmission losses. In some cases these transmission losses and the loss relationships were high and their use discussed. Otherwise, the flow calibration results appear satisfactory and indicate the model is suitable for use except for flows less than around 100 ML/d.</p> <p>The operations calibration is thorough and appears to be robust with the exception of over-order factors which appear high but is what was needed to generate sufficient order volumes. This has been addressed with the full incorporation into the Murrumbidgee model such that the overorder factors are more realistic</p>
MS8	Has the modelling team adequately detailed the intended approach for losses?	Yes, the relationships established are properly documented and justifications included for where losses are elevated.
MS9	Have the EWRs locations been identified for output?	No EWR locations were identified.
MS10	Was an appropriate time period and timestep used? If non-daily timestep has been used, has an appropriate justification been provided?	Yes, a daily model was established, calibrated and verified.
<b>Action Advised:</b>		
	<i>The above comments should be read in conjunction with the detailed comments within the report. It is noted that there are no critical issues identified, and that the model should be sufficient for its intended use, with the comments and items</i>	

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	<i>noted for improvements where required, both in terms of the model and the documentation.</i>
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## Review of model data, build and calibration/validation

MODEL DATA MANAGEMENT		
Item Reviewed		Comments
MD1	Have all files required for the model review been supplied? <ul style="list-style-type: none"> <li>• Model files</li> <li>• Model results</li> <li>• Base datasets</li> </ul>	Yes, models, results and reports were supplied.
MD2	Have appropriate naming conventions been used? Are the contents of files readily understandable?	Yes, the files were able to be identified and understood.
MD3	Have assumptions been appropriately documented and are they justified?	Yes, though some further documentation in places would be helpful
<b>Action Advised:</b>		
<i>All satisfactory</i>		

MODEL BUILD		
Item Reviewed		Comments
<b>Model Setup</b>		
MB1	Is the base data for the configuration of the model components clearly recorded in the model documentation	Yes, these are clearly documented
MB2	Are there any identifiable issues apparent in the base data that will impact model results?	Yes, there a number of issues with different gauges which have been examined and catered for where possible. Overall this has led to a model that is suitable for use for flows of 100ML/d and above.
MB3	Was an appropriate routing method used? If the routing	Yes, routing was properly incorporated into the model.

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	guidelines have not been used, has this been adequately justified?	
<b>Channel Representation in Model</b>		
MB4	Does the model geometry provide an appropriate representation of the various channels?	Yes, the channels and reaches are appropriately established for the different reach configurations.
MB5	Are losses adequately documented in the report?	Yes, see above
<b>Model Losses</b>		
MB6	How were losses assigned within the model? Was this an appropriate method?	Losses were assigned according to relationships developed on a reach-by-reach basis. These were appropriately configured and tested. It should be noted that losses are in effect a calibration parameter that can be used to assist in improving overall calibration results. Whether these are real losses or just those needed to achieve reasonable calibration is not always obvious.
<b>Hydrological Model</b>		
MB7	Are the required watercourses represented?	Yes, including tributaries, headwaters, offtakes and irrigation channels
MB8	Have appropriate parameters been applied to the various sub-catchments	Yes, the parameterisations noted in the report are those within the model.
<b>Initial Conditions</b>		
MB10	How have the Initial Conditions or warm-up period been derived and are they appropriate?	Warm up is not documented within the report.
<b>Structures</b>		
MB11	Have structures been adequately represented? Is the representation of the infrastructure and the associated operational philosophy of various scenarios modelled in sufficient detail to achieve hydrologic objectives?	Yes, the critical structures appear to have been properly represented. Noting that this is a very complex system, ongoing assessment and improvement of the model is recommended where data around specific infrastructure items is limited.
MB12	Are you able to determine which structures have been included and excluded from the model? Are exclusions suitably justified?	No, not explicitly.
MB13	Can you determine how structures have been	Yes, the structures appear to have been properly established.

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	represented in the model? Is the method of structure representation justified?	
MB14	Have the appropriate operation rules been incorporated into the model?	Yes, these have been incorporated and robustly examined.
<b>Climate Change (if required)</b>		
MB15	How was climate change incorporated in the modelling?	NA
MB16	Has a suitable method been applied to define the climate change scenarios?	NA
<b>Action Advised:</b>		
	<i>The above comments should be read in conjunction with the detailed comments within the report. It is noted that there are no critical issues identified, and that the model should be sufficient for its intended use, with the comments and items noted for improvements where required, both in terms of the model and the documentation.</i>	

<b>MODEL OUTPUTS</b>		
	<b>Item Reviewed</b>	<b>Comments</b>
<b>Model Runs and Stability</b>		
MO1	Are there any warnings or checks that would indicate problems with the model? Have any warnings or errors produced by the model been confirmed as non-significant?	Yes, the model operated successfully
<b>Model Outputs</b>		
MO3	Are there any changes in flows at unexpected locations?	No, the model runs appeared to produce outputs consistent with the report. Several gauges were checked, and the results were reproducible with those in the report.
MO4	Do the model outputs seem sensible?	The model outputs appear to be consistent with that documented in the model build report.
<b>Sensitivity (if required)</b>		
MO5	Has sensitivity testing been completed and reported for key uncertainties?	No.

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MO6	Are the results of the sensitivity analysis reasonable?	N/A
MO7	Are there any regions/nodes where there are significant changes in flow during sensitivity testing? Has any reasoning for these variations been documented?	N/A
<b>Calibration</b>		
MO8	Have model outputs been provided for a representative calibration period? Is the selected calibration period appropriate? (e.g. does it include appropriate wet/dry periods, high flow, regulated flows, etc, given the objectives of the model)	Yes, we examined the calibrated model, and the results appear consistent with what was reported in the model build report.
MO9	Is the calibration approach clearly documented and is it appropriate? (e.g. choice optimisation algorithm, objective functions, overall workflow)	Yes, though it should be noted that the verification process is relatively arbitrary as the full period of data available has been used for calibration therefore it was not possible to conduct a verification or validation process.
MO10	Have checks been made against recorded storage level, allocations and flows? Have any significant differences been investigated and explained?	Yes, all satisfactory
MO11	Has the performance of the model been verified with appropriate flow components (wet/dry periods, high flow, regulated flows, cease-to-flow, etc.)?	Yes, noting that low flows are not well represented.
<b>Reporting</b>		
MO12	Does the model reporting adequately meet the requirements of the modelling objectives?	Yes
MO13	Have any model limitations/assumptions been reported? Are these	Yes

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	limitations/assumptions reasonable?	
<b>Action Advised:</b>		
	<i>The above comments should be read in conjunction with the detailed comments within the report. It is noted that there are no critical issues identified, and that the model should be sufficient for its intended use, with the comments and items noted for improvements where required, both in terms of the model and the documentation.</i>	

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## ADDITIONAL COMMENTS

(If required)

Please see those annotated within the Model Build Report.

## ADDITIONAL INFORMATION - FIGURES

Use this section for figures, referenced to the Item Number