

# **Waste Water Re-use Study**

Identifying Alternative Uses for  
Irrigation Drains  
to Reduce Off-Farm Impacts

**Final Report  
February 2004**

Undertaken and Conducted by: Ord Land and Water.  
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Detheridge wheels monitor the flow of water onto farms.

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## 1.0 INTRODUCTION

### 1.1 Background to the study

The Ord River Irrigation Area (ORIA) was built in the early 1960's utilising practices that did not consider many of the environmental issues that are relevant to present day thinking and values. Since that time much has been done in an attempt to improve on the design and management of irrigation systems to address water quality, water efficiency and ground water.

In conjunction with the improvement of irrigation systems has come the need to allocate water for environmental, social and other economic uses. 'Water Allocation' came as a result of the establishment by the Council of Australian Governments (COAG) in 1994 of a national Water Reform Framework to address the need for the sustainable management of Australia's water resources. The framework was formulated in response to considerable concern about the state of many of Australia's river systems and a recognition that an important part of the solution lay in significant policy and institutional change.

The design of the ORIA as a 'flow-through' flood irrigation system makes the management of water efficiently difficult. In addition the current system design is prone to facilitating the transportation of silt, nutrients and pesticides off farm into the drainage system and the Ord and Dunham Rivers.

Within the ORIA there is a need to increase irrigation efficiency levels and reduce off farm movement of silt, nutrients and pesticides. This has come from a regulatory perspective where water quality and efficiency targets will be a part of the licensing agreement of the Ord Irrigation Cooperative (OIC). In addition present community expectations expect that farm management practices are developed to reduce the impacts of agriculture on riverine systems.

With the release of the Ord Land and Water Management Plan 2000 came a commitment from industry and the community to reduce waste moving off farm and increase on-farm and system water efficiency. Goals that specifically address these issues are-

- To improve irrigation management to achieve 65% average annual water use efficiency on all irrigation farms within five years.
- To improve irrigation infrastructure and management to achieve a water delivery efficiency of 75% within five years.
- To reduce the load of chemical contamination in tailwater by 40% within five years.
- To reduce the load of nutrient contamination in tailwater by 40% within five years.
- To reduce sediment loads in tailwater by 40% within five years.

The role of Ord Land and Water (OLW) is to encourage and assist where able in the implementation of the plan and the achievement of the goals within.

## **1.2 Scope and Purpose of the study**

Currently there are several projects and initiatives within the ORIA that are addressing surface water quality and water efficiency managed by organisations such as Department of Agriculture, Ord Irrigation Cooperative, Ord Land and Water and the Water and Rivers Commission. These are dealing with pesticide runoff, monitoring and on-farm water efficiencies.

In addition to this, two concepts that industry and the community have flagged to be further explored are –

- Increasing water efficiency within the ORIA by pumping wastewater from the drains back into supply channels for irrigation.
- Developing wetlands at the end of drainage systems to remove silt and pollutants from drainage water prior to it entering the riverine environment.

In order to test the validity of these two concepts OLW secured Envirofund funding to gather for further use specific information on the present channel and drainage systems.

The purpose of this report is to –

- Identify where tailwater can be re-used from within the drainage systems for further on-farm use at a system level.
- Perform some limited monitoring of the effectiveness of a wetlands system for containing contaminants.
- Examine what and how wildlife utilises the current drainage system.
- Explore some concepts relating to infrastructure required for water re-use.

It is understood that currently the OIC is unable to return used water to the system's supply channels. This is due to potential quality issues that are associated locally with used water. They include the potential for unwanted nutrients and pesticides to be transported off farm and affect crops down stream.

The OIC is currently investigating ways that this issue can be overcome including actively seeking with OLW reductions in nutrients and pesticides leaving the farms. If this can be achieved re-use will become a viable option to ensure water efficiency commitments are met.

## **2.0 Methodology**

### **2.1 Water re-use.**

Actual water use per hectare at a block level is liable to change from year to year along with changes in management practices, rainfall and crop rotation. Water has been allocated to the irrigation area at 17 megalitres per hectare of cropped area. Sugarcane is by far the largest user of water per hectare of the major crops and covered over 4,000 hectares of irrigated land in 2002 (DAWA Final Crop Returns 2002). Most farmers are currently unsure of their ability to irrigate within the allocation when it is understood that sugar transpires one megalitre of water per 10 tonnes of harvested cane (DAWA sugar extension officer) when allowing for seasonal variations. It is considered by some farmers that a figure of between 20 and 25 megalitres may be required for longer-term economically sustainable yields.

Horticulture has very different watering needs; with most crops occupying the ground for only a part of the year. Crops can be successfully irrigated on as little as six megalitres or less. Cover crops that are increasingly following horticulture production have similar water requirements. Other significant crops such as sandalwood use four to six megalitres and leuceana 22 megalitres per annum.

As a consequence drainage catchment areas that have large areas of cane have the potential to run much more waste water to areas that are mainly horticulture.

Based on these crop mixtures that could and will vary on an annual basis to some extent it was decided for the calculations within this report to use the current annual allocation of 17 megalitres per hectare.

### **3.0 Water Re-use**

#### **3.1 The irrigation system.**

The ORIA system is designed around the furrow irrigation system. A series of channels deliver water to supply points situated on the boundaries of property blocks. Water is sub-divided on the properties through a further series of channels that deliver water directly to crops through siphons.

Infiltration of water into the soil profile is dependant on –

- The slope of the block.
- Flow of water into the block (head).
- Impediments within the furrows.
- Structure, type and tilth of the soil.



Water delivered from farm channels to the field by siphon hoses.

On almost all blocks the water flow down the furrow exceeds its lateral movement across the soil surface and into the profile. As a consequence there is potential for a significant flow of water through the block prior to adequate soil moisture levels being achieved based on crop requirements. Excess irrigation water is removed from the system through a series interlinked drainage systems that re-enter the river at points along its course.



Excess water building in the tail drain of an irrigated field.

### 3.2 Water use.

The annual average water usage of ORIA Stage 1 area is currently 185 gigalitres. No figures are currently available to show water losses back to the river through irrigation runoff or venting of surplus water within the delivery system.

The Ord Irrigation Cooperative (OIC) is currently installing the Supervisory Control and Data Acquisition (SCADA) system to control and reduce venting of surplus water from the supply system. SCADA will also contribute data to identify efficiency levels of the supply system. OIC is working towards having a system efficiency level of 85% by five years after SCADA installation.

Irrigation efficiency within the ORIA varies greatly between the variety of crops and management practices currently present. The Ord Land and Water Management Plan 2000 has the goal: *'To improve irrigation management to achieve 65% annual water use efficiency on all irrigation farms within five years'*. Based on the assumption that the OLW water efficiency goal can be achieved it is assumed that 35% of irrigation water will pass through the system back to the river. This would mean that close to 65 gigalitres of the current annual usage of 185 gigalitres would pass through the system and back into the river annually. At an allocation 17 megalitres per hectare this amount could potentially irrigate 3,800 hectares of crop, if it was possible for this water to be reused totally.

### 3.3 Possible re-use options on selected sites.

This study selected six sites from where water re-use appears to be a feasible option. Site selection was done in consultation with staff from the OIC. Other sites were also considered but were put aside as they failed to meet the criteria set.

#### *Selection criteria*

Site selection was based on the size of the separate drainage catchments and their capacity to supply a regular flow of water. Also considered was the proximity of a power supply (electrical) and the proximity of a delivery point in the form of a supply channel or area of land that could be potentially irrigated.

The six study sites are listed below in table 1.

Table 1

<b>Drainage area</b>	<b>Total area drained (hectares)</b>	<b>Potential water destinations</b>	<b>Power available</b>	<b>Pumping height</b>	<b>Potential re-use capabilities (megalitres)*</b>
Packsaddle	1,400	New farming area.	Nil	?	8,330
D1	574	New farming area.	Yes	5 metres	3,415
D2	1,600	New farming area.	Yes	?	9,520
D6	635	Existing area 1041 ha.	Yes	3 metres	3,778
D4 (option 1)	2,700	Existing area 1926 ha.	Yes	5 metres	16,065
D4 (option 2)	1,900	New farming area.	Nil	?	11,305
D4 (option 1 and 2 combined)	4,600	New farming area.	Nil	?	27,370

\* Based on assumptions of crop allocation of 17 megalitres per hectare is used at an on-farm 65% efficiency level.

#### *Packsaddle*

The drainage system for the packsaddle irrigation system is predominantly Packsaddle Creek. Approximately 1,400 hectares of irrigated farmland drains into the creek whilst the rest of Packsaddle drains into Packsaddle Swamp.

There is very little in the way of opportunities for re-use of drainage water on the existing irrigation area apart from perhaps some limited 'in-farm' re-use. This is due to the distance between the main drainage system (Packsaddle Creek) and the SP1 and SP1A systems. If water were to be reused within the existing area it would be difficult to engineer a cost effective method of moving re-use water back into the supply system.

While there appears to be little opportunity for cost effective re-use within the existing system there may be opportunities for re-use on land that could be brought into agricultural production at a later stage. There is a portion of land on King Location 512, which the Department for Planning and Infrastructure (DPI) Land Asset Management Services considers suitable for proposed horticultural development. The

amount of land to be released is dependent on advise from various agencies and a suitable development plan being provided by the successful developer.

If this proposed land release goes ahead it will require an irrigation supply. Based on that, there is scope for tailwater from the existing system to be pumped onto this land for that purpose.

***D1***

At 574 hectares this is the smallest of the examined drainage catchments. Although D1 does run for some of its length parallel to the Main Supply Channel it is not until it has been diverted away that it picks up a significant portion of the catchment. The confluence between D1 and D1A1 appears to be from both a catchment capacity level and power source supply the best position for any re-use pumping. Close to this point at the bottom of S1 there are two sets of wheels supplying water to approximately 80 hectares of irrigated farmland. This appears to be the only opportunity that presents itself for re-use within the existing irrigation area.

Another option water re-use from the D1 catchment would be if there was any agricultural development of the adjacent Unallocated Crown Land (UCL). There is an area in excess of 300 hectares that lies between D1A1 and the river. However at this stage there are several impediments to the development of UCL including the issue of ‘Native Title’. Until these issues are resolved it would be difficult for a proponent to successfully have this land approved and made available for irrigated agriculture.



Pumping out of drains onto land currently not serviced by existing channel structures within the ORIA.

***D2***

D2 has a catchment of 1600 hectares, but has limited scope to supply re-use water to the existing irrigation area, the only opportunity may come from some limited use from farms adjacent the proposed pump out point.

A parcel of land of 657 hectares currently vested in DPI titled ‘Vacant Parkland’ (38358) is situated down stream of the existing irrigation area. If this was to be developed for irrigated agriculture the re-use pump out point could be situated downstream of where D2 crosses under Research Station Road.

**D6**

This drainage catchment is relatively small, however it intersects the S6 supply system at a point where 635 hectares of catchment has been collected making this an attractive option. As an added benefit electrical power is present. The pump out point for this system would need to be placed just downstream of the intersection of D6 and D6A. This position would allow water to be supplied to the S6 system that services over one thousand hectares of irrigated farmland.



Picture shows the proximity of D6 (background) to S6 (foreground).

**D4 option 1**

The D4 drain is the largest drainage catchment in the ORIA and as a consequence has more than one option for re-use. ‘Option 1’ proposes a pump out point downstream of the ‘D4 Bridge’ on Weaber Plains Road between S5B and M1. This would allow water to be pumped into either or both of these supply channels to service S7 and S8 (a combined total of 1926 hectares).

**D4 option (Green Location)**

*Green Location* is situated to the north of the existing irrigation area. Currently a proponent is attempting to make the land available for irrigated agriculture. If the proponent is successful there is an opportunity for drainage water from the existing irrigation area to be used for irrigation of the new land. The pump out point could be situated at a suitable location on the D4 drain.

The drainage catchment downstream of the 'D4 option 1' totals 1,900 hectares but if all of the D4 drainage was allocated to this point including drainage for 'option 1' the catchment would total 4600 hectares. This could represent more than 27,000 megalitres per annum available for irrigation. Currently this site does not have power close at hand however it is expected that once the 'Green Location' proposal moves forward the power grid will be extended to the area.

## 4.0 ORIA WETLANDS SYSTEMS

### 4.1 Wetland Drains.

Currently the majority of the ORIA drains empty straight into the river without going through any prior filtering process to remove pollutants, apart from the deposition of sediment within the drains and natural attenuation over time. However there are some smaller drainage systems not a part of the main drainage infrastructure that have developed a wetlands system either within them, or at their end, but prior to their entry into the river. Water from these drains still enters the river but must first pass through the wetlands they contain.

The wetlands system within these drains has developed for a number of reasons. Either lack of regular maintenance, difficulty in getting heavy equipment in the clean them out or as in the case of the drainage system for the Department of Agriculture Western Australia (DAWA), a developed strategy to reduce the flow of any potential pollutant into the river.



A drain that has developed a wetlands system within itself.

Wetlands are currently being used and trialed in other areas to trap silts and contaminants such as pesticides and nutrients to stop them running off farm and into rivers. The suitability of wetlands systems to act as a filter to remove silt and contaminants from farm wastewater has been a subject for discussion the some years in

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the ORIA. Strategies within the ‘Land’ component of the Ord Land and Water Management Plan specifically call for work to be done on demonstrating if artificial wetlands within the local drainage system have the capacity to remove silt and contaminants from farm wastewater.

The Ord Irrigation Cooperative (OIC) is aware of the interest in utilising the filtering effect of wetlands. However is concerned about a number of issues concerning their placement within the drainage system that they need to maintain. Currently they spend a significant portion of their operating budget on clearing silt and associated vegetation from the drainage system to ensure that the flow of tail water and wet season runoff is largely unimpeded. The issues associated with wetlands within the drainage system include-

- Their maintenance and the extra costs associated with it including the removal of trapped silt.
- The possibility that they may impede wet season storm runoff from the irrigation area and cause some localized flooding.
- Their effectiveness and what if any cost benefits they are able to generate over other methods of silt and contaminant removal.

Prior to any establishment of demonstration trials of wetlands within the existing drainage system it was felt that there needed to be some investigation into how existing systems work and some monitoring of their ability to remove silt and contaminants from drainage water.

#### **4.2 Monitoring Trial.**

The wetlands system that receives tailwater from the Department of Agriculture Western Australia (DAWA) has a catchment of 450 hectares. The system has been there for many years and receives very little in the way of on-going maintenance (*pers comm.* G Plunkett). On this basis it was decided that this should be the site selected for any ongoing wetlands monitoring work.

On a large-scale system such as the one selected, the practicalities of tracking and monitoring a single ‘event’ would be extremely difficult over its length (close to a kilometre). For this initial trial it was decided to concentrate on a small portion close to a bay that could be treated.

The chemical Endosulfan was selected for this work as it is transported off farm mainly attached to soil particles. One of the characteristics of a wetlands system is its ability to slow the flow of water and allow soil particles to drop out taking with it any attached pesticide particles. These can then be degraded biologically within the system.

#### ***Methodology***

Approximately three hectares of ground was sprayed aerially with the product Thiodan (containing Endosulfan 350gms/litre active constituent). Three days later the field was irrigated and water samples were taken from three points along the wetlands system. These points were-

1. Just prior to the tailwater entering the wetlands.
2. 25 metres into the system.
3. 50 metres into the system.

Samples were taken at 30-minute intervals from all three sites with a ‘lag time’ factored in to ensure the water had had time to move the required distance (see table 2). Samples 1 – 3 were used as a benchmark for water quality and were taken from the head ditch prior to the water running through the field. Samples 4 – 7 were taken in the tail drain prior to the wetlands system. Samples 8 – 11 were taken 25 metres into the system and samples 12 – 15 were taken 50 metres in.

Table 2

Sample No	Time taken (pm)	Location
1	8.00	Head ditch
2	8.00	
3	8.00	
4	6.05	Prior to wetlands
5	6.35	
6	7.05	
7	7.35	
8	6.15	25 metres into wetlands
9	6.40	
10	7.10	
11	7.40	
12	6.20	50 metres into wetlands
13	6.45	
14	7.15	
15	7.45	

### **Results**

No endosulfan sulfate was recorded coming from the field; perhaps due to the low overall levels the sulfate was below detectable limits (see table 3). Sampling shows a typical rise in concentrations through out the measured watering cycle.

Table 3

Sample Number	Endosulfan 1	Endosulfan 2	Endosulfan sulfate
1	nd	nd	nd
2	nd	nd	nd
3	nd	nd	nd
4	.024	nd	nd
5	.055	nd	nd
6	.049	nd	nd
7	.055	.049	nd
8	.034	.027	nd
9	.048	.047	nd
10	.065	.047	nd
11	.061	.051	nd
12	nd	nd	nd
13	.069	.068	nd
14	.043	.069	nd
15	.047	.032	nd

Due to the ever-rising concentrations throughout the monitoring period it was decided that the trend in concentration levels between the monitoring points should be compared. From the point prior to the wetlands (Graph 1) the typical rising trend is

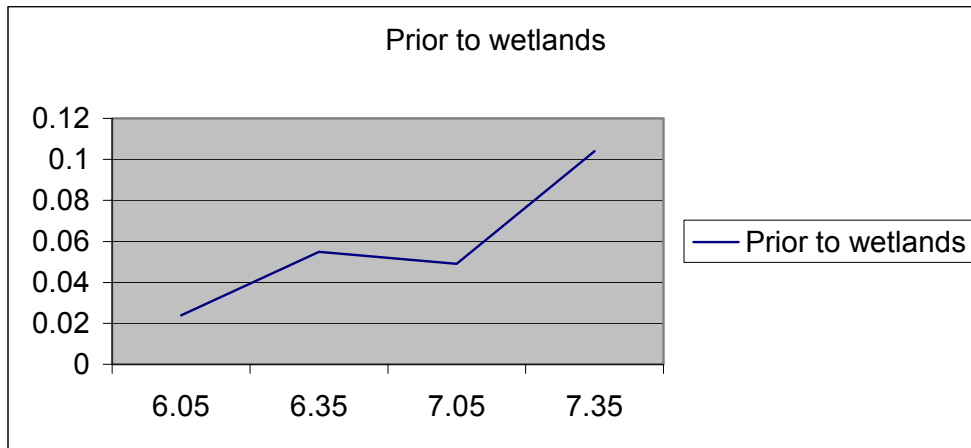
evident over the sampling time. From the sampling point 25 metres into the wetlands (Graph 2) the trend is for a slower rise followed by a plateau. From the final sampling point 50 metres into the wetlands (Graph 3) the trend is for the concentrations to decline.

What is unclear in the results from the sampling is why there was an overall rise in concentrations from the points further into the wetlands compared with the sampling point prior to the wetlands. For example, there are only five-minute gaps between the taking of samples 5,9 and 13, this was to allow time for the water to move the 25-metre distance. Yet the concentration rose from .055ppm to .137ppm. There is no record of endosulfan being used in that area prior the experiment and according to the Farm Manager no endosulfan has been used on the farm for the past seven years.

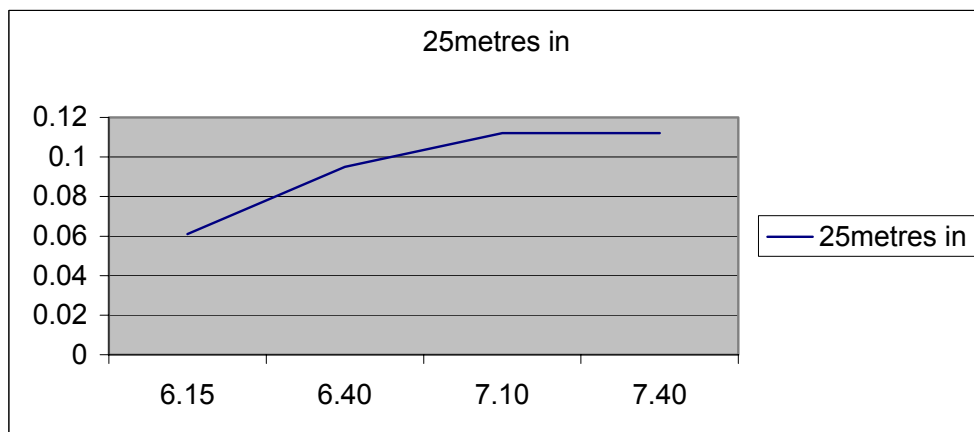
**Conclusions.**

Results from this sampling show very different trends between the sampling points that could be attributed to the influence of the wetlands system. It needs to be stated however that this is far from conclusive. It is strongly recommended that further work be done to monitor the DAWA wetlands system as a whole of an extended period. Monitoring work should include pesticides, nutrients and silt. Monitoring should be carried out throughout both the wet and dry seasons to assess the impact of climatic and management variations on the system.

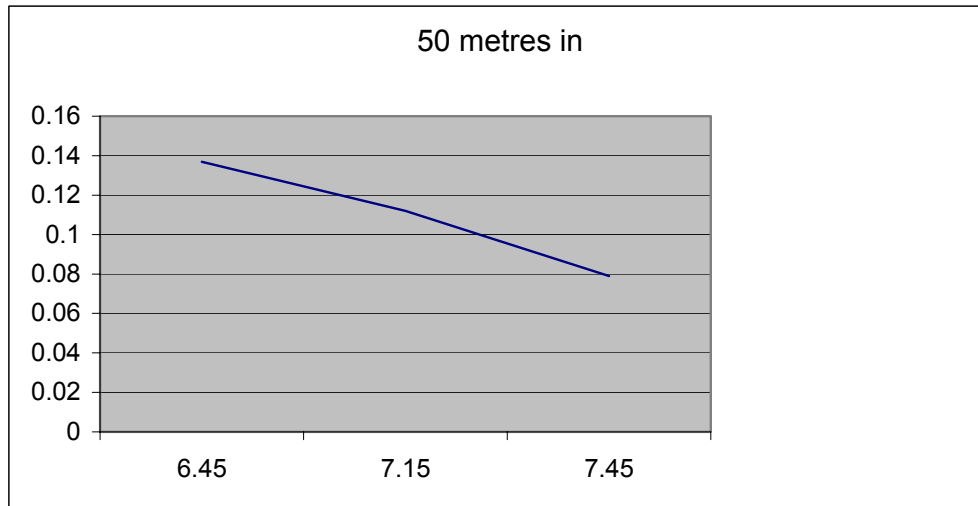
Graph 1



Graph 2



Graph 3



## 5.0 WILDLIFE AND THE DRAINAGE SYSTEM

### 5.1 Fish.

Several fish and crustacean species are known to inhabit the ORIA drainage system. Some such as barramundi appear to be seasonal in their usage whilst other species such as barred grunter appear to be permanent residents. Fish species that utilise the drainage system as a habitat are subject to high variations in flows and water temperatures. As a consequence hardy fish such as grunters will be found consistently whilst more fragile species such as glassfishes are mostly absent.

It is generally well-established local knowledge that diadromous fishes such as barramundi and Ord River mullet will use the ORIA drainage system in an attempt to move from the estuary up into the fresh water sections of the river. This is due to the drainage systems returning significant flows of water to the river during the seasonal migratory period of these fish. At times the urge to move upstream has been strong enough to enable mullet to swim out of the drainage systems, into irrigated fields and through the larger two inch siphons into the on-farm supply channels.

This occurrence has led many to believe that there may be an opportunity to use the ORIA drainage and supply system to act as migratory corridors with the construction of fishways between the drains and the supply channels. If successful it would allow access to the upper freshwater catchment of the Ord River that was closed with the construction of the Kununurra Diversion Dam in 1963.

The Lake Kununurra Fish Stock Enhancement Group recently commissioned the Centre for Fish and Fisheries Research of Murdoch University to produce a report on the *Ecological and Social Issues Concerning the Establishment of a Recreational Barramundi Fishery in Lake Kununurra*. Part of the report deals with the options for fishways locally and their effectiveness for tropical species to move through them. The report makes the following observations regarding the possible use of drainage channels-

- *Alternatives to a dedicated fishway at the Kununurra Diversion Dam will include suggestions that barramundi might enter Lake Kununurra via the waterways of the Ivanhoe Plain Agricultural precinct, because juveniles are occasionally found in the near-river sections of some agricultural drains. The extent that barramundi utilise these waterways is unknown, however the generally poor and occasionally toxic water quality of drainage channels in the irrigation area (Doupe et al. 1998) probably limits the usefulness of present infrastructure as an adequate fish passageway.*



Confluence of the Ord River and D4 drain.

From 1998 to 2003 the East Kimberley Recreational Fishing Advisory Committee has kept a record of barramundi and mullet movement into the D2 drainage system (see Table 4). From this limited record of observations it appears that fish don't attempt to use the drainage system for migration every year.

Table 4

Year	Fish Species	Comments
1998	Barramundi	Large numbers within drain.
	Mullet	Large numbers within drain.
1999	Barramundi	Large numbers within drain.
	Mullet	Large numbers within drain.
2000	Barramundi	Large numbers within drain.
	Mullet	Large numbers within drain.
2001	Barramundi	No fish found.
	Mullet	Large numbers within drain.
2002	Barramundi	No fish found.
	Mullet	No fish found.
2003	Barramundi	No fish found.
	Mullet	No fish found.

In addition to the incidence of migration within the drains observations have indicated that numbers sedentary species of fishes such as the northern trout gudgeon and the crustacean cherabin have reduced since the Ord River Irrigation Cooperative (OIC) started regular de-silting maintenance on the drainage systems (*anglers observations*).

### 5.2 Reptiles.

A recent study was conducted but not yet concluded by Phillip Mayes supported by Murdoch University looked at the ecology of Merten's water monitor (*V. mertensi*) living in the ORIA. A preliminary assessment of the data does suggest that water monitors appear to be resident within certain areas of the ORIA, usually the larger channels and drains. Some animals move between the channels and drains and other natural features such as Lake Kununurra.

From surveys of M1 for Johnston's crocodile (*C.johnstoni*) and *V. mertensi* over the years 2001 and 2002 it would appear that large numbers of both these species appear resident in M1 channel. Some monitors resident in areas of channel can be located only with 800-1000m of the channel appearing to have rather small homer ranges.

### 5.3 Birdlife.

No evidence of any bird surveys that specifically dealt with the ORIA's drainage systems has been found. However there has been significant work done to document bird species within the ORIA and the surrounding Ord region through the 'Birds Australia Atlas' project with recordings of location and species documented since 1996. In a 12-month survey of a single farm within the ORIA 65 of the 246 species of birds reported in the wider Ord region were recorded. It is clear from these observations that some birds do take up semi permanent or permanent residence in the ORIA drainage systems. Although when compared visually with the utilisation of some migratory birds of the farmland on a seasonal basis, the populations that make use of the drainage systems appear to be low.



The Great Egret is particularly common within the drainage system.

## 5.4 Conclusions.

Although far from comprehensive the information highlighted in this report would indicate that the present drainage system currently is a habitat either of a temporary or permanent nature for only a limited suite of reptiles, fish and bird species compared to a natural waterway.

Phillip Mayes' work once concluded should give a much clearer indication of how the species of reptile studied utilise the system.

## 6.0 CONCEPTUAL DESIGNS

### 6.1 Re-use infrastructure.

The building of holding points within the drainage systems for water to be pumped for re-use needs to consider a number of factors including wet season rainfall, its impact on any damming structure and the impact of the structure in terms of flooding. Currently the Ord Irrigation Cooperative does not allow any damming infrastructure within the drains for the taking of 'opportunity water' for irrigation. Where 'opportunity water' is pumped from the drains the only allowable modification is for the bed of the drain to be deepened to form a sump to allow a reasonable depth for pumping.

Wet season rains of in excess of 50 millimeters are regularly recorded each wet season. When these events occur in a short period of time a significant portion of the ORIA drainage catchment fills close to capacity. Any dam structure within the drains would more than likely impact on the ability of the drain to transport flood waters quickly away from the farmlands. In addition to the potential to cause local flooding there is the potential for the floodwaters to impact on the structure itself causing damage.

This report is unable to look closer at any conceptual design for re-use infrastructure within the drains. However a local surveying company did an estimate of costings to enable a perspective to be gained of resources that would be required to be secured to initiate any 'onsite' works, they are as follows-

Step	Estimated cost
Scoping study	\$15,000
Concept design	\$15,000
Preliminary design	\$20,000
Survey	\$12,000
Construction of retention dams (6)	\$480,000
<b>Total</b>	<b>\$542,000</b>

### 6.2 Wetlands.

The National Program for Irrigation Research and Development looked at the use of wetlands to remove contaminants from drainage water in a project completed June 2000. The project '*Nutrient Control in Irrigation Drainage Systems Using Artificial Wetlands*' showed that that the vegetated wetlands used were effective in removing around 40% of atrazine and Diuron applied at the inlets. In addition the wetlands removed 60-70% of the suspended solids load (compared to 16-49% from a control bay without vegetation). However there was a net increase (ranging from 0.4% to 67%)

in total phosphorous, this suggests that physical, chemical or biochemical enrichment processes occurred during the transit through the bays. Changes in total nitrogen were relatively small and variable (within a range of  $\pm 22\%$ ).

Design of the wetlands for this project consisted of four wetlands bays each 60m long. Three bays were excavated to a depth of 1m and 6m wide and included deeper settling basins and planted with local wetland macrophyte species. The fourth bay was designed as a control and its dimensions were altered within the life of the project. Water took between two and three days to move through the wetlands area.

## **7.0 SUMMARY AND RECOMENDATIONS**

### **7.1 Water re-use**

This study concludes that there is significant potential for the re-use of tailwater at a system level within the ORIA. This report identifies a total of six points within the drainage system that could potentially become pump out points for water to be re-used both within the existing irrigation system and on areas yet to be developed.

Of the sites selected two have the capacity to contribute to the irrigation requirements of large areas of existing farmland (2967ha). Prior to this happening however the issue of the quality of re-use water in terms of potential pesticide and nutrient levels would need to be dealt with by the Ord Irrigation Cooperative and the local agricultural industry.

The other four remaining sites would have the potential to supply some water in the event that new irrigated farmland was developed close to these sites.

#### **Potential sites**

##### ***D6 and D4 (option1)***

These two sites could provide re-use water for a portion of the existing irrigation area. They are situated where channel and drain systems intersect. Both sites have the power grid in close proximity and have reasonable drainage catchments (635ha and 2700 respectively).

##### ***D4 (option2)***

With the possibility that 'Green Location' will become irrigated agriculture there is an opportunity to incorporate water re-use into the design of the system utilising both the Green Location drainage catchment and some of the existing irrigation drainage catchment. The pump out point would be situated at a suitable location in the D4 drain. The drainage catchment downstream of the 'D4 option 1' totals 1,900 hectares but if all of the D4 drainage was allocated to this point including drainage for '*option 1*' the catchment would total 4600 hectares. This could represent more than 27,000 megalitres per annum available for irrigation.

##### ***Packsaddle***

There are limited opportunities for re-use water to be pumped back into the supply system on packsaddle. Re-use could occur 'on-farm' but due to the distances between the main drainage system (Packsaddle Creek) and SP1 and SP1A systems re-use would be difficult to engineer.

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However the Department of Land Administration (DoLA) has currently listed for proposed horticultural development 800 hectares of land on King Location 512. If this parcel of land is released there are opportunities to re-use a significant amount of packsaddle's drainage water to contribute to the irrigation requirements of this new development.

### ***D2***

D2 has a catchment of 1600 hectares, but limited opportunities to supply re-use water to the existing irrigation area. A parcel of land of 657 hectares currently vested in DoLA titled 'Vacant Parkland' (38358) is situated down stream of the existing irrigation area. If this was to be developed for irrigated agriculture the re-use pump out point could be situated downstream of where D2 crosses under Research Station Road.

### ***D1***

This is the smallest of the drainage catchments (574hectares). The intersection between D1 and D1A1 appears to be from both a catchment capacity level and power source supply the appropriate position for any re-use pumping. At this point there is a limited opportunity for re-use water to be used on approximately 80 hectares of irrigated farmland.

Another option would be for the development of the adjacent Unallocated Crown Land (UCL). However at this stage there are several impediments to the development of UCL for agriculture including the issue of Native Title that a proponent would need to deal with.

## **7.2 ORIA wetlands systems.**

Given the right conditions it is apparent that wetlands are able to naturally establish themselves within the ORIA drainage systems. Unknown to date is their capacity to effectively filter contaminants from tailwater flowing through them and what maintenance is required for their upkeep.

Several wetlands currently exist in varying sizes from small systems that have a catchment of less than 50 hectares to a large and well-established system that has a catchment of 450 hectares.

Wetlands within the drainage systems could create significant problems for the OIC by way of their management and with respect to their potential to restrict the movement off farm of wet season flooding and other associated impacts on drainage infrastructure.

Wetlands are currently being used and trialed in other areas to stop silts and other contaminants from running off farm and into rivers. The suitability of wetlands systems to act as a filter to remove silt and contaminants from farm wastewater has been a subject for discussion the some years in the ORIA. Strategies within the 'Land' component of the Ord Land and Water Management Plan specifically call for work to be done on demonstrating if artificial wetlands within the local drainage system have the capacity to remove silt and contaminants from farm wastewater.

Prior to any establishment of demonstration trials of wetlands within the existing drainage system it was felt that there needed to be some investigation into how existing

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systems work and some monitoring of their ability to remove silt and contaminants from drainage water.

Results from this sampling show very different trends between the sampling points that could be attributed to the influence of the wetlands system. It needs to be stated however that this is far from conclusive. It is strongly recommended that further work be done to monitor the DAWA wetlands system as a whole of an extended period. Monitoring work should include pesticides, nutrients and silt. Monitoring should be carried out throughout both the wet and dry seasons to assess the impact of climatic and management variations on the system.

### **7.3 Wildlife and the drainage system.**

#### ***Fish.***

Several fish and crustacean species are known to inhabit the ORIA drainage system. Some such as barramundi appear to be seasonal in their usage whilst other species such as barred grunter appear to be permanent residents. Fish species that utilise the drainage system as a habitat are subject to high variations in flows and water temperatures. As a consequence hardy fish such as grunters will be found consistently whilst more fragile species such as glassfishes are mostly absent.

Due to the drainage systems returning significant flows of water to the river during the seasonal migratory period of some diadromous fishes such as barramundi and Ord River mullet fish. Enter the drainage system in an attempt to move into the upper catchment.

This occurrence has led many to believe that there may be an opportunity to use the ORIA drainage and supply system to act as migratory corridors with the construction of fishways between the drains and the supply channels.

The Lake Kununurra Fish Stock Enhancement Group recently commissioned the Centre for Fish and Fisheries Research of Murdoch University to produce a report on the *Ecological and Social Issues Concerning the Establishment of a Recreational Barramundi Fishery in Lake Kununurra*. Part of the report deals with the options for fishways locally and their effectiveness for tropical species to move through them. The report suggests that the current drainage system is limited in its usefulness as an adequate fish passageway.

Further to this the East Kimberley Recreational Fishing Advisory Committee records of fish movement within a drainage system show that seasonal migration is not reliable

In addition observations have indicated that numbers sedentary species of fishes and crustaceans have reduced since the Ord River Irrigation Cooperative (OIC) started to regular de-silting maintenance on the drainage systems.

#### ***Reptiles.***

A recent study not yet concluded by Phillip Mayes supported by Murdoch University looked at the ecology of Merten's water monitor (*V. mertensi*) living in the ORIA. A preliminary assessment of the data does suggest that water monitors appear to be resident within certain areas of the ORIA, usually the larger channels and drains. Some

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animals move between the channels and drains and other natural features such as Lake Kununurra.

From surveys of M1 for Johnston's crocodile (*C. johnstoni*) and *V. mertensi* over the years 2001 and 2002 it would appear that large numbers of both these species appear resident in M1 channel. Some monitors resident in areas of channel can be located only with 800-1000m of the channel appearing to have rather small homer ranges.

### ***Birdlife.***

No evidence of any bird surveys that specifically dealt with the ORIA's drainage systems has been found. However there has been significant work done to document bird species within the ORIA and the surrounding Ord region through the 'Birds Australia Atlas' project with recordings of location and species documented since 1996. In a 12-month survey of a single farm within the ORIA 65 of the 246 species of birds reported in the wider Ord region were recorded. It is clear from these observations that some birds do take up semi permanent or permanent residence in the ORIA drainage systems. Although when compared visually with the utilisation of some migratory birds of the farmland on a seasonal basis, the populations that make use of the drainage systems appear to be low.

### ***Conclusions.***

Although far from comprehensive the information highlighted in this report would indicate that the present drainage system currently is a habitat either of a temporary or permanent nature only for a limited suet of reptiles fish and bird species compared to a natural waterway.

Phillip Mayes' work once concluded should give a much clearer indication of how the species of reptile studied utilise the system.

## **7.4 Conceptual designs**

### **Re-use infrastructure.**

The building of holding points for water within the drainage systems to be pumped for re-use needs to consider a number of factors including wet season rainfall, its impact on any damming structure and the impact of the structure in terms of flooding. Currently the Ord Irrigation Cooperative does not allow any damming infrastructure within the drains.

This report is unable to look closer at any conceptual design for re-use infrastructure within the drains. However a local surveying company did an estimate of costings to enable a perspective to be gained of resources that would be required to be secured to initiate any 'onsite' works. They indicate that to place a damming structure within the drainage system and equip it with pumps could cost up to \$90,000.

The recommendations of the report would be to further investigate associated costs with the placing of a water holding point within the drains based on some type of damming structure or the present method of excavating a hole in the bottom of the drain to collect water.

***Wetlands.***

The National Program for Irrigation Research and Development looked at the use of wetlands to remove contaminants from drainage water in a project completed June 2000. The project '*Nutrient Control in Irrigation Drainage Systems Using Artificial Wetlands*' showed that that the vegetated wetlands used were effective in removing around 40% of atrazine and Diuron applied at the inlets. In addition the wetlands removed 60-70% of the suspended solids load (compared to 16-49% from a control bay without vegetation). However there was a net increase (ranging from 0.4% to 67%) in total phosphorous, this suggests that physical, chemical or biochemical enrichment processes occurred during the transit through the bays. Changes in total nitrogen were relatively small and variable (within a range of  $\pm 22\%$ ).

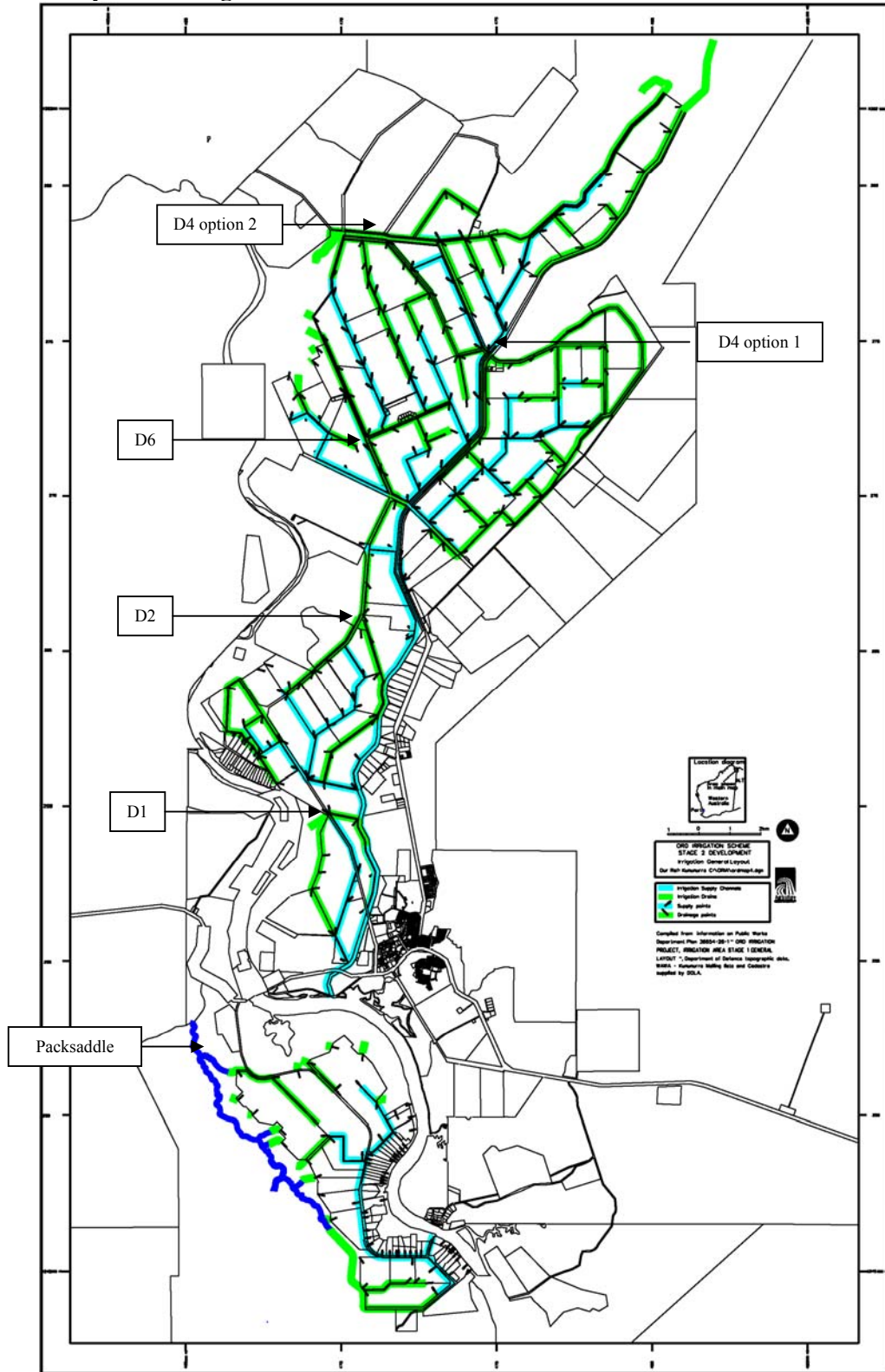
***Conclusions***

Wetlands are now considered to be an effective means for removing and breaking down pollutants. If a wetlands system can be built and maintained that is suitable and effective for the ORIA is unknown at this stage. However it could already be in existence at sites such as the DAWA study site.

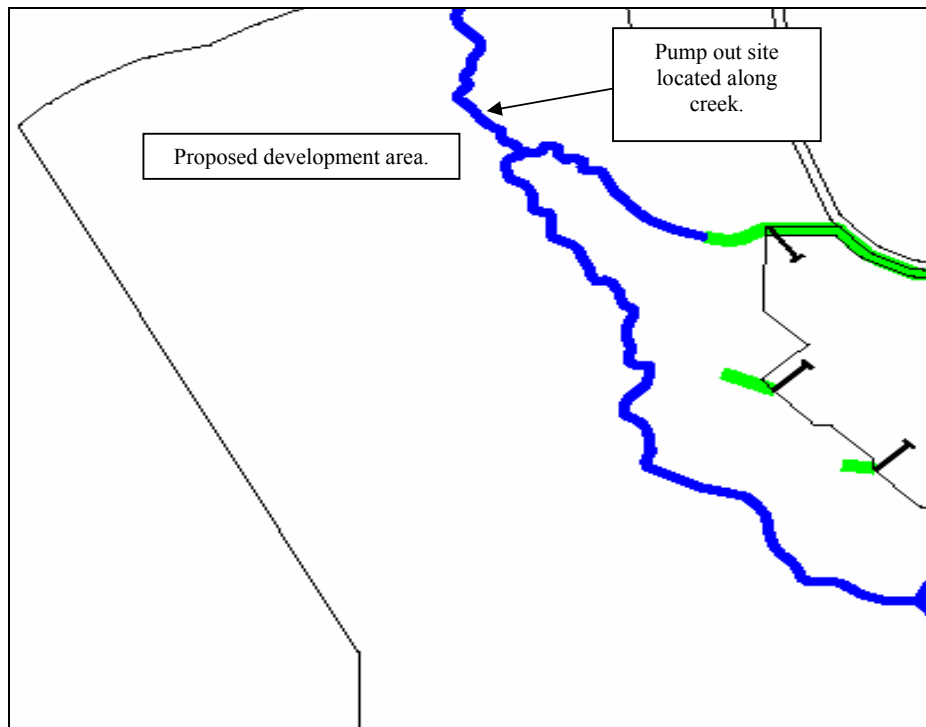
This report recommends that further monitoring of the DAWA site be given priority to test its ability to remove and breakdown pollutants.

## 8.0 IRRIGATION MAPS AND LOCATIONS

### 8.1 Map of the irrigation area.

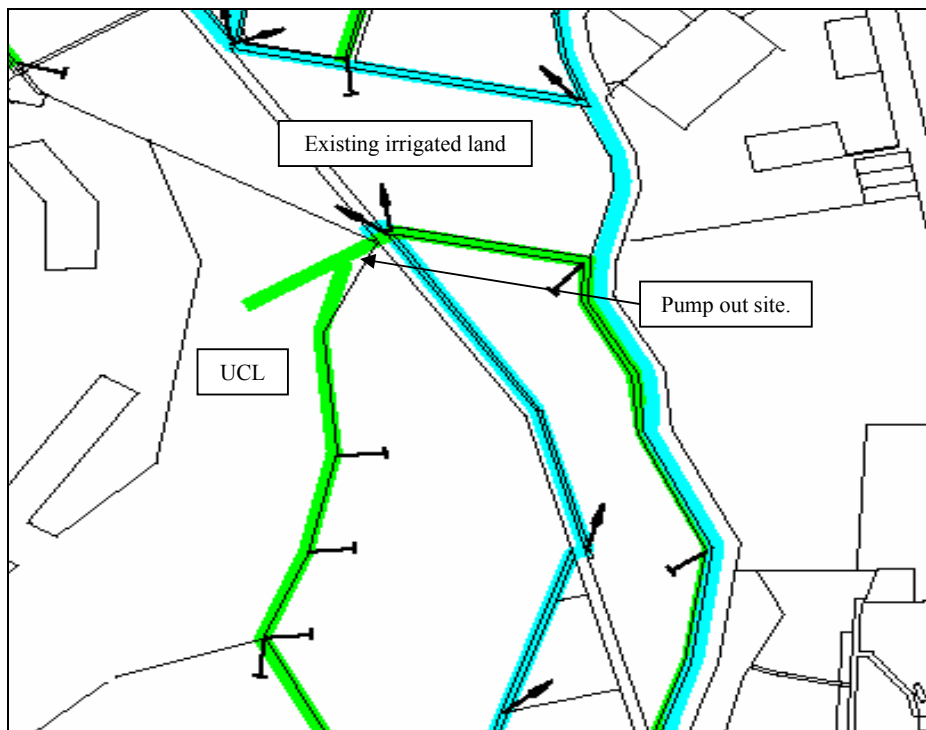


### 8.2 Packsaddle proposed pump out point.



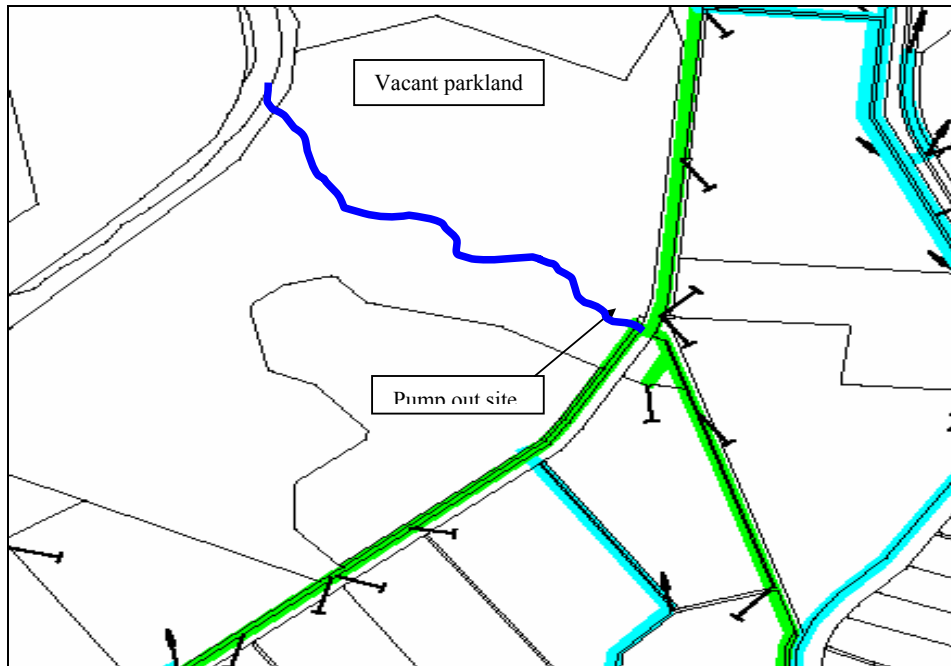
Packsaddle pump out options showing land proposed for future horticultural development.

### 8.3 D1 proposed pump out point.



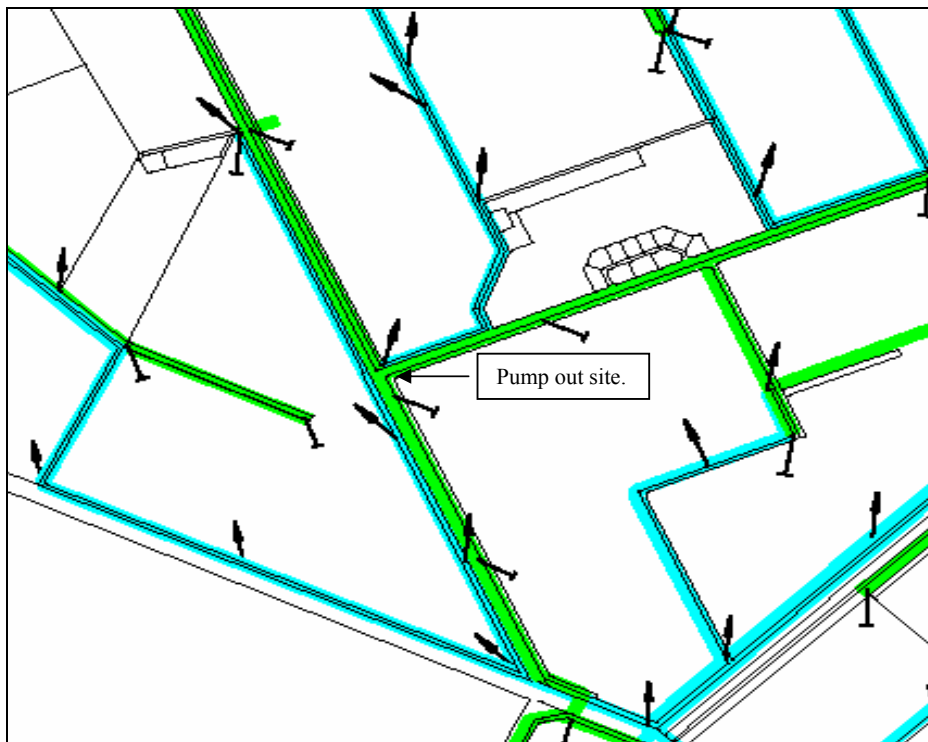
D1 proposed pump out point, Unallocated Crown Land (UCL) and existing irrigated land as mentioned in the report.

### 8.4 D2 proposed pump out point.

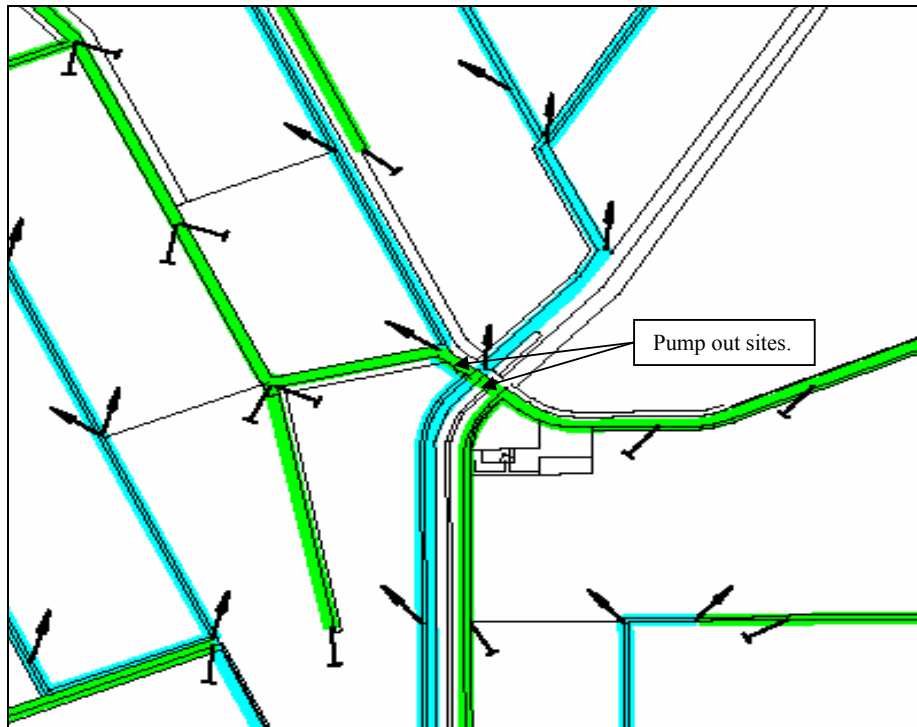


D2 proposed pump out point and 'Vacant Park Land'.

### 8.5 D6 Proposed pump out point.

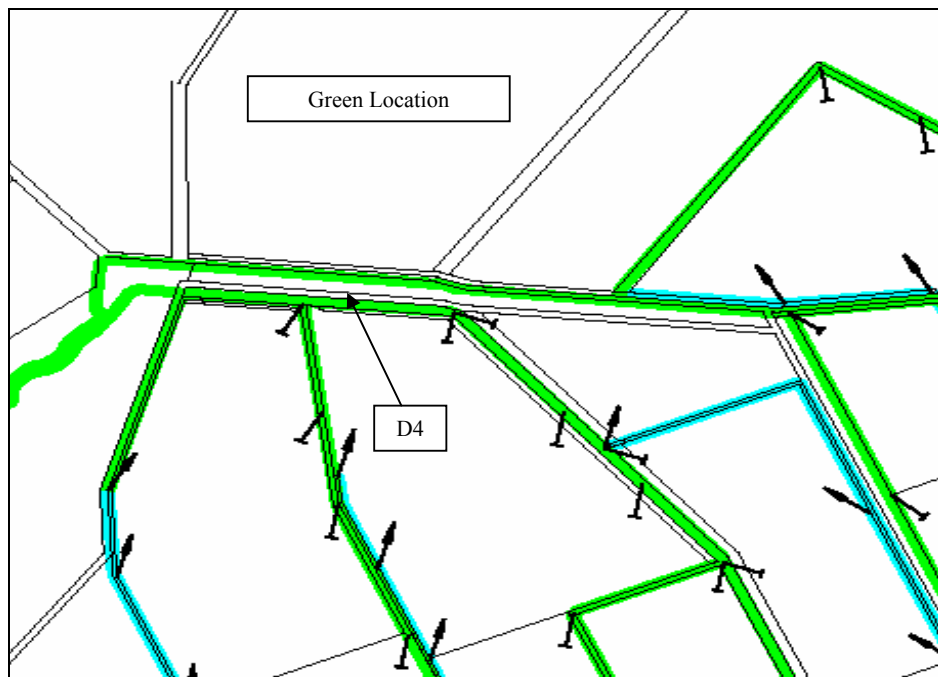


**8.6 D4 (option 1).**



Proposed pump out sites for M1 and S8B (D4 option 1).

**8.8 D4 (option 2).**



Proposed pump out site for Green Location (D4 option 2).