Shepparton Irrigation Region Drainage Program Review

Overview October 2015

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

NORTH CENTRAL Catchment Management Authority
Connecting Rivers, Landscapes, People

GOULBURN-MURRAY WATER

VICTORIA State Government

Contents

Introduction

This report summarises a high level review of the Shepparton Irrigation Region (SIR) Drainage Program. The review includes the development of a new strategy for appropriate surface and sub-surface drainage infrastructure and works.

This was undertaken in three phases:

- **Phase A – Review;**
- **Phase B – Strategy development;**
- **Phase C – Works prioritisation, consultation and integration.**

These three phases are provided as three chapters in this report.

The review was overseen by a steering committee that included community and agency representatives.

The SIR Drainage Program is one of four components of the SIR Land and Water Management Plan (LWMP) designed to implement a package of works across the region to support and grow the natural resource base to ensure agriculture, biodiversity and people flourish. The SIRLWMP is, in turn, a key part of the Goulburn Broken Regional Catchment Strategy (RCS).

Phase A: Review

1.1 Goals and objectives

A review of previous surface and sub-surface strategies found the objectives have remained relatively consistent with regard to the need to provide drainage, but goals have broadened to have more emphasis on environmental management issues.

It was also found that drainage programs need to be flexible to respond to:

- a reduced irrigation footprint
- irrigation system modernisation
- climate change/variability
- the resilience approach outlined in the Goulburn Broken Regional Catchment Strategy (RCS).

Therefore, future implementation of the drainage program has been developed to reflect these changes.

1.2 Previous reviews of surface and sub-surface programs

There have been significant changes to the assumptions underpinning the original 1989 plan. Key changes and consequences for future strategies are:

Planning and design:

- Change to a uniform one-to-two-year design criteria, which is a more affordable level of service.
- Incorporation of drainage systems to conserve or improve environmental features to reflect changing community expectations.
- Increasing costs of installing surface drainage systems.
- Reduced irrigation footprint and location due to water trade and modernisation of the backbone supply.
- The prioritisation framework needs to be adaptive so it recognises the areas where drainage may be required will be difficult to predict, due to water "moving" as a result of trade and the economic benefits of drainage becoming more transient than originally envisaged.
- Private groundwater pumping has exceeded original targets, but public pumps are well below original targets. This is good news as the emphasis has always been to maximise private pumping where it is feasible.

Operations:

- Initial focus was a large capital works program with expenditure in excess of $10 million per year.
- With less emphasis on construction of new drainage systems the new focus will most likely be on operating and maintenance of existing drainage services.
- The need to accommodate "on" then "off" again demand for drainage from landholders through adaptive management, which is difficult to incorporate into surface drainage, but is possible with sub-surface drainage, with groundwater pumps to be mothballed.
- Climate change/variability, which was not included initially, but is now recognised as critical and needing to be incorporated into the adaptive management approach.
- Lack of government funding to support further drainage, which resulted in very limited additional infrastructure since 2006/7.
- Identified that there was likely to be stranded assets for sub-surface drainage with the need to decommission selected groundwater pumps.
- In the case of surface drainage, assets are not stranded as they remove rainfall runoff from unirrigated land, but they do become under-used and there is the question about what is an appropriate level of operation and maintenance.

Outcomes:

This high level review has not specifically examined the performance of existing drainage services, but notes from previous reviews:

- Initially the project benefits depended upon preventing salinity losses from existing agricultural productivity. Later economic reviews identified that the main benefit that underpinned the positive economic cost benefit was land use change. New drainage resulted in irrigators converting to more high value irrigation such as horticulture and dairying.
- More recently the expected project benefits were achieved without drainage (2007 review of surface drainage). This was due to the drop in water tables associated with a drying climate and reduced water availability. The subsequent rise in water tables post-drought has only slightly changed this situation.
- Economic evaluation of the surface drainage program is less positive at each review. This has created the need to re-evaluate the economic case for drainage and in particular assess whether there are any other benefits of providing drainage that were not included in previous assessments. For example, if salinity were to reappear due to inadequate protection there may be irreparable damage.

1.3 Key performance indicators and progress

1.3.1 Progress

The drainage strategies made reasonable progress for the first 15 years of implementation but stopped with the onset of the drought and limited funding. Across the region 56% of the area is serviced by surface drainage or does not require drains. This has increased from 45% when the plan started with most of the works completed from 1990 to 2000. Most catchments and districts have around 50% of land drained. Maintenance of existing surface drainage systems has been identified as an increasingly important priority.

Similarly the removal of "bottle necks" or flow impediments in existing natural drainage lines may be cost effective and should be examined as part of a suite of possible works; although there can be high costs associated with drainage course declarations (DCDs) and in some cases compensation due to changed flooding regimes would need to be paid. In the western part of the GMID (Tragowel Plains) small shallow drainage lines installed by local government under the Water Act appear to have been successful in removing excess water. There remains a question of whether there are adequate powers under the Water Act for this to be a cost effective solution for the smaller property sizes in the SIR.

The areas within the zone protected by sub-surface pumping have increased from 40,000 ha (28% of the target area) in 1990 to 82,500 ha (58% of target area) by 2014. This leaves around 60,000 ha (42%) of the target area to be protected.

Overall, in surface and sub-surface drainage programs there has been little additional funding for works since 2006/7.

1.3.2 Drivers, opportunities and challenges

A key difference from the 1990s is that water trade has been introduced and adopted on a widespread scale. Water trade and reduced water availability means that the area of irrigation now at risk from high water tables or at risk from being undrained is smaller and more mobile. The area irrigated in 1995 in the SIR was around 300,000 ha; the expected future irrigated area is between 120,000 to 200,000 ha.

Water trade is a tool that was not readily available in the 1980s when the original strategy was developed. At that time an irrigation volume was fixed to a particular piece of land. Water trade allows people to move water to the best locations, including towards drained land and to areas that are not at risk from high water tables. This does not necessarily mean the strategy should be based on farm relocation as many farms without access to drainage have been able to adjust by ensuring areas prone to drainage problems are simply not irrigated and areas of higher elevation and not prone to losses are preferentially selected for irrigation.

Surface drainage

There is sufficient surface drainage (250,000 ha) to accommodate the future irrigation footprint but the existing irrigation footprint and drained catchments do not align. This raises questions about whether the strategy should be about assisting the movement of irrigation water (within properties or across properties) to land that is drained or at low risk of inundation.

Or should the strategy continue to recommend installing further works to high priority existing land that is not drained? Perhaps a mix of both is appropriate.

There are difficult issues associated with moving irrigation farms/ locations. Perennial horticulture is particularly immobile and has a high need for a high level of drainage service. However, in general it is also located on lighter soils where there is usually a lower risk of surface water inundation.

Surface catchments have generally changed from having in a typical year around two thirds of the land area irrigated and one third unirrigated in the 1990s to now having one third irrigated and two thirds unirrigated. The reduced irrigation footprint, along with farm efficiency improvements and reduced channel outfalls through modernisation, has meant that the patterns of runoff are lower for smaller events. There is more unirrigated land to absorb gentle rain events, but for intense storms where unirrigated land and irrigation produce similar peak flows, there is no change in the peak flow. Climate change may mean these storms become more frequent.

This means that the surface drainage strategy is now more about managing these larger events by ensuring adequate removal of water away from high value assets, ie.a floodplain management type approach. Therefore, the identification of high value assets and bottlenecks to the efficient removal of water from these assets is to be investigated as part of a suite of possible works.

It is also be important to look at the limits to the size of reuse systems and water harvesting from drains under farm dams legislation.

There have been substantial changes in the flow rates used for irrigation and the changing flow patterns may mean that this could be part of the solution for undrained areas.

Sub-surface drainage

A similar situation exists for sub-surface drainage in that there is sufficient land with low water tables (approximately 300,000 ha) or existing groundwater protection (approximately 95,000 ha) to accommodate the future irrigation footprint, but again the footprint and protected areas do not neatly align.

In 2013/14 there was 28,000 ha of intensively irrigated land (> 3 ML/ha) at risk due to high water tables ("high risk < 3 m") without groundwater pumping protection. This area used 138 GL and of this:

- 10,000 ha (2% of SIR) had water tables less than 2 m and used 49 GL (6% of SIR water use). This area can be considered currently at risk as water tables are within 2 m of the surface.
- 18,000 ha (4% of SIR) had water tables between 2 to 3m and used 89 GL (11% of SIR water use). This area is at risk if water tables rise, which can rapidly occur following a large scale wet event.

While there are public benefits from groundwater pumping, the private benefits of groundwater control are generally sufficient to justify private investment in groundwater pumps. Therefore, public investment is justified where private pumps are not feasible, which is at the margins (low yield or high salinity) or where there are specific public assets at risk such as environmental features.

1.4 Knowledge and principles

This review has identified the following key issues that need to be addressed.

- The overall water applied and the footprint of irrigation has approximately halved and thus;
  - the need for drainage has reduced,
  - the irrigated areas at risk have reduced,
  - the ability to relocate water within farms away from high risk areas has increased, and
  - the ability to relocate farms to areas with drainage but unirrigated is now possible, but relocation is not easy, as experienced with GMW Connections Program.
- As a result, the original program requires re-evaluation, as it may be uneconomic in its original form. What is the future justification for extending drainage if the area drained is more than the land area that can be irrigated with the water available?
- Are there any public assets (wetlands, roads) that are in the at risk areas that justify drainage protection?
- The original philosophy of equal access to surface drainage for everyone or protecting all land at risk from high water tables, is now looking impractical and is irrelevant given that there is now so much unirrigated or infrequently irrigated land in the SIR, much of it protected by surface and/or sub-surface drainage.
- It is likely that there will be stranded or underused drainage assets that need a specific action in the strategy.
- What level of maintenance is needed given the changed footprint and what is the strategy to maintain drainage service levels?
- What are the drainage needs for environmental assets and other public infrastructure (eg. roads)?
- What is the new adaptive management framework to reflect the changed footprint?

There are already well developed program principles, prioritisation frameworks and cost sharing that can guide the revision of the drainage program and the GMW drainage tariff review will be important.

1.5 Future directions to be developed for the revised strategy

Key topics that emerged from the review in Phase A were the need to develop a strategy considering:

- New vision. The overarching philosophy of responding to the underground flood of the 1990s when two thirds of the catchment was irrigated has changed. The emphasis for the future would be more relevantly described as "to provide risk based floodplain drainage services for an intensively irrigated productive SIR". This reflects the need to adapt to risk and protect the high value asset of intensively irrigated areas. This also has implications on the size of the program given that only around 10% of intensively irrigated areas are undrained.
- Continue to use and develop the adaptive management framework for operations.
- Maintenance of existing drainage infrastructure.
- Examination of removal of flow impediments as an option (in a suite of possible capital works).
- Examine need for additional drainage systems.
- If future drainage is not provided what are the costs and what options do people have in undrained and unprotected areas?
- Policy instruments, trading rules and annual use limits (AUL) as a tool to minimise drainage risk.
- Management of stranded/ underutilised or redundant drainage assets.

Phase B: Strategy Development

2.1 Changed catchment

Changed land use, especially more rural residential land use and differing levels of benefit received from drainage make it increasingly difficult to meet existing requirements for a high level of community agreement to install new drainage systems.

Shared drainage infrastructure is increasingly used only for extreme rainfall events.

The area identified as requiring drainage was examined in detail and revised downwards in Phase B from 229,000 ha from the last strategy review to 103,000 ha.

2.2 Farmers mitigating the effects of a lack of drainage

In undrained areas farmers have taken mitigation actions to reduce losses caused by lack of drainage. This includes minimising inputs on land that is subject to regular flooding; building farm water storages, drainage reuse and drainage redirection on-farm; and in some cases earthworks and pumping to channels or neighbouring areas, roads etc.

These actions are unco-ordinated and can cause offsite problems, especially in areas where there are many small farms. They are less of a problem in areas where there are fewer and larger farms. Encouraging sensible farm mitigation has similarities with the approach proposed in the Draft Floodplain Management Strategy (DELWP 2015).

The Draft Floodplain Management Strategy proposes an approach that:

1. assesses flood risks and shares information (through flood risk metrics, flood maps and data to inform risk assessment)
2. avoids or minimises future risks (through planning and building)
3. reduces existing risks (through flood warnings and mitigation works/actions)
4. manages residual risks (through flood insurance, disclosing risk through flood mapping, vendor disclosure statements, emergency management).

This review advocates a similar approach, in that it proposes additional information sharing on surface and sub-surface drainage risks and on-farm management practices. This will help ensure that irrigated landholders, who may be affected by excess surface water or high water tables can make informed choices about the current and future risks and how best to manage them for their enterprise.

Making this information more accessible is key to enabling individuals to make informed choices and to the implementation of appropriate farm actions to manage risk.

2.3 New principles

The principles for surface drainage are to maximise on-farm efficiency and reuse and then look at new lower cost drainage systems that provide cost effective solutions for undrained catchments where the benefits exceed the costs.

The principles for subsurface drainage are to maximise private pumping and maintain an adaptive management approach for public pumps in response to changes in water table levels.

2.4 Economics of surface drainage

2.4.1 Analysis

Previous reviews have shown the original strategy to be uneconomic unless land use change occurs. This review conducted a fresh analysis of the economic viability of drainage, assuming:

- a discount rate of 4%
- a time period of 30 years
- all works are implemented in year zero and all benefits accrue from year one, rather than staged over a multi-year period. This simplifies the analysis and is considered adequate for prioritisation of options.

2.4.2 Costs of drainage

Costs for constructed surface drains are high and have increased over time and average $48/ha/y based on the previous strategy mix of primary drains, community drains and their unit costs.

However, if the undrained area can be served by 50% drainage course declarations (DCDs) and 50% community surface drainage then costs can reduce to $34/ha/y.

There is a large discrepancy between GMW average surface drainage charges ($15/ha) and the annual operation and maintenance costs of new drains ($4/ha) that have been used for previous economic analysis and also for this analysis. $15/ha/y is higher than the average agricultural benefits per ha from surface drainage.

2.4.3 Benefits of drainage

This analysis shows the estimated agricultural annual benefits of drainage are:

- $54/ha using 1990s irrigation intensity with higher value land use as a benefit of drainage
- $20/ha with 1990s irrigation intensity if land use change is not included.
- $12/ha with current land use and high water tables
- $6/ha with current land use and current water tables. This is the most likely scenario and was adopted for the remainder of the economic analysis. This is a conservative assumption, because if water tables rise the level of agricultural benefits from drainage are estimated to increase to around $12/ha.

In addition to the agricultural benefit, it is estimated that the benefit to roads averages $20/ha of catchment drained and the benefit to the environment is approximately $11/ha.

This means that the total average benefits are estimated at $38/ha/y drained.

2.4.4 Net benefit

The annual benefit of $38/ha compares equivalent annual cost (capital and annual) of:

- the original strategy works and area at $48/ha/y (uneconomic)
- original strategy works modified to the new revised area at $48/ha/y (uneconomic)
- revised works modified to the new revised area at $34/ha/y (economic). These revised works were costed assuming 50% of the area was DCDs and 50% community surface drainage. This remains economic on average, even after sensitivity testing for a further 10% decline in irrigation area. Given that drainage is increasingly used only for extreme rainfall events, this suite of low-cost, revised works will provide the same benefits as the works outlined in the original strategy.

This analysis shows that a lower cost approach to regional surface drainage using unit costs based on a combination of 50% covered by DCDs and 50% of community surface drainage is more economic than the original strategy. This was further developed as the basis for the new strategy (Phase C).

This does not necessarily mean that the current approval process and extensive consultation for community surface drainage should remain a requirement. Instead, the approval process previously used for primary drains could apply, but to works installed to community surface drainage standards.

The bulk of the benefits are now associated with non-agricultural benefits, particularly roads. Therefore local government will need to be a key partner in this new approach.

2.5 Review and update goals, objectives and principles

The principle that underpinned the original strategy was that irrigation without drainage is unsustainable. This is still true, but the form of the drainage needing to be tailored to the new diminished risk.

The risks in the 1990s were influenced by a wet sequence and higher irrigation water use. In 2015 risks are diminished by the sequence of more dry years and with a much lower irrigation footprint.

The growth of water trade and the high value of water has meant that there are commercial drivers for irrigators to minimise loss of tail water and encourage drainage reuse. Many farmers have set up systems for achieving this. The primary future need is removal of surface drainage water after high rainfall.

Farmers with access to channel pumping do have an option, but there are water quality issues for those supplied by channels and this risk needs to be better understood and managed.

Lack of drainage also causes damage to public assets such as roads and environmental features that need to be considered.

Policy instruments, such as trading rules and limits to AUL that were identified as a possible options to minimise salinity risks in Phase A were not pursued in Phase B as salinity risks are perceived to be low. However, these may need to be revisited as part of the adaptive strategy if salinity risks increase.

The following principles were developed to apply to the drainage strategy.

Overarching

SIR needs an integrated drainage strategy to provide drainage services appropriate to the risk in its unique intensive water management region. The strategy will build resilience and adaptation through coordinated actions that consider stakeholder environmental, social, spiritual, cultural, and economic aspirations.

The strategy will:

- Be consistent with regional, state and national legislation and policies that apply. This includes the Murray Darling Basin Plan, Victorian land and water policies and the Regional Catchment Strategy.
- Provide a planning approach to ensure that landholder development decisions are informed by knowledge of the risk of flooding, risk of high water tables and the level of protection.
- Be consistent with market drivers, particularly for irrigated agriculture and horticulture eg. affordability and flexibility to respond to market change.
- Promote adaptability and mitigation of climate change, eg. improve energy efficiency (related to property accessibility, travel distances etc).
- Consider the need for improved property access and minimising occupational health and safety and public health risks that are influenced by lack of drainage. In particular, enabling improved access to properties for emergency services (police, fire, ambulance) following large floods.
- Demonstrate that the SIR community considers and cares for its impacts on downstream use.
- Provide sufficient serviced land that can attract regional economic growth and protect and enhance existing economic land use, especially irrigated agriculture.
- Protect and enhance the SIR environment.
- Protect and enhance social and cultural values.
- Provide robust institutional arrangements for ensuring the financial sustainability of any new drainage infrastructure assets. This means clarifying a level of service, and ensuring that the expected benefits exceed costs so that serviced landholders recognise the value of service provided by their drainage rates. Also there needs to be strong institutional arrangements for maintenance, ownership and responsibility.

Surface drainage

- The first priority is for farm efficiency and farm collection and reuse of surface drainage.
- Secondly the strategy will provide extension and information to enable landholders to assessing drainage risks so they are able to plan farm works and plantings to minimise risks, eg. risk of flooding. It will encourage landholders to consider insurance. The strategy will maintain human capital so that knowledge of flooding risk and the drainage network is maintained.
- Thirdly, it will seek modification of the administration of farm dams legislation (the 1 ML per 10 ha rule) so that larger reuse systems can be installed in undrained areas. This is on the proviso that larger reuse storages in these areas will not result in reduced flows to the Murray, as there is no surface water drainage to provide the required connection whilst the reuse systems are operating.
- Fourthly, it will investigate risks and possible risk mitigation associated with channel pumping.
- Fifth, it will look at providing drainage services where costs are less than the benefits of drainage.
- Sixth, it will look at revised cost sharing that could include drainage rates that help fund capital works where required, rather than rely on government funding 100% of capital works.

Subsurface drainage

- The first priority is to maximise private pumping.
- The second is to maintain adaptive management of public pumps.
- The third is to install new public pumps where private pumping is not appropriate, and there is demonstrated need that the benefits will exceed costs. Implementation needs to be cost effective. The current process that requires agreement of local landholders to local cost sharing, doubles the implementation cost.

Phase C: Works prioritisation, consultation and integration

3.1 Rationale

Directions from Phase A (review) and Phase B (strategy development) investigations include:

- An endorsement of the adaptive management approach for subsurface drainage.
- That farm reuse of collected runoff is an integral part of the drainage strategy and that irrigation and rainfall runoff is collected and reused before entering any community or GMW drains.
- That an understanding of drainage/flooding risk underpins landholder plans with regard to where to irrigate, crop types etc.
- A clear need to address the changed economics by developing a new type of lower cost surface drainage system; this could be developed using a "hybrid drain" comprising DCDs and constructed drains, where constructed drains are similar to community surface drainage systems.
- Prioritise possible surface drainage works using the new "hybrid drain" system.

Therefore, Phase C focuses on the needs of surface drainage, in particular the last two dot points.

3.2 Provision of additional surface drainage services

3.2.1 Justification

The main justification for a new type of drain is that the cost of the traditional primary drain and community drainage system as shown is no longer economically viable. Fortunately for most of the SIR, primary drains are already in place and the main body of work is to use hybrid drains to connect the remaining "economic to drain" areas to the natural drainage system.

However, there will also be areas that are not economic to drain. In these situations, there needs to be options for landholders to manage the risks themselves and this could include:

- pumping to GMW channels where the risks are acceptable and operating rules are in place (this is a recommended as a key area of investigation)
- the use of decommissioned channels to remove water to an outfall
- allowing larger reuse storages than currently allowed is seen as part of the solution to alleviate drainage problems
- equipping landholders with a better understanding of flooding risks, so that they can minimise their losses on areas that are prone to flooding and waterlogging losses.

3.2.2 New hybrid drains

DCDs provide the planning and regulatory backing for removal/ modification of manmade obstructions including infrastructure that may impede surface water flows in natural depressions and drainage lines. They assist in managing risks associated with surface flow events (eg. waterlogging), and can be adequate in some areas to meet the surface drainage needs.

The intent is to find economic ways of removing excess rainfall runoff by enhancing natural drainage lines.

The rationale behind these drains is to reduce the cost of drainage by maximising the use of DCDs on natural drainage lines and to link fragmented natural drainage lines with constructed drains. The constructed drains will be needed where natural lines are blocked and artificial barriers to flow cannot be practically cleared. Constructed drains may also be needed where the natural drainage lines do not provide an optimal environmental outcome, eg. undesirable or excessive pooling in a wetland.

With good design and management these hybrid drainage systems have the potential to enhance environmental values by providing flow to and removing flow from natural drainage features while at the same time reducing economic losses caused by a lack of drainage.

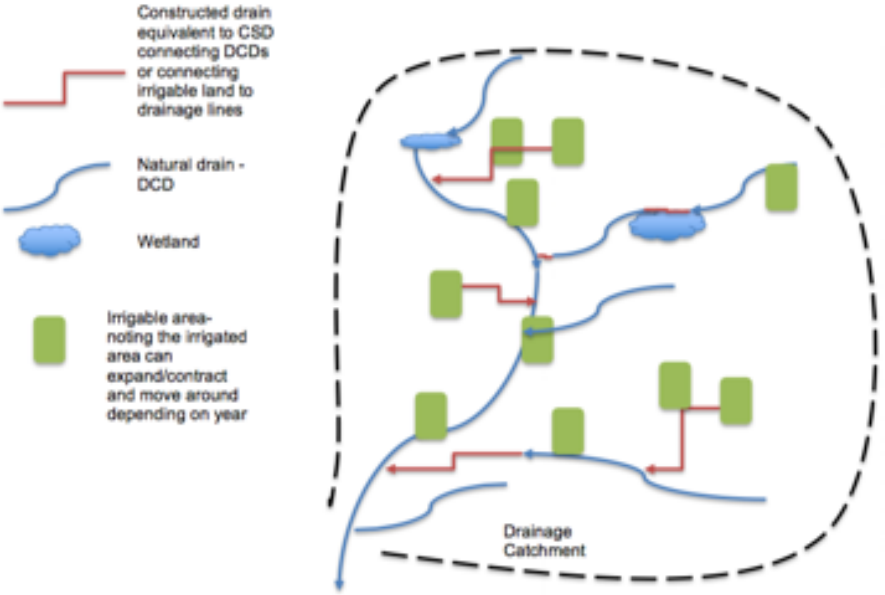


Figure 1: Characteristic hydrographs from catchments with different levels of irrigation intensity (exaggerated difference for illustration)

A stylised diagram showing the relationship for hybrid drains is shown above. Again it should be noted that farm reuse and management is part of the solution.

Like all surface drains it will be important to implement the "hybrid drains" by starting at the lower catchment outfall downstream and working to upstream. This will ensure the outfall is adequate and avoid upper catchment drainage issues creating mid catchment flooding.

It is understood that current arrangements do not allow GMW to rate customers for access to DCDs, therefore it is recommended that a ratings base for a DCD/hybrid drain system be developed.

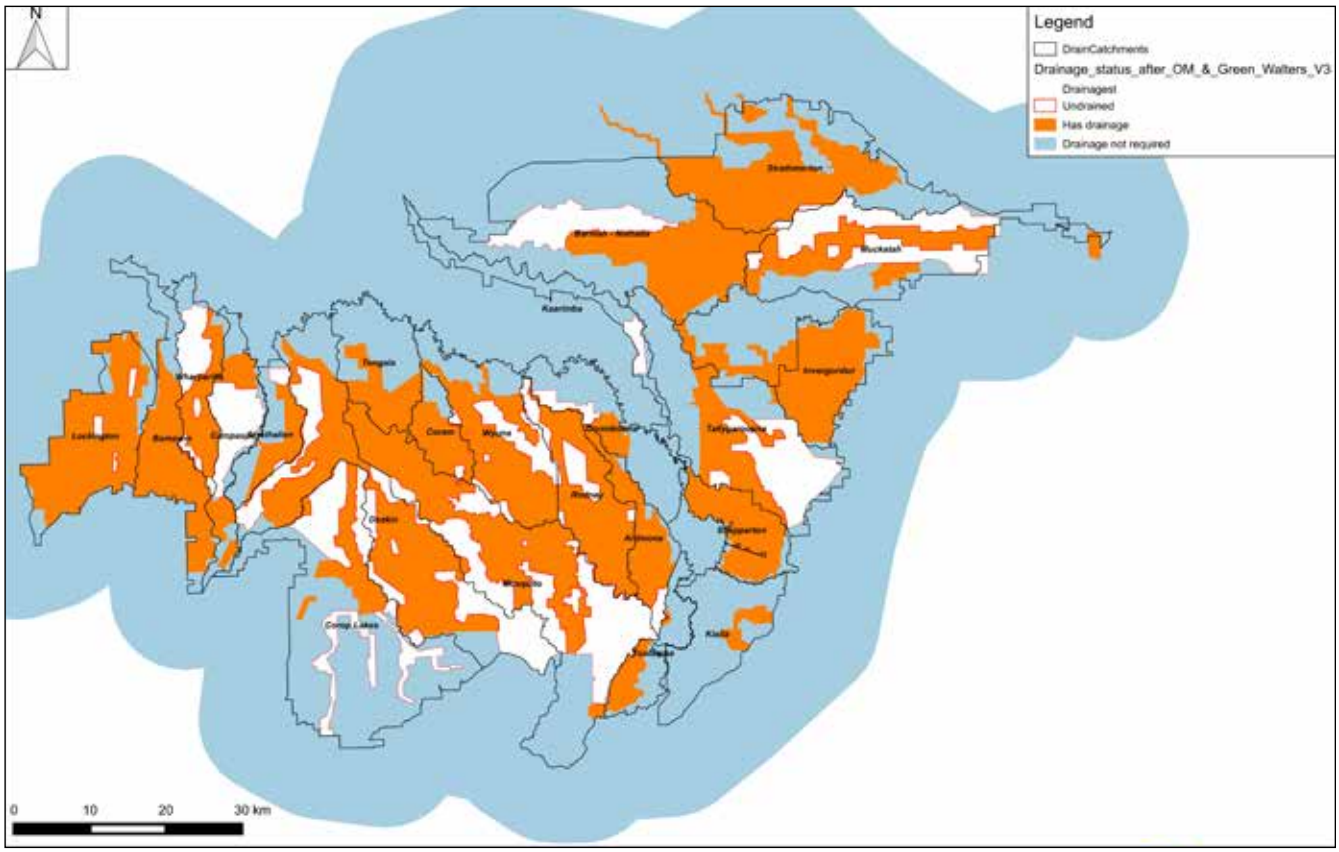
3.2.3 Areas considered for "hybrid drains"

The areas that have been identified as "undrained" are land that is not served by the existing drainage network or has been classified as "not required". The "not required" areas have been identified using extensive local knowledge considering areas that have:

- adequate "natural drainage" due to proximity to natural drainage lines
- very light soils, which generally do not produce runoff
- are mostly unirrigated areas
- a combination of these factors.

These areas within each catchment of the SIR are illustrated in the figure over page.

Figure 2: Location of undrained land (shown in white), not required (blue) and already drained (orange) by catchment



3.3 The cost benefit analysis with "hybrid drains"

Following discussions with agency staff the unit costs from Phase B were revised upwards to account for contemporary conditions.

Benefits have been calculated for the low water table environment with 2013/14 land use as outlined in the Phase B report. The Present Value of Costs (PVC) and the Present Value of Benefits (PVB) have been calculated at a discount rate of 4% over 30 years. Table 1 shows that there are:

- Large differences between catchments.
- From an economic viewpoint the BCR improves from 1.0 to 1.3 if only economic sub-catchments are selected.
- The area requiring drainage falls from 103,000 ha to 64,000 ha if economic catchments only are selected.
- A key reason for catchments not being economic is a higher present value of costs per ha, this is associated with a low amount of DCD and a high amount of constructed drainage, which is more expensive.
- Apart from a few exceptions (eg. Lockington) there is less variability in the present value of benefits per ha. Most of the benefits are associated with roads (46%) and the environment (30%), while agricultural benefits are relatively low at 24% of the average benefits, but this mix does vary from catchment to catchment.

The calculated PVB does include costed environmental benefits, based on the length of natural waterways and area of wetlands. It includes agricultural benefits based on the reduction in flooding, waterlogging and salinity costs by land use in each catchment; and it includes road benefits based on a reduction in maintenance costs for the length of roads in each catchment.

However, the NPV ignores the social benefits, which will vary from catchment to catchment; and are included in scores for prioritisation in Section 3.4.

Table 1: Economic evaluation by drainage catchment

Catchment	Area to be drained	Capital cost $M	Present Value Costs (PVC)	PVC/ha	Adjusted present value of benefit	PVB/ha	NPV	BCR	NPV/ha
Tallygaroopna	10,640	3.55	$3,669,325	$345	$7,701,460	$724	$4,032,135	2.1	$379
Wharparilla	4,672	1.17	$1,208,394	$259	$2,789,993	$597	$1,581,599	2.3	$339
Campaspe	5,995	1.50	$1,550,583	$259	$3,326,596	$555	$1,776,013	2.1	$296
Kaarimba	1,247	0.31	$322,532	$259	$540,531	$433	$217,999	1.7	$175
Strathallan	670	0.32	$333,255	$497	$443,781	$662	$110,526	1.3	$165
Corop Lakes[1]	12,368	5.95	$6,151,796	$497	$8,120,405	$657	$1,968,609	1.3	$159
Barmah - Nathalia	8,318	4.16	$4,626,575	$556	$5,344,477	$643	$717,902	1.2	$86
Mosquito	19,627	15.51	$16,987,678	$866	$17,118,729	$872	$131,050	1.0	$7
Deakin	14,982	12.6	$13,879,564	$926	$12,221,471	$816	-$1,658,094	0.9	-$111
Wyuna	4,431	4.26	$4,739,458	$1,070	$3,406,649	$769	-$1,332,809	0.7	-$301
Muckatah	13,699	11.52	$12,693,214	$927	$8,546,794	$624	-$4,146,420	0.7	-$303
Rodney	3,647	3.51	$3,900,881	$1,070	$2,612,934	$716	-$1,287,947	0.7	-$353
Ardmona	856	0.82	$915,910	$1,070	$606,756	$709	-$309,155	0.7	-$361
Coomboona	1,423	1.37	$1,522,060	$1,070	$997,620	$701	-$524,441	0.7	-$369
Lockington	797	0.77	$852,482	$1,070	$410,489	$515	-$441,993	0.5	-$555
Sub total economic catchments	63,537	32.46	$34,850,139	$549	$45,385,972	$714	$10,535,833	1.30	$166
Sub total uneconomic catchments	39,836	34.85	$38,503,570	$967	$28,802,713	$723	-$9,700,857	0.75	-$244
Totals	**103,373**	**67.31**	**$73,353,708**	**$710**	**$74,188,684**	**$718**	**$834,976**	**1.01**	**$8**

[1] *Corop Lakes DCD in the upper catchment is unique in that private farm drains can extend the area served into parts of the "drainage not required" areas. The benefits and costs of this component have not been included in the analysis.*

3.4 Prioritisation of catchments with hybrid drainage

3.4.1 Method

Prioritisation needs to consider, social, environmental and economic impacts. In this phase input from other stakeholders was sought using a workshop held on the 28th August 2015. Workshop participants considered catchment characteristics and contributed to the scoring method , where scores were based on the relative rank of each catchment as below.

- *npv_rank* = is the rank number for economics based on the npv/ha,
- *e_rank* = environmental ranking, based on ha of wetlands and natural water courses per ha of catchment.
- *s_rank* = social ranking based on number of water use licences (using more than 10 ML in 2013/14) per ha in each of the undrained areas; this is a proxy for the number of properties per ha that are likely to benefit.
- *Workshop A_rank* = social/ local community values (over and above number of water use licences already included). This included a score out of 10 based on consideration of the following factors:
  - population density,
  - community facilities (eg. sports grounds, schools etc), agricultural land values/soil type and potential,
  - community support for drainage
  - potential for irrigation growth and connection to the backbone.
- *Workshop B_rank* = environmental value (over and above the area calculation already included). This included a score out of 10 based on consideration of the following factors:
  - environmental features low in the landscape (likely to benefit from drainage)
  - wetlands
  - roadside vegetation
  - waterways
  - terrestrial vegetation
  - local value and aesthetics.

Table 2 (right) shows the results.

3.4.2 Discussion of results

The top five catchments are Mosquito, Tallygaroopna, Wharparilla, Barmah-Nathalia and Corop Lakes. The capital cost of implementing surface drainage in these five catchments is estimated at $30.34 million.

A key issue raised at the workshop was that the demands for a surface drainage service are sometimes from catchments that overall are un-economic such as the Muckatah and Deakin . These catchments are very large and were previously seen as high priority. The undrained areas within these catchments are made up of several discrete areas, some of which may be economic. The strategy recommends that where surface drainage can be demonstrated to be economic, these works should be included as a high priority. This can be by further investigation or because landholders are prepared to self-fund works.

Also, it should be noted that:

- The benefits have been assessed at one point in time (2013/14) and water can move within the landscape and the irrigation area can change. This means that the program must remain flexible and adjust for changes in the irrigation area and for climate change. An adaptive management approach is recommended.
- Each catchment needs its own set of operating rules given its unique drainage characteristics, plus an independent umpire to ensure these rules are being followed. Governance arrangements need to be developed for this role.

It should be recognised that these priorities reflect 2015 conditions, perceptions and state of knowledge.

Priorities will be also influenced by the level of community support for new drains in an undrained area. The overall program requires commitment from community and governments working in partnership in order to achieve the public and private benefits.

Table 2: Catchment prioritisation and key characteristics

Priority	Catchment	Priority scoring Rating	Ha un-drained	Irrigation intensity ML/ ha 2013/14	NPV/ha	Catchment characteristics as they relate to drainage need
1	Mosquito	11.0	19,627	1.6	$7/ha	Historically a high priority, Intensive irrigation, disconnected natural drainage lines, large proportion of channel pumping, large catchment, community support in both areas, fully surveyed and designed
2	Tallygaroopna	10.1	10,640	1.3	$379/ha	Historically a low priority. High level of natural drainage means that most of the works will be based on using DCDs with a very small amount of constructed drains. Is an area of low irrigation intensity with large broad acre farming.
3	Wharparilla	9.8	4,672	0.7	$339/ha	Historically a low priority, has low community support but is low cost because of the ability to use DCDs.
4	Barmah - Nathalia	9.1	8,318	1.2	$86/ha	Historically a high priority. The Murray Valley Drain 11 is designed and the outfall is completed. But laterals to service undrained areas are missing. Also, completing works will address flooding associated with upper drain 7 catchment, which has a limited (throttled) outfall to drain 10; and similar limitations apply to the upper catchment of drain 10, which pumps to both drain 13 and drain 18 lower.
5	Corop Lakes	9.0	12,368	0.6	$159/ha	Northern undrained area is a lower priority. Southern end is a high priority and relies on DCDs. This will address longstanding flooding issues and protect high environmental values. It will also provide environmental watering opportunities.
6	Rodney	8.3	3,647	1.7	-$353/ha	Lower priority, has low community support for the previous community drain proposed. Serviced by licensed channel pumping.
7	Wyuna	8.2	4,431	1.8	-$301/ha	Lower priority, has low community support for the previous community drain proposed. Serviced by licensed channel pumping.
8	Ardmona	7.8	856	1.9	-$361/ha	Lower priority, costly, does have some horticulture, has completed survey and designs, historically had waterlogged swamp (not recently).
9 (*)	Deakin	7.4	14,982	1.4	-$111/ha	Previously a high priority. The Deakin Catchment has a BCR of 0.9 and is close to being economic. The upper catchment (Harston) is environmentally significant, has community support and designs completed. The Middle and Western zones of undrained areas occur along the western boundaries. Parts of this catchment could be economic to serve.
10 (*)	Muckatah	7.4	13,699	1.5	-$303/ha	Previously a high priority. The Muckatah Catchment has a BCR of 0.7. But there are two zones of high intensity at (i) the western end and (ii) south of Cobram. Primary drains exist, some of CSD has been designed. Parts of this catchment may be economic to serve.
11	Strathallan	7.0	670	1.3	$165/ha	Previously a low priority. All DCD and low cost. Small area, low community support and small number of individuals
12	Kaarimba	6.7	1,247	1.1	$175/ha	Previously a low priority. All DCD and low cost. Light soils. Small area, low community support and small number of individuals.
13	Campaspe	6.5	5,995	1.4	$296/ha	Previously a low priority. All DCD and low cost. Low environmental values, low community support. May have high use of natural drainage lines already.
14	Coomboona	6.5	1,423	1.5	-$369/ha	Previously a low priority. High cost as needing all constructed drains. Intensively irrigated. Low environmental values, low community support. Serviced by licensed channel pumping.
15	Lockington	2.4	797	2.2	-$555/ha	Previously a low priority. High cost as needing all constructed drains. Intensively irrigated. Low environmental values, low community support, small area.

3.5 Opportunities for integration with other programs and activities

3.5.1 Recommended actions

The strategy recommends the development of "hybrid surface drainage" systems where economic to do so based on the priories above.

In areas where surface drainage cannot be currently justified, it recommends support for farm practices to minimise drainage loss, information and extension on flooding risks and the expansion of reuse storages in undrained areas. It also recommends GMW develops a long term strategy for managing risks associated with channel disposal.

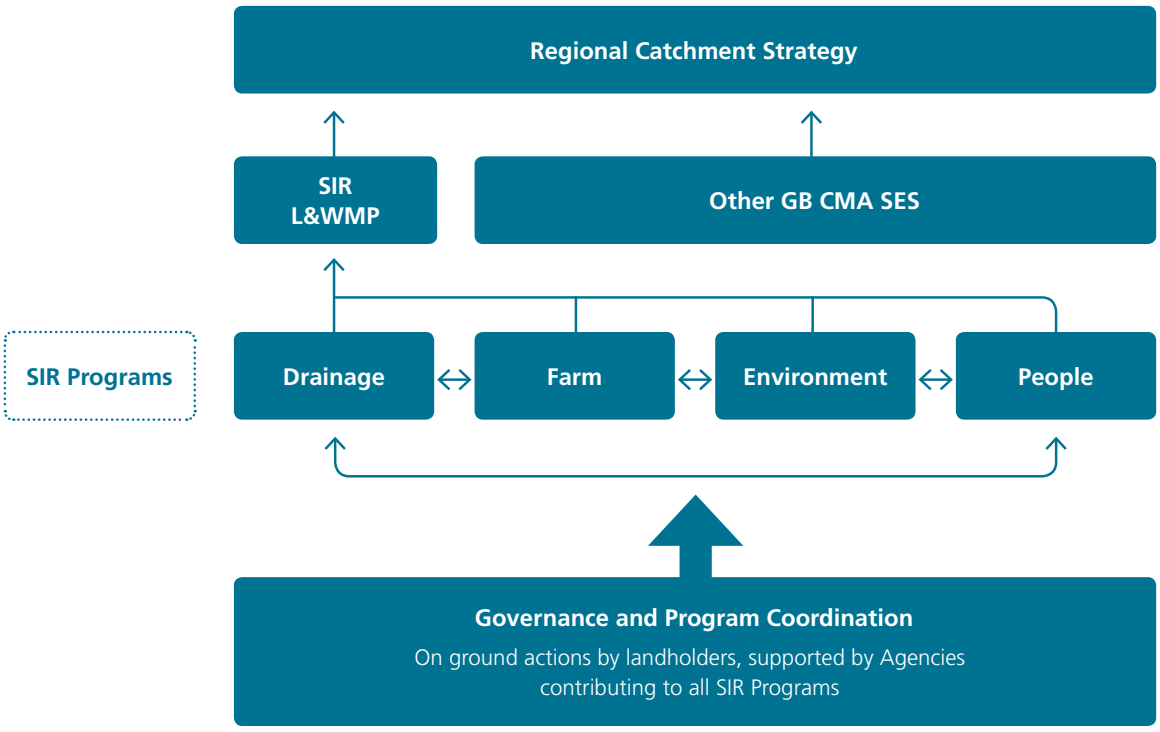
3.6 Roles of stakeholders in recommended actions

The actions listed in this strategy will be integrated with other programs in the Shepparton Irrigation Region Catchment Implementation Strategy (SIRCIS) and pursued in partnership with local, Victorian and Federal governments. This includes any Murray Darling Basin or other natural resource management initiatives that are relevant to sustainable water management.

This is consistent with a range of other regional programs that form part of the Goulburn Broken RCS.

The role of each of these stakeholders in the drainage strategy and RCS is shown as an overview in Figure 3 and is detailed in Table 3.

Figure 3: Relationship between programs and Regional Catchment Strategy



Note: SES stands for socio-ecological systems in the RCS, of which Agricultural Floodplains SES encompasses the Shepparton Irrigation Region (SIR) Land and Water Management Plan.

Table 3: Stakeholder role in recommended actions of the revised drainage strategy

Stakeholder	Actions to support the implementation of the drainage program (funding sources will be different)
Landholders	• Implement farm actions to mitigate drainage risks. • Participate in coordinated "hybrid" drainage schemes. • Contribute to cost share of drainage via new GMW tariff.
GMW	• Design and implement hybrid drains in priority areas including constructing "hybrid" drainage works/ drainage course declarations. • Provide support to investigations on sub-catchment areas in Deakin and Muckatah or other areas where landholders have indicated that they are prepared to self-fund surface drainage works. • Develop operating rules. • Maintain drainage systems. • Ensure tariff and rating arrangements are in place (especially for DCD). • Undertake risk assessment of channel pumping and depending on outcomes develop a channel pumping strategy with operating rules. • Maintain knowledge base on surface and subsurface drainage risks and also groundwater management. • Maintain drainage flow and water quality monitoring network. • Maintain groundwater monitoring, reporting to ensure adaptive approach can be implemented and that up to date extension on watertable risks can be maintained.
GBCMA	• Provide environmental input into drainage design. • Oversee farm extension programs, including whole farm planning, to assist landholders manage drainage risks, including larger scale reuse. • Assess impact of larger reuse storages on compliance with MDB cap (in partnership with GMW/DELWP/DEDJTR). • Coordinate and integrate drainage program within broader Regional Catchment Strategy. Including investigations on sub-catchment areas in Deakin and Muckatah or other areas where landholders have indicated that they are prepared to self-fund surface drainage work. • Flooding mapping and risks.
Local Government	• Contribute to the operations and maintenance costs of the Salinity Public Asset Control Works (NB As per existing cost sharing agreement (17% contribution)). • Contribute to drainage costs and the construction of road crossings built as part of the drainage systems according to the benefit to Local Government and on case by case basis).
Vic Roads	• Contribute to drainage system costs and the construction of road crossings built as part of the drainage systems (according to the benefit to roads and on a case by case basis).
Aboriginal groups	• Provide cultural heritage assessments and management plans for drainage.
Department of Environment, Land, Water and Planning (DELWP)	• Provide investment and support for implementation of the drainage strategy (extension and works). • Alignment with state strategies and programs. • Assess public benefits, particularly environmental benefit. • Progress the development of an "umpire" and responsible agency for resolving drainage issues. • Coordinate IDMOU. • Ensuring drainage complies with Victorian Water Resource Plans under the Murray Darling Basin Plan.
Department of Economic Development, Jobs, Transport and Resources (DEDJTR)	• Provide extension services to the drainage program related to farm risk mitigation and environmental management. Provide monitoring and evaluation services. • Provide monitoring and research services. Including tracking areas of irrigation, areas served by reuse systems, irrigation intensity and demand for drainage in undrained areas. This should be GIS based.
Environmental Protection Authority (EPA)	• Continue to participate with IDMOU and manage point source discharges to drains.
IDMOU partnership (GMW, EPA, DELWP, DEDJTR, CMAs)	• Water quality monitoring, evaluation and reporting through GMW and other agency program.s • Water quality impacts and risk assessment.
VFF, Industry and farmer groups	• Provide advice on drainage needs and solutions. • Technical inputs and research services.
Environmental non-government organisations	• Provide advice on environmental issues related to drainage.
Australian Government	• Potential investor for areas of national environmental benefit, referral for any EPBC requirements. • MDBA – salinity accounting in the Basin Salinity Management Strategy, plus compliance with the MDB cap on diversions. Also meeting water quality obligations of the Basin Plan.