SDL Adjustment Ecological Elements Method Development Report

Review of Final Project Report

by the Independent Review Panel

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1. PREAMBLE

1.1 The Sustainable Diversion Limits (Adjustment) - Ecological Elements method ('SDL-EE method') has been developed by a highly capable scientific team (the 'project team') comprised of staff from CSIRO, other leading Australian scientific organisations and consultants. Each member of the project team is an experienced freshwater scientist, of good standing and regard within the Australian freshwater science community.

1.2 Key steps and inputs to the method, determined partly through a previous scientific advisory process, were specified a priori in Schedule 6 (esp. S6.05) of the Basin Plan. Further, the ease by which the MDBA and jurisdictions could practically and routinely apply the method outside the research environment of CSIRO and universities was identified by them as a critical project need. The Independent Review Panel (IRP) also provided early advice to the project team that the final SDL method must avoid unnecessary scientific complexity, wherever possible.

1.3 The IRP was convened by the MDBA and its work guided by Terms of Reference, as follows:

"Consistent with the requirements of the Basin Plan, the independent review will review the ecological elements to ensure they are science based and fit for purpose. To be fit for purpose, the ecological elements must:

i. effectively represent environmental outcomes from environmental flow delivery (including works and measures) to ensure that potential SDL adjustments will provide equivalent or improved environmental outcomes when compared with those to be achieved under benchmark operating conditions with a 2750 GL/y reduction in diversions;

ii. be compatible with the methods used by the MDBA to determine the environmentally sustainable level of take, as required by Schedule 6 of the Basin Plan;

iii. be compatible with modelling and assessment tools such that they can practically be used to determine potential SDL adjustments;

iv. be compatible with aggregated assessment of notified supply measures as a package that takes into account interaction between individual supply measures as a primary purpose. As a secondary, highly desirable purpose be compatible with assessment of individual supply measures; and

v. be compatible with the limitations of knowledge, data and the timeframe in which the SDL adjustment method will be applied.

Basin jurisdictions will be provided with an opportunity to review and provide comments on the two key documents identified above. The independent review panel will consider and assess these comments as a part of its review process."

1.4 Consistent with these terms of reference, the IRP has provided written scientific review and recommendations on the developing SDL-EE method at appropriate stages during the project period. The IRP's review process included a number of meetings with the project team and representatives of the MDBA and jurisdictions (this and more details of the IRP's role is outlined in Appendix C).

1.5 This, the IRP's final report, includes our review of the SDL-EE Method Final Report[1] and, where relevant, restates interim review advice provided earlier in the project period.

2. KEY FINDINGS ON THE SDL-EE METHOD

Noting recommendations for further work set out in sections 3 and 4 following, the IRP considers the final SDL-EE method to be:

2.1 Scientifically robust and defensible

Development of the SDL-EE method has been informed by sound scientific rationale, analysis and critique, and it is founded on an appropriate mix of published scientific literature and expert judgement. The existing knowledge base has appropriately informed the choice of ecological elements, and the scientific evidence supporting the ecological 'preference curves' is well documented, particularly for vegetation and waterbirds. Limited testing to date has not revealed any significant scientific shortcomings of the method, though further testing is recommended in section 3.

2.2 Sufficiently sensitive

Testing in two reaches by the project team shows that the method's sensitivity (ability to assess change) is commensurate with the scale of the SDL adjustments being proposed (5% maximum change to SDL), and also sensitive to the nature of the ecological inputs used (especially ecological preference curves).

Based on the testing described in the final report, the IRP believes that the method is sufficiently sensitive for the intended SDL-adjustment purpose. Notwithstanding, in future application of the method, a cautionary approach to assuming confidence in the precision of the method is advised.

2.3 Practically applicable by the MDBA and jurisdictions

There are no reasonable grounds to conclude that the SDL-EE method will be too complex, too time consuming or too resource intensive to be routinely implemented by the MDBA or jurisdictions.

The IRP notes that there are a large number of input parameters in the SDL-EE method. But once fully set-up in the method, as is now the case, these inputs do not have to be re-set or re-entered for routine use. In addition, the IRP understands that the ease of application of the SDL-EE method has been substantially improved through a computerised work-flow framework, and will be further enhanced by automation of the hydrological 'pick-a-box' method used by the MDBA for selecting environmental flows options.

[1] Overton IC, Pollino CA, Roberts J, Reid JRW, Bond NR, McGinness HM, Gawne B, Stratford DS, Merrin LE, Barma D, Cuddy SM, Nielsen DL, Smith T, Henderson BL, Baldwin DS, Chiu GS and Doody TM. (March 2014) Development of the Murray-Darling Basin Plan SDL Adjustment Ecological Elements Method. Report prepared for the Murray-Darling Basin Authority. CSIRO, Canberra. 161 pp.

2.4 Compatible with the Basin Plan ESLT assessment

Whilst some differences are noted, it is the IRP's judgment that the final SDL-EE method is fully compatible with the ESLT approach used in developing the Basin Plan.

The key refinement on the ESLT approach is that the SDL-EE method responds to short- and long-term sequences of annual river flows in the historic record, rather than to a single event (the longest dry spell). This better reflects current knowledge of ecological responses to annual flow history, and is a significant improvement on the ESLT approach, while still being compatible with it. The use of a continuous scoring sequence has also been demonstrated by the CSIRO team to increase the method's sensitivity – a key requirement for the SDL-EE method already noted. The IRP strongly endorses this particular aspect of the method as contributing to confidence in the assessment results and also the sensitivity of the method for evaluating 'equivalence' under SDL adjustment and supply scenarios.

2.5 Transparency of method

The capacity for reporting the full provenance of aggregated regional scores at each stage of the SDL-EE method, and the ability of the method to be 'unpacked' for individual reaches and/or ecological elements, is well demonstrated in the two trial reaches. This is a strength of the SDL-EE method. Without such functionality, individual ecological outcomes at the site or reach scale, which may be negative as well as positive, could be obscured.

2.6 Overall scientific 'fitness-for-purpose'

It is the judgement of the IRP that the SDL-EE method, as presented in the project final report, complies with the review objectives set out in the IRP's terms of reference (Sec. 1.3). In summary, these objectives ensure the SDL-EE method (is):

- Effectively represents equivalent ecological outcomes of supply measures
- Compatible with the Basin Plan ESLT assessment approach
- Practically applicable by MDBA and jurisdictions
- Sufficiently sensitive and discriminatory
- Appropriately informed by available scientific knowledge and practice

The IRP considers the SDL-EE method to be **scientifically fit for the SDL-adjustment purpose** intended under schedule 6 of the Basin Plan, subject to the completion of further testing by the MDBA, as described in Section 3 below.

Nevertheless, in reaching this judgement, the IRP recognises that the method is also novel and untried. Hence, there are significant ecological and management risks involved in its application. Some possible scientific actions to mitigate these risks are described in section 4 following. The IRP recommends that these scientific risk mitigation actions should be fully considered as part of the next phase of work by the MDBA and jurisdictions.

3. FURTHER TESTING

The SDL-EE method described in the final report can be reasonably described as 'complete, but not properly road-tested'. It is a new method, ready for trial and use, but it will nevertheless benefit from further testing, review and refinement. The IRP emphasises that a rigorously designed testing protocol must be part of on-going project risk management and an adaptive management approach to the next phase of SDL-adjustment implementation. Initial testing of the Ecological Elements method as described in the project final report has not revealed any major shortcomings. But, the IRP strongly recommends that further testing as outlined below should be carried out to enhance confidence that the method is performing adequately during implementation of the SDL adjustment process.

3.1 Aggregation of reach to regional scores

Testing of the SDL-EE method at regional scale (viz. for the nine identified reaches of the southern MDB), as required under the Basin Plan (S6.06), has not yet been possible. Whilst no major anomalies or problems are foreseen, there remain risks that particular ecological elements or reaches may have a disproportionate influence (or under influence) on the total regional score. Performance of the method at the regional scale needs to be carefully tested and considered during the implementation phase of the SDL adjustment project.

3.2 Consistency with scientific expectations

The SDL adjustment process and consequently the SDL-EE method is without precedent in Australia, or indeed elsewhere. The approach thus requires concerted and continuous assessment to ensure it passes the scientific 'common sense test' at each stage of further development, testing and implementation. By scientific common-sense, the IRP is posing the question "Does the SDL-EE method give results for individual ecological elements (types of bird, fish and vegetation) that would seem reasonable to another, appropriately qualified scientist?"

It is not possible to fully answer this question at the present time, as only limited testing has been undertaken for the final report. During the next phase of testing and implementation, a more extensive and systematic effort to verify results against expected ecological outcomes would be beneficial. Such testing would provide a stronger scientific basis to assess the performance of the method for individual ecological classes and elements - this applies to overall and component scores for individual reaches, works areas, ecological elements and SFIs.

3.3 Sensitivity to initial conditions

The SDL-EE method provides an annual time-series of scores where results for a given year reflect scores from previous years with some incremental change. In the first year of record, the score must be set at an initial value (lacking any history on which to base the score). It is possible that 'future' scores are (inappropriately) sensitive to this initial condition, noting that ideally the test of equivalence should not be sensitive to an arbitrary choice of initial condition. A procedure for properly testing the effect of initial conditions is required to ensure the method is not overly affected by this decision.

3.4 Representation of floodplain and wetland ponding

Long duration inundation events are required for successful waterbird breeding and this is normally achieved by ponding water within wetlands when commence to flow levels are exceeded. Any loss of long-duration ponding in these areas, with an increased SDL, should be reflected in a commensurate reduction in the score for the relevant ecological elements. Unfortunately, current hydrological modelling of 'natural' wetland ponding is limited to a few larger wetlands in the southern MDB. Further investigation is required to assess whether there is a loss in ponding of water outside of works areas with SDL adjustments, and the significance of such losses relative to gains in ponding as a result of works-based supply measures. If these losses are significant then the hydrological modelling capability to integrate this effect into the SDL-EE method will be needed for the method to correctly assess ecological equivalence. Preliminary analysis of wetland commence-to-fill levels along the Murray River relative to SFI thresholds (provided by the MDBA) supports the need for further investigation of this issue during method implementation.

4. FUTURE REFINEMENTS

It would be dangerous to assume or to insist that the SDL-EE method set out in the final report is not improved in any way, prior to its final application for SDL-adjustment purposes. Evidence-based refinements to input parameters of this type should be encouraged and should not be considered as 'changes to the method'. For example, knowledge of how target species respond to the artificial flooding events and hydrological regimes provided by engineering infrastructure (or other human interventions) could inform risk-based adjustments to preference curves in the SDL-EE method. Nevertheless, there should be independent scientific review of any proposed input changes, before they are implemented.

A non-exhaustive list of possible refinements to the current SDL-EE method recommended by the IRP is presented below.

4.1 Ecological significance weighting

It is recognised that the current ecological elements (EE's) represent a simplified sub-set of ecological outcomes for birds, fish and vegetation, restricted by available scientific knowledge and consistent data across the southern basin. The relationship between hydrology and the ecology of an increasing range of taxa is currently a very active area of research. Some of these relationships (e.g. migration and dispersal of native fish – of which there is already a good deal known – and carbon dynamics between floodplain and channel) may be highly sensitive to the mode of delivery of environmental water, and some (and again fish migration may be an example) may operate only at spatial scales larger than 'site' or 'reach'. The IRP recognises that the current level of development of the method is sufficient for application, in an adaptive framework, to all nine of the southern basin reaches. It does suggest, however, that a watching brief be maintained on current research during the implementation phase, for new knowledge that might help to refine EEs, and preference curves.

At the other end of the spatial scale are species of restricted spatial distribution -which includes rare species. Despite the enhanced value of rare species (ecological and/or social) their presence does not influence the estimation of SFIs. This is because there is no commonly accepted means of accounting for such species across large spatial scales or for determining a relative value amongst

various rare species. There is little doubt that the SDL-EE method would be improved by the inclusion of such biota as Moira grass and listed species of floodplain fish, and there are other reasons for wishing to value some sites more highly than others. However, at this stage, there appears to be no generally accepted method for establishing equivalence amongst such sites across the Basin and, at this point, spatial extent remains the only ecological significance weighting factor available across all reaches and jurisdictions.

The added value of a 'universal' scheme for representing relative conservation value amongst sites is recognised and the IRP would encourage efforts by the MDBA and jurisdictions towards developing a broadly applicable scheme for ecological significance weighting during the implementation phase, when the application of the method to nine reaches may provide a more comprehensive basis to test such weighting.

4.2 Learning from The Living Murray

In 2005 the Living Murray (TLM) Business Plan was activated as a collaborative arrangement between the Australian and relevant State Governments aimed at providing an average of 500 GL environmental water per year and developing a program of works, both aimed at providing ecological benefits at six 'icon' sites along the River Murray. This was Stage 1 of TLM and constituted an international first in large-scale experimental investigation of the management of environmental flows, including the use of infrastructure to enhance (and later to substitute for) environmental releases. No doubt learnings from TLM have informed the development of the method in a variety of informal ways, but perhaps a more formal assessment of TLM outcomes might have strengthened some assumptions regarding the form of delivery of water and provided guidance for further targeted investigation during the application phase. Any upcoming analyses of TLM outcomes should be formally assessed for potential contribution of knowledge to the SDL-EE method.

4.3 Adaptive management

The IRP is aware that the SDL adjustment arising from the 'supply contribution' will be assessed only once by application of the method in 2016, and that after this there is no legislative or administrative provision for the SDL adjustment to be revised. Notwithstanding this, the IRP notes that using works and measures to adjust the SDL represents a large-scale experimental manipulation of a river system, which has never been trialled before. Nesting the supply measures within an adaptive management framework - hypothesis testing, monitoring, review and refinement - will enable effective implementation and adaptation of supply measures to be developed and, subsequently to ensure that the 'equivalent environmental outcomes' required under the Basin Plan are achieved.

Two major groups of threats pose a risk to achieving the 'equivalent environmental outcomes' intended from the Basin Plan, and hence to the meaningful application of the SDL-EE method. The first is intervention failure. These occur when the outcome predicted on the basis of the assumptions linking flow regime (natural or managed) to ecological response, as embedded in the SDL-EE method, do not occur. Intervention failures could occur when the management action is based on an incorrect flow/ecology concept (incorrect hypothesis), or when the hypothesis is correct but other factors intervene to prevent the planned outcome (e.g. limiting factors, competition from other species).

The second group of threats derive from the fact that the project is dealing with a complex system which may produce negative collateral outcomes in parallel with the desired ecological results; for example, black-water events, algal blooms or mosquito plagues resulting from a watering event designed to deliver water for the maintenance of floodplain vegetation. A risk assessment at the application phase and a targeted monitoring program are necessary to identify and manage these risks appropriately.

5. APPENDIX A. KNOWLEDGE GAPS

Although formally not a requirement under its terms of reference, the IRP offers some thoughts on knowledge gaps around future adoption of works and measures, and the necessary SDL-adjustment.

At the current transitional point in the overall SDL adjustments project – i.e. the completion of the SDL-EE method development and the commencement of the implementation phase – it would be useful to have a clear assessment of shortfalls in current knowledge that present a threat to the successful application of the method in the future. As already noted, this would be particularly valuable in refining an adaptive management framework (learning by doing) for the application phase and should concentrate on developing hypotheses aimed at broader understanding of flow/ecology relationships. Knowledge gaps (questions to be resolved during the application phase) could be further distilled through a workshop similar to the one of January 2014, or, perhaps more directly, by a formal risk assessment to identify threats to the success of the program that require more knowledge for successful management.

Of particular significance is the limited testing of structurally assisted flooding as a successful river restoration strategy as distinct from merely 'irrigating' components of the floodplain. To our knowledge, a formalised evaluation of the marginal environmental costs and benefits arising from of structural and operational measures to improve the effectiveness of environmental flow delivery, as proposed in schedule 6 of the Basin Plan, has never been attempted anywhere in the world. Hence, the SDL adjustment process described in the Basin Plan is policy operating in 'unchartered waters' from both a scientific and management perspective. No one should assume that adoption of the SDL-EE method is without significant uncertainty or risk.

As a consequence, there is little understanding of the performance of structurally-assisted environmental flooding. In particular, the effect on more complex processes such as interchange of propagules, biota, nutrients and carbon between the floodplain and main channel, and the triggering and support of native fish migration and dispersal are inadequately understood to allow them to be included in the SDL-EE method. In many cases these are the processes in which the range of supply measures under evaluation might be expected to perform less well (to varying extents) than overbank flows, causing the equivalence of supply measures to be over-estimated. Whilst the report indicates that this cannot currently be redressed, it is a risk that needs to be addressed as part of the application phase of the method both in terms of monitoring programs and targeted research.

6. APPENDIX B. OTHER APPLICATIONS OF THE SDL-EE METHOD

The SDL-EE method was developed for the specific purpose set out in the Basin Plan, of assessing environmental equivalence at regional scales subject to supply contributions and SDL adjustments. Without further context-specific scientific review and development, the IRP would not endorse the use of this method for other management purposes.

7. APPENDIX C. ROLE OF INDEPENDENT REVIEW PANEL

Schedule 6 of the Basin Plan sets out the default method by which the contribution of "supply measures" is calculated for adjustment of the Sustainable Diversion Limit (SDL). Supply measures are operational or structural measures intended to achieve the same ecological outcome with less environmental water. The MDBA has commissioned a project to develop the ecological elements of the scoring method for assessing environmental outcomes from supply measures. The project is known as the SDL Adjustment Ecological Elements Development Project (SDL-EE project). It is a requirement of the Basin Plan that this method is science-based, independently-reviewed and fit-for-purpose. Consequently, an Independent Review Panel (IRP) was established the Murray Darling Basin Authority to review the SDL-EE method.

Consistent with its terms of reference (Sec. 1.3) the IRP has independently reviewed the ecological elements method as it has developed providing comments at six stages in the project including this review of the final report (Table 1). The IRP has also received comments from the basin jurisdictions at several stages through the project and considered these comments as a part of its review process. These comments have been discussed with jurisdictions via phone conference at several of the IRP workshops and at a face-to-face workshop on the 23rd of January 2014, chaired by the IRP with the participation of MDBA and SDL-AEEDP project team (Table 1). A total of five reviews have been provided in consolidated form including this review. Given this review deals with the final report from the SDL-AEEDP, it summarises the resolution of key issues identified by the IRP in its previous reviews.

Table 1: Stages of IRP Review

Review Stage	IRP Workshop	SDL-AEEDP Report Provided to IRP	Jurisdictional Comments	IRP Review Report Date
Stage 1: Approach to developing the method and a project plan	8-9 July 2013	'SDL Adjustment Ecological Elements Stage 1 Development Methodology Report' (21 June 2013)	Provided in writing and discussed with IRP by phone conference	11 July 2014
Stage 1: Approach to developing the method and a project plan	28-29 August 2013	'SDL Adjustment Ecological Elements Method – Stage 1 Report' (21 August 2013)	Provided in writing and discussed with IRP by phone conference	2 September 2013
Stage 1: Approach to developing the method and a project plan	Out of session	'SDL Adjustment Ecological Elements Project Regional Workshop – Pre-Meeting Notes'(17 October 2013)	None	Individual feedback by IRP members
Stage 2: Development, demonstration and evaluation of the method	19 November 2013	'SDL Adjustment Ecological Elements Project Regional Workshop – Post Meeting Notes – Preference Curves and Rules-Based Combinations' (5 November 2013) and 'SDL Adjustment Ecological Elements Development Project Summary of Method and Demonstration Results' (12 November 2013)	Provided in writing	Undated notes provided 25 November 2013
Stage 2: Development, demonstration and evaluation of the method	23-24 January 2014	'SDL Adjustment Ecological Elements Method – Final Report' (29 November 2013)	Provided in writing and discussed in person at the workshop	30 January 2014
Stage 2: Development, demonstration and evaluation of the method	18 March 2014 and follow up discussion on 25 March 2014	'Development of the Murray-Darling Basin Plan SDL Adjustment Ecological Elements Method' (14 March 2014) and CSIRO 'SDL Adjustment Project – Response to IRP Review Comments' (14 March 2014)	Provided in writing	This report