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## **SUBMISSION**

# **INDEPENDENT REVIEW OF NSW FLOODPLAIN HARVESTING POLICY IMPLEMENTATION**

## **Draft Report**

May 2019



## Introduction

The NSW Irrigators' Council (NSWIC) is the peak body representing irrigation farmers and the irrigation farming industry in NSW. Our Members include valley water user associations, food and fibre groups, irrigation corporations and commodity groups from the rice, cotton, dairy and horticultural industries. Through our members, NSWIC represents over 12,000 water access licence holders in NSW who access regulated, unregulated and groundwater systems.

NSWIC engages in advocacy and policy development on behalf of the irrigation farming sector. As an apolitical entity, the Council provides advice to all stakeholders and decision makers.

Irrigation farmers are stewards of tremendous local, operational and practical knowledge in water management. With over 12,000 irrigation farmers in NSW, there is a wealth of knowledge available. To best utilise this knowledge requires participatory decision making and extensive consultation to ensure this knowledge can be incorporated into best-practice, evidence-based policy. NSWIC and our Members are a valuable way for Governments and agencies to access this knowledge.

NSWIC welcomes this public exhibition as an opportunity to share local, practical and operational knowledge and expertise in water management. NSWIC offers the expertise from our network of irrigation farmers and organisations on an ongoing basis to ensure water management is practical, community-minded and follows participatory process.

This submission represents the views of the Members of NSWIC with respect to the Draft Report of the *Independent Review of NSW Floodplain Harvesting Policy Implementation* (the Draft Report). Each member reserves the right to independent policy on issues that directly relate to their areas of operation, expertise or any other issues that they deem relevant.



## NSW Irrigators' Council's Guiding Principles

Integrity	Leadership	Evidence	Collaboration
Environmental health and sustainable resource access is integral to a successful irrigation industry.	Irrigation farmers in NSW and Australia are world leaders in water-efficient production with high ethical and environmental standards.	Evidence-based policy is essential. Research must be on-going, and include review mechanisms, to ensure the best-available data can inform best-practice policy through adaptive processes.	Irrigation farmers are stewards of tremendous knowledge in water management, and extensive consultation is needed to utilise this knowledge.
Water property rights (including accessibility, reliability and their fundamental characteristics) must be protected regardless of ownership.	Developing leadership will strengthen the sector and ensure competitiveness globally.	Innovation is fostered through research and development.	Government and industry must work together to ensure communication is informative, timely, and accessible.
Certainty and stability is fundamental for all water users.	Industry has zero tolerance for water theft.	Decision-making must ensure no negative unmitigated third-party impacts, including understanding cumulative and socio-economic impacts.	Irrigation farmers respect the prioritisation of water in the allocation framework.
All water (agricultural, environmental, cultural and industrial) must be measured, and used efficiently and effectively.			Collaboration with indigenous nations improves water management.



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## Overview

NSWIC welcomes the draft report, and the independent review process to ensure that Floodplain Harvesting (FPH) Policy is accurate, appropriate and fosters public confidence. This submission contains recommendations to ensure that the Final Report is most effective to realise these objectives.

There are 7 key areas addressed within this submission:

- i. Calibration Period
- ii. Rainfall Runoff
- iii. Downstream Impacts
- iv. Return Flows
- v. Communication with water users
- vi. Regulated & Unregulated water sources
- vii. Modelling

NSWIC is supportive of the need to licence floodplain harvesting activities and to issue the appropriate water access licences to bring a recognised and accepted existing practice (*Water Act 1912*) into line with the newer requirements of the *Water Management Act 2000*.

## Background

The Department of Industry requested that the modelling and implementation of the NSW Floodplain Harvesting Policy (the Policy) be independently reviewed.

The Policy is about a volumetric conversion to allow the transition of the regulation of floodwater take from the *Water Act 1912* (descriptive regulation) to the requirements of the *Water Management Act 2000* (volumetric regulation).

The most fundamental aspect of any FPH Policy is that it must give confidence to both water users and the community.



## List of NSWIC Key Recommendations

**Recommendation 1:** That the Independent Reviewers recommend to Government a calibration period to ensure that the modelling accurately reflects what is actually occurring, and that both water users and the public can have confidence in the modelling.

**Recommendation 2:** That the Independent Reviewers include in the final report further assessment of the ability of the model to provide farm level entitlement data with the current model limitations.

**Recommendation 3:** That the Independent Reviewers – in identifying the lack of justification of the model’s representation of rainfall runoff – recommend to Government the need to action more accurate modelling and investigate alternative options for regulating/accounting for this water.

**Recommendation 4:** At the minimum, the definition of rainfall runoff as take should be clarified as the natural conditions level.

**Recommendation 5:** That since the Independent Reviewers have identified the Department did not provided the required level of detail to assess how rainfall runoff has been included in the models – the reviewers should complete and expand their assessment to comment on the way in which rainfall runoff is included in the model and if this is fit for purpose.

**Recommendation 6:** That the Independent Reviewers include in the final report a recommendation that future modelling must be able to identify the impacts on downstream flows, as fundamental to the purpose and effective implementation of the FPH Policy. Government must be able to identify proposed means to fill this knowledge gap.

**Recommendation 7:** That the Independent Reviewers include a firm recommendation in the final report that return flows must be incorporated into the modelling for it to be accurately reflective.

**Recommendation 8:** That the Independent Reviewers continue to emphasise the need for improved engagement with water users in the final report, and further include a recommendation that communication of farm parameters to landholders must occur prior to model finalisation to contribute to draft entitlement being issued. The Independent Reviewers should include a recommendation that communication must extend beyond water users who undertake floodplain harvesting, and include other water users and communities to ensure the public are informed (critical for social licence).

**Recommendation 9:** That the Independent Reviewers provide clarification for properties with multiple sources of water, including both regulated FPH and unregulated water sources.



## Submission

### Calibration period to verify modelling of volumetric licences

There is a fundamental need for quality data to inform the volumetric conversion of FPH. Further data with greater certainty of the accuracy is required to give confidence to water users and communities. However, also important is the need not to stall the regulatory transition of FPH to be aligned with the regulatory requirements of the *Water Management Act 2000*. For that reason, NSWIC recommends a flexibility mechanism which allows adjustments to the volumetric number to be made as higher quality data and model calibration is made possible, to ensure the modelling is accurate and ground-truthed.

A calibration period is needed to verify that the modelled volumetric licences are an accurate indication of current FPH volumes. NSWIC recommends that a calibration period should be included as a *specific recommendation* of the final report, to address a number of the issues raised by the Independent Reviewers in the draft report and ensure quality data.

The aim of this calibration period would be to:

- i. Improve confidence and trust in the model; and,
- ii. Ensure that the outcomes produced are robust and accurately reflect what is actually occurring.

The calibration period may take the form of a sunset clause, flexibility/adjustment mechanism, or formalised review / adaptive process to continue to allow for improvements based on verification/validation after major floodplain harvesting events occur.

### **Reasoning**

The draft report notes the absence of measured data for validation as a particular difficulty when trying to develop numerical model estimates.<sup>1</sup> The purpose of the proposed calibration period would be to fill these data gaps.

NSWIC thus strongly supports statements from the draft report that:

*“there needs to be cross verification of the final parameters adopted with the individual enterprises simulated to ensure they are an adequate reflection of what is actually occurring”<sup>2</sup>.*

*“Some verification or validation of the final OBF and FPH values needs to occur, ideally in collaboration with water users.”<sup>3</sup>*

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<sup>1</sup> T Weber & G Claydon, “Independent Review Of NSW Floodplain Harvesting Policy Implementation”, *Draft Report for Consultation* (Alluvium, 08 April 2019) [36].

<sup>2</sup> Ibid [45].

<sup>3</sup> Ibid [71].



*“a method of validation that has some direct link to actual OBF volumes rather than a result by difference would provide further confidence... a separate validation process would provide greater confidence in the results obtained”<sup>4</sup>*

The draft report highlights that, had this calibration period taken place five years ago, extremely useful data and information to assist model calibration and verification would now be available.

*“It is instructive with the benefit of hindsight, that had agreement been reached to take action to measure and monitor floodplain diversions, even when the Policy was first published in May, 2013, we could now have up to five years of extremely helpful data and information to assist model calibration and verification and the determination of volumetric licences.”<sup>5</sup>*

There still remains a need for this calibration period to occur before finalisation to ensure that the determination of volumetric licences is an accurate indication of current FPH volumes. There is significant risk to irrigation farmers and their business, as well as to public confidence in governance of water resources, if the model produces an inaccurate volume.

NSWIC has previously raised the need for a calibration period to verify/validate data in the submission to the *FPH Monitoring & Auditing Strategy*.

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***Recommendation 1: That the Independent Reviewers recommend to Government a calibration period to ensure that the modelling accurately reflects what is actually occurring, and that both water users and the public can have confidence in the modelling.***

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### ***Individual farm level entitlements***

The draft report also does not fully address the ability of the model to determine individual farm level entitlements. Whilst section 4.7 addresses the appropriateness of the data, information and assumptions used to validate on-farm water balances - further work is needed to understand on-farm entitlements, including the physical limitations of farm infrastructure to use water, and crop water usage. The Independent Reviewers must request that Government conduct further research to understand on-farm water entitlements.

Furthermore, the Independent Reviewers find that when the simulated on and off allocation diversions were compared to recorded data for the extraction location/s associated with each property, that the overall result was -3%. It must be acknowledged that this 3% is a significant change in terms of licence outcomes, particularly if on-ground limitations (e.g. physical capacity for farm infrastructure to use water) are ignored. The final report should include identification of risks in the model's capacity to determine individual farm entitlements.

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<sup>4</sup> Ibid. [58].

<sup>5</sup> Ibid) [35].



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***Recommendation 2:*** *That the Independent Reviewers include in the final report further assessment of the ability of the model to provide farm level entitlement data with the current model limitations.*

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## Rainfall Runoff

Rainfall Runoff is relevant to the peer-review and should not fully be included in FPH licences.

**NSWIC maintains the position repeatedly advocated for by water users, that it is inappropriate, impractical and illogical to include rainfall runoff in FPH licencing.**

It has become apparent since the release of the draft *FPH Monitoring & Auditing Strategy*, that the inclusion of rainfall runoff evidently complicated monitoring and compliance rather than simplifying it. NSWIC encourages the Independent Reviewers to review the NSWIC as well as the Northern Valleys Irrigators Groups submissions on the draft FPH Monitoring & Auditing Strategy to understand the implications and complexities caused by including rainfall runoff.

### Licencing Rainfall Runoff

For irrigation farmers, the preferred option is removing rainfall runoff from FPH licencing in entirety (Option A). However, should the current policy decision persist, which does include rainfall runoff, then at the very least the definition of rainfall runoff as *take* should be clarified as the natural conditions level (Option B).

### **Option A – Exclusion of Rainfall Runoff**

Rainfall runoff is not a form of additional take.

A significant proportion of rainfall runoff is the result of farmers developing their farms in a way that maximises water efficiency, and thus creates ‘rainfall runoff’ as water can then be recycled and reused multiple times on the farm to maximise water efficiency.

Rainfall runoff is thus artificially created / recycled water. This does not involve additional take.

Given the difficulties with modelling rainfall runoff (as found in the draft report), and thus the difficulties in effectively implementing this policy with rainfall runoff included, other options to regulate/account for rainfall runoff are required.



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***Recommendation 3:** That the Independent Reviewers – in identifying the lack of justification of the model’s representation of rainfall runoff – recommend to Government the need to action more accurate modelling and investigate alternative options for regulating/accounting for this water.*

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### **Option B – Inclusion of Rainfall Runoff, with the definition clarified as at the natural conditions level**

Whilst not the ideal option, an improved method of regulating rainfall runoff would involve only the volume of rainfall under natural conditions (pre-development) be included on the FPH licence. The additional rainfall runoff (the result of water use efficiency developments), on top of this pre-development baseline amount should be considered/accounted for as tailwater return, and as a system loss. Including the post-development amount of rainfall runoff would disincentivise water use efficiency, risk the accuracy of the modelling, create equity issues between those on and off floodplains, and is widely criticised amongst irrigation farmers as being inappropriate and impractical.

Tahlee Consulting Services (TCS) have prepared a rainfall runoff model based on the KII Method for determining Rainfall Runoff developed by the US Department of Agriculture (see **Appendix 1** for further information on the KII Method). This model predicts runoff from daily rainfalls.

The results found by TCS show that the increase in runoff from irrigation development is significant across all valleys where the model has been run. A comparison of runoff days where more than 2mm/day runs off from the Namoi Pendennis gauge is shown in **Appendix 2**.

The pre-development levels of rainfall runoff have been modelled by TCS at:

- 0.2meg/ha Macquarie;
- 0.3meg/ha Namoi;
- 0.4meg/ha Gwydir.<sup>6</sup>

The additional rainfall runoff, on top of this pre-development baseline amount, is the result of water use efficiency developments that farmers have initiated to develop their land.

The Independent Reviewers should consult with water users to explore opportunities to best regulate and account for rainfall runoff in a sensible and practical manner. NSWIC offers to assist in coordinating consultation with water users.

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<sup>6</sup> The Independent Reviewers should consult with Tahlee Consulting Services (Agricultural Engineers) who have been working on the modelling of pre-development rainfall runoff.



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***Recommendation 4: At the minimum, the definition of rainfall runoff as take should be clarified as the natural conditions level.***

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#### **Inclusion of Rainfall Runoff within the scope of the Independent Assessment**

NSWIC firmly believes that rainfall runoff is within scope of this independent review (as a modelling complication and implementation risk).

The issue of rainfall runoff has previously been excluded from this review as it was deemed a ‘policy decision’ and thus outside the scope of this review (limited to modelling and implementation). However, now that it has been acknowledged in the draft report that the modelling of rainfall runoff is insufficient, which thus may lead to implementation failure, it now becomes highly relevant.

NSWIC strongly supports the draft recommendation that:

*“Significant further documentation and justification of the rainfall-runoff model used and the parameters chosen in each valley, soil type, and farm enterprise is required before the inclusion of the rainfall-runoff component within the models can be considered suitable or not.”<sup>7</sup>*

NSWIC strongly agrees that:

*“It is therefore difficult to determine how the current approach is calibrated or validated and without further evidence **it is a challenge to support the inclusion of rainfall-runoff volumes within the FPH take as currently modelled.**”<sup>8</sup>*

There is implementation risk of including rainfall runoff (as it currently stands) in the FPH model, as it will likely lead to a change in irrigator behaviour and remove the incentive for water efficient practices, and the unnecessary complexities reduces the accuracy.

In the final report, NSWIC strongly encourages the peer reviewers to give more detailed consideration to the inclusion of rainfall runoff within FPH licences, as this is now considered one of the largest risks of inaccurate modelling to reflect actual volumes of FPH, and thus implementation failure.

Given the findings in the draft report regarding rainfall runoff, the reviewers should recommend that the Government look to alternative means to regulate rainfall runoff due to implementation difficulty, modelling uncertainty, and the incredibly high risk to farmers, businesses, communities and government of getting this wrong.

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<sup>7</sup> T Weber & G Claydon, “Independent Review Of NSW Floodplain Harvesting Policy Implementation”, *Draft Report for Consultation* (Alluvium, 08 April 2019) [60].

<sup>8</sup> *Ibid* [60].



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**Recommendation 5:** *That since the Independent reviewers have identified the Department did not provided the required level of detail to assess how rainfall runoff has been included in the models – the reviewers should complete and expand their assessment to comment on the way in which rainfall runoff is included in the model and if this is fit for purpose.*

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## Downstream and further impacts

NSWIC is concerned of the impact of the finding that:

*“the models for the floodplain flows and the determination of floodplain harvesting volumes... cannot be used to specifically assess the impact of floodplain harvesting per se on specific downstream flows”<sup>9</sup>.*

*“The effect of this model configuration is that the simulation of downstream flows is insensitive to the volume of floodplain harvesting take”<sup>10</sup>.*

The reason for concern is that the general public wants to know the impact of FPH on downstream flows, which has been repeatedly expressed in recent media. There is a public perception that FPH has detrimental impacts on downstream flows, which risks the social licence for FPH. It is vital that governments, as well as the irrigation farming industry, are able to identify with confidence what the exact impact on downstream flows from FPH is in order to communicate with the public and maintain social licence to operate.

NSWIC thus strongly supports the statement from the Draft Report that:

*“Our concern therefore is that that if the implementation of the policy results in changes to FPH take... surely the downstream impacts of this need to be determined, otherwise how will it be determined whether this is an improvement or detriment for downstream users.”<sup>11</sup>*

NSWIC strongly recommend progressing discussions around sustainability, as a core principle, as it fits within the overall water management framework. Environmental health and sustainable resource access are core principles of NSWIC and our industry. Importantly for discussions on sustainability, is the need to have the volumetric conversion and licencing framework in place within the water management framework in the first instance, to inform discussion on how to understand and manage impacts. Without a volumetric understanding nor licencing framework to work with, discussion around sustainable resource use would be intangible and lacking in implementable detail.

Whilst NSWIC strongly recommends that this work is undertaken to understand the exact impacts of FPH, it must be understood that understanding these impacts is not the intent of this particular FPH policy, and this policy setting (volumetric conversion) must be put in place

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<sup>9</sup> Ibid [41].

<sup>10</sup> Ibid [42].

<sup>11</sup> Ibid [75].



in the first instance to inform discussions about water management. Simply, this research should occur as a complementary project (separately/subsequently) to ensure it does not stall the regulatory transition to bring the practice into alignment with the requirements of the *Water Management Act 2000* (provided there is flexibility to respond to any impacts through adaptive management should it be required following completion of further research). It should be remembered that the intention of the FPH Policy is not to limit FPH take, but for volumetric conversion of *existing levels of take*. A delay or stalling of the licencing process would have serious impacts across the entirety of the river systems.

This approach (to progress volumetric measurement and a licencing framework as the initial phase) would be consistent with previous conversion processes. For example, as documented in the *Report of the Independent Audit Group (IAG), (November 1996)*, “a cap on the volume of diversions associated with the 1993/94 levels of development was seen as an essential first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses”<sup>12</sup>. Further, “the IAG believes that once effective cap arrangements are in place, priority needs to be given to identifying more fully the environmental water requirements, including flow regimes”<sup>13</sup>. To be clear, NSWIC strongly agrees with the need to better understand the impacts of FPH across the entire river system, and strongly supports research in this regard going forward, but emphasises that this research is a complementary project (separate or secondary phase), as both water users and the environment would be better positioned for practical and tangible water management discussions once a volumetric conversion of the regulatory framework is determined.

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**Recommendation 6:** *That the Independent Reviewers include in the final report a recommendation that modelling must be able to identify the impacts on downstream flows, as fundamental to the purpose and effective implementation of the FPH Policy. Government must be able to identify proposed means to fill this knowledge gap.*

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## Return Flows

NSWIC is concerned with the finding that:

*“the models for the floodplain flows and the determination of floodplain harvesting volumes do not adequately represent return flows to the rivers”<sup>14</sup>*

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<sup>12</sup> *Report of the Independent Audit Group (IAG), (November 1996)*, referenced in NSW Submission on the Review of the Operation of the Cap (2000), available at:

<https://www.mdba.gov.au/sites/default/files/archived/cap/nsw.pdf>

<sup>13</sup> Ibid.

<sup>14</sup> T Weber & G Claydon, “Independent Review Of NSW Floodplain Harvesting Policy Implementation”, *Draft Report for Consultation* (Alluvium, 08 April 2019) [41].



And further:

*“Most of these simulated floodplain flow paths that have been incorporated into the models do not re-join the main river, and any water not harvested is “lost” to the river.”<sup>15</sup>*

Return flows are a significant component of the water balance, and thus, a very significant limitation of the model. This limitation of the modelling requires further development to better understand and account for return flows. This modelling limitation also further complicates the ability to determine the impacts on downstream flows, with the aforementioned risks (see above).

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***Recommendation 7: That the Independent Reviewers include a firm recommendation in the final report that return flows must be incorporated into the modelling for it to be accurately reflective.***

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## Communications with water users

NSWIC strongly agrees with the statement in the Draft Report that:

*“In general, there appears to be a reluctance to collaborate with landholders and it was noted in stakeholder discussions that the former collaborative approaches (e.g. Modelling Consultative Committee) used in developing the models is no longer undertaken.”<sup>16</sup>*

NSWIC strongly supports the emphasis in the draft report on the importance of communication and engagement with water users during the process to determine FPH licences, and believes it is vital that this emphasis is continued into the final report.

NSWIC thus strongly supports the statement in the Draft Report that:

*“Given the likely impact of these individual entitlements on the operations of a farm or enterprise, there needs to be a process by which the actual information used to represent that farm or enterprise, including the assumptions around water use and management, in addition to infrastructure information already covered by Water Infrastructure Plans, is communicated back to the land holder for transparency, procedural fairness, confirmation, verification where appropriate, and building of trust.”<sup>17</sup>*

The Independent Reviewers should further recommend that communication (of the farm parameters) back to the landholders must occur prior to the draft entitlement being issued, to ensure the adequacy of the entitlement to represent farm operations, and to ensure opportunity to resolve any discrepancies or grievances in the process of determination.

NSWIC notes that improved communication is needed on multiple fronts:

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<sup>15</sup> Ibid [42].

<sup>16</sup> Ibid [49].

<sup>17</sup> Ibid [4].



1. Communication with landholders on the model parameters for determining the draft entitlement at the individual farm level;
2. Communication more broadly regarding the Model Build reports, and the required evidence to justify and support the decision-making underpinning the modelling processes.

NSWIC also recommends that communication extends beyond those water users applying for a volumetric licence, but to the broader irrigation industry, and general public. There is significant public interest in this process, and greater communication is needed beyond just those directly involved.

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***Recommendation 8:*** *That the Independent Reviewers continue to emphasise the need for improved engagement with water users in the final report, and further include a recommendation that communication of farm parameters to landholders must occur prior to model finalisation to contribute to draft entitlement being issued. The Independent Reviewers should include a recommendation that communication must extend beyond water users who floodplain harvest, and include other water users and communities to ensure the public are informed (critical for social licence).*

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## Regulated and unregulated water sources

NSWIC understands that *“the process for determining share components for floodplain harvesting access licences in unregulated river water sources (except for the Barwon– Darling) will be different from that used in regulated water sources”*<sup>18</sup>.

According to the diagram showing the steps taken to calculate FPH entitlements for properties with eligible FPH works that are associated with unregulated river water and/or groundwater<sup>19</sup>, it appears that currently properties with multiple water sources (both regulated and unregulated) will be categorised as part of the unregulated cap. Clarification, and explanation of the appropriateness of this is sought from the Independent Reviewers.

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***Recommendation 9:*** *That the Independent Reviewers provide clarification for properties with multiple sources of water, including both regulated FPH and unregulated water sources.*

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<sup>18</sup> Ibid [26].

<sup>19</sup> Ibid [27].



## Modelling

### Model Build & Scenario Reports

NSWIC supports the draft recommendation that

*“as a matter of priority, the Model Build and Scenario reports for each valley should be completed by the Department and made publicly available”<sup>20</sup>.*

Clarification is sought around the stated need to ensure the farm level models are consistent with basin wide information. The farm level data was specifically modelled to be fit-for-purpose for individual farms. Adjustments to ensure consistency with basin-scale data risk skewing the accuracy of the modelling at the farm-scale. NSWIC believes that accuracy at the farm scale is crucially important, and accuracy should not be risked merely for consistency with high-level basin-scale data.

NSWIC recommends that the Independent Reviewers consult with water users on what should be included in the Model Build reports.

### IBQs

Documentation is required to demonstrate the reasoning for disregarding IBQs. The draft report indicates that this was due to inconsistency and data quality issues. NSWIC supports the draft recommendation that “the decision rules around when and why different data inputs are considered and used or rejected”<sup>21</sup> needs to be completed and made publicly available.

## Conclusion

NSWIC welcomes the Draft Report.

NSWIC strongly encourages the Independent Reviewers to give consideration to the issues and recommendations raised in this submission when preparing the final report.

NSWIC thanks the Independent Reviewers for their time in preparing the draft report and would welcome the opportunity to further engage with the Independent Reviewers in the development of the final report, as required.

Kind Regards,

NSW Irrigators’ Council.

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<sup>20</sup> Ibid [49].

<sup>21</sup> Ibid [49].



## Appendix 1: Tahlee Consulting Services – KII Method

Long-term runoff from a catchment can be estimated using the KII method developed by the US Department of Agriculture (USDA, 1971). The information provided here is generally taken from the Farm Water Supplies Design Manual Volume 1 (Horton and Jobling, 1992).

The KII method predicts runoff from daily rainfalls. Using historical rainfall data for an extended period, (say 100 years) the long-term runoff from a catchment can be estimated. The KII method relies on assigning the catchment a “KII index” that is based on soil type, vegetation, condition and land use. This is done using Table B-1 and Table B-2.

The hydrologic condition referred to in Table B-2 is the general condition of the catchment. “Poor Condition” refers to an overstocked, sparsely grassed, or sheet eroded catchment, which would yield more runoff than a “Good Catchment”, that is appropriately stocked and well grassed.

**Table B-1 General Classification of Soil Types for KII**

Soil Group	Description of Soil Characteristics
A	Soil having very low runoff potential. For Example, deep sands with very little silt or clay.
B	Light soils and or well-structured soils having above average infiltration when thoroughly wetted. For example, light sandy loams, silty loams.
C	Medium soils and shallow soils having below-average infiltration when thoroughly wetted. For example, clay loams.
D	Soils having high runoff potential. For example, heavy soils, particularly clays of high swelling capacity, and very shallow soils underlain by dense clay horizons.

**Table B-2 Catchment Index KII**

Land Use or Cover	Farming Treatment	Hydrologic Condition	Soil Group			
			A	B	C	D
Native Pasture or Grassland	-	Poor	68	79	86	89
		Fair	50	69	79	84
		Good	39	61	74	80
Timbered Areas	-	Poor	46	68	78	84
		Fair	36	60	70	76
		Good	26	52	62	69
Improved Permanent Pastures		Good	30	58	71	78
Rotation Pastures	Straight Row	Poor	66	77	85	89
		Good	58	72	81	85
	Contoured	Poor	64	75	83	85
		Good	55	69	78	83
Crops (Small, Grain)	Straight Row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
Fallow	Straight Row	-	77	86	91	94
Contoured Native Pastures	-	Poor	47	67	81	88
		Fair	25	59	75	83
		Good	6	35	70	79
Homestead Areas	-	-	59	74	82	86
Roads (Dirt, Hard Surfaced)	-	-	72	82	87	89
			74	84	90	92

Once the KII index is defined then KI and KIII indices can be defined. Using these indices with the rules and equations of the USDA model, the runoff for each day over the study period can be estimated.



## Appendix 2: Tahlee Consulting Services – Modelling Rainfall Runoff

Tahlee Consulting Services have prepared a rainfall runoff model based on the KII Method for determining Rainfall Runoff developed by the US Department of Agriculture. A description of the model is included as **Appendix 1**.

Results have been prepared based on a number of different rainfall data sets across a number of irrigation valleys.

The period of rainfall data analysed for each of the gauges is shown below:

BOM Station Number	Name	Valley	Location	Date Range
53034	Pendennis	Namoi	Doreen Lane Wee Waa	1900-2018
55023	Gunnedah	Namoi	Gunnedah Memorial Pool	1900-2018
53011	Garah	Gwydir	Garah	1906-2018
51008	Wyanga	Macquarie	South West of Narromine	1900 - 2018
51034	Mumblebone	Macquarie	North West of Warren	1900 - 2018
74040	Jerilderie	Murrumbidgee	Jerilderie	1900 - 2018
74081	Mulwala	Murray	Mulwala Post Office	1903 - 2018

Model results are presented in the table below:

Site	Condition	Average Annual Rainfall (mm)	Average Annual Runoff (mm)	Average Annual Runoff (%)	Runoff Increase from Base (mm)
Macquarie Valley - Wyanga Gauge - Lighter soils, Higher infiltration	Native Vegetation - Unimproved	503	15	3%	0
	Irrigation - Fallow	503	72	14%	57
	Irrigation Summer - Irrigated	503	116	23%	100
Macquarie Valley - Mumblebone Gauge - Lighter soils, Higher infiltration	Native Vegetation - Unimproved	437	14	3%	0
	Irrigation - Fallow	437	65	15%	51
	Irrigation Summer - Irrigated	437	110	25%	96
Macquarie Valley - Mumblebone Gauge - Heavier Soils, Lower infiltration	Native Vegetation - Unimproved	437	22	5%	0
	Irrigation - Fallow	437	92	21%	70
	Irrigation Summer - Irrigated	437	113	26%	91



Namoi Valley - Gunnedah Gauge	Native Vegetation - Unimproved	609	33	5%	0
	Irrigation - Fallow	609	132	22%	99
	Irrigation Summer - Irrigated	609	140	23%	107
Namoi Valley - Pendennis Gauge	Native Vegetation - Unimproved	556	40	7%	0
	Irrigation - Fallow	556	138	25%	98
	Irrigation Summer - Irrigated	556	145	26%	105
Gwydir Valley - Garah Gauge	Native Vegetation - Unimproved	560	43	8%	0
	Irrigation - Fallow	560	149	27%	107
	Irrigation Summer - Irrigated	560	155	28%	112
Murrumbidgee Valley - Jerilderie Gauge - Lighter soils, Higher infiltration	Native Vegetation - Unimproved	329	3	1%	0
	Irrigation - Fallow	329	27	8%	24
	Irrigation Summer - Irrigated	329	82	25%	79
Murrumbidgee Valley - Jerilderie Gauge - Heavier Soils, Lower infiltration	Native Vegetation - Unimproved	329	6	2%	0
	Irrigation - Fallow	329	44	13%	38
	Irrigation Summer - Irrigated	329	76	23%	70
Murray Valley - Mulwala Gauge - Lighter Soils, Higher infiltration	Native Vegetation - Unimproved	471	8	2%	0
	Irrigation - Fallow	471	47	10%	39
	Irrigation S & W - Sprinkler Irrigated	471	131	28%	124
Murray Valley - Mulwala Gauge - Heavier Soils, Lower infiltration	Native Vegetation - Unimproved	471	13	3%	0
	Irrigation - Fallow	471	71	15%	59
	Irrigation S & W - Sprinkler Irrigated	471	117	25%	104

As is evident in the results above the increase in runoff from irrigation development is significant across all valleys where the model has been run. A comparison of runoff days where more than 2mm/day runs off from the Namoi Pendennis gauge is shown below:

#### No Irrigation, but cleared and cropped

Average Annual	3.7 days
Min Annual	0 days
Max Annual	11 days



### 10 irrigations in Summer

Average Annual	14 days
Min Annual	0 days
Max Annual	26 days

A comparison to overland flow events in this area is shown in figure below:

