

Land Development and Stream Management in the Tully and Murray Rivers Catchment, North Queensland.

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ABSTRACT:

The Tully-Murray Rivers catchment of North Queensland is located in one of the highest rainfall areas in Australia and has the highest average annual discharge per catchment area in Queensland. The catchment has considerable economic potential and is an important fish habitat area.

More than 9000 hectares of grazing and forest lands within the catchments floodplain have been targeted for sugarcane expansion under the joint community, industry and government-sponsored Sugar Industry Infrastructure Package.

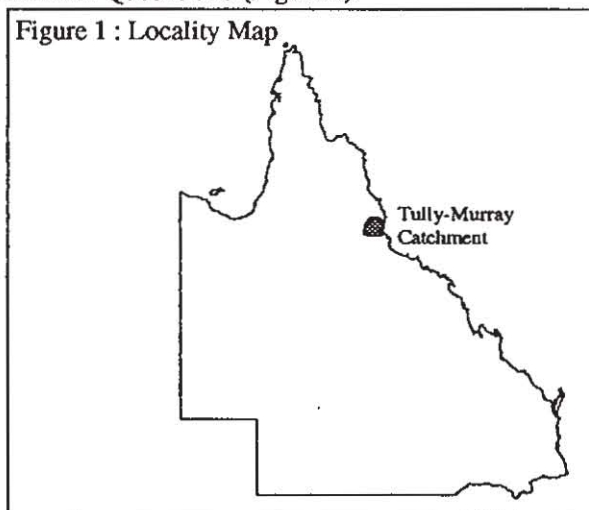
The expansion of the sugarcane industry in the catchment would significantly boost the local and state economies but is contingent on removal of residual floodwater to minimise inundation times. It is the basic requirement of the Package that any development will proceed in a planned and environmentally responsible manner.

Strategic management of the waterways which traverse the floodplain is fundamental to the success of the Package.

1. THE TULLY-MURRAY RIVERS CATCHMENT

1.1 Location and Climate

The Tully-Murray Rivers catchment (Latitude 18°S, Longitude 146°E) is located in the wet tropical coast of North Queensland (Figure 1).



The catchment experiences humid summers and mild relatively dry winters. Rainfall is concentrated in the period between October and March and is monsoonal. There is a strongly declining rainfall gradient from north to south with the town of Tully - to the north of the catchment receiving a mean annual rainfall of 4287mm over 151 wet days, and the town of Cardwell - to the south of the catchment receiving a mean annual rainfall of 2127mm over 135 wet days. It is not unusual for little or no rain to fall from April to September.

Mean monthly temperatures range from 14°C in June to 31°C in December. The prevailing summer winds are northeasterly and are monsoonally influenced. During winter much drier southeasterly winds prevail (Cannon, Smith and Murtha, 1992).

1.2 Catchment Hydrology

1.2.1 Surface Hydrology

The two main drainage features of the catchment are the Tully and Murray Rivers. The Tully River rises in the ranges immediately inland of Tully and has a total length of only 80km. It is classified as a Wild and Scenic River and flows through World Heritage listed area for the first 30km of its course. In this section the Tully River has steep bed gradients. Where it enters the floodplain, gradients flatten remarkably and the river becomes meandrine.

The mean annual discharge of the Tully River is 3401 521 ML with a range of between 4972 953 ML (1973-1974) and 2 003 425 ML (1977-1978) (QWRC, 1980). The area of the catchment above the measuring point is only 1475 km². Consequently the Tully River has the highest mean annual discharge per catchment area of any river in Queensland.

By contrast, the Murray River has a much smaller catchment area with a mean annual discharge of 226 240 ML ranging from 420 041 ML (1973-1974) to 86 508 ML (1977-1978). The total length of the Murray River is only 45km. It, too, rises in steep World Heritage listed land only 30km from its mouth.

For the purposes of this paper discussion will be limited to the Tully-Murray Rivers floodplain. Figure 2 shows that section of the floodplain which is being considered for expansion of the sugarcane industry. A number of smaller, but nonetheless

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important, streams traverse the floodplain. The majority of these enter the Murray River.

Several major lagoons, up to 6m deep, are present in the floodplain. These have resulted as the major watercourses have abandoned their channels with time.

During moderate and high floods the Tully and Murray Rivers merge and that section of the floodplain between their courses may remain inundated for days or weeks, depending on the intensity of the flood event. Potential development of the grazing lands in the western section of the floodplain will probably increase runoff and may exacerbate the flooding problem if unplanned.

1.2.2 Subsurface Hydrology

The floodplain contains two significant aquifers (Herbert and Lait, 1994). The older and deeper aquifer is a semi-confined alluvial aquifer which extends beneath the majority of the floodplain. It is used mainly by landholders adjacent to the Tully River. This aquifer is generally found at depths of between 20 to 40 metres below the surface and is mainly recharged laterally in areas around the periphery of the catchment where it is exposed at the surface. It is overlain by 10 to 15 metres of clayey sediments.

Perhaps the more significant aquifer of the floodplain underlies the area between Porter Creek, the Murray River and Dundonald Creek (Figure 2). This aquifer is unconfined, only 6 metres thick, and very dynamic - completely recharging and rapidly draining each climatic year. This aquifer is heavily exploited for domestic, stock watering and irrigation purposes. It is also in direct hydraulic connection with the floodplain lagoons. Unco-ordinated drainage of the floodplain has the potential to impact heavily on the availability of groundwater in this section of the floodplain.

1.3 Soils

Cannon, Smith and Murtha (1992) provide a comprehensive description of the soils of the floodplain. Generally, the soils are of two main types - those which are derived from the granite hills which form the catchment rim and those which are deposited as flood overbank deposits. The former are generally sandy and the latter silty. Both soil types are suitable for agricultural production.

Associated with the Tully and Murray Rivers are heavy, clayey, potential acid-sulphate soils in a strip

which extends for several hundreds of metres either side of these watercourses. Unco-ordinated drainage of these areas could generate acidic leachate.

1.4 Land Use

There are three main types of land use on the floodplain. These are banana production along the Tully River, beef cattle grazing in the King Ranch area west of the Murray river, and sugarcane production in the remainder of the catchment.

The floodplain is also recognised as a major fish breeding area (Hogan and Graham, 1994). The importance of this area to the fisheries of North Queensland has been recognised by the Queensland Government and, following a period of community consultation, the majority of the Tully and Murray Rivers, the floodplain lagoons and any lands which landholders wish to be included will probably be gazetted as a Fish Habitat Area.

2. THE RIVERSDALE - MURRAY VALLEY WATER MANAGEMENT SCHEME

Sections of the Tully-Murray Floodplain are already a major sugarcane producing area in the Wet Tropical Coast region of Far North Queensland with the potential for sugarcane expansion to occur in more than 9000ha of grazing land in the Murray Valley area.

The Riversdale-Murray Valley Water Management Scheme is an approved project under the Sugar Industry Infrastructure Package (SIIP). The Package is a joint initiative developed by the Queensland and Federal Governments in conjunction with the Sugar Industry in 1993, to enhance productivity in the sugar industry on an ecologically sustainable basis.

The purpose of the Water Management Scheme is to enhance productivity of existing and potential agricultural lands in the Riversdale-Murray Valley area through the provision of infrastructure and associated strategies to reduce the period of inundation from the frequently occurring high intensity rainfall events in the area. Measures to mitigate the potential for sustained waterlogging of canelands, and the ensuing yield decline, are seen to be critical in this area due to the likely impacts of the current rates of more intensive agricultural development which is occurring in the Murray Valley area.

It is important to emphasise that the Scheme is not essentially a flood mitigation scheme, but rather a

scheme to improve residual drainage in the area, thus reducing the period for which lands remain inundated. The Scheme will need to address the impacts of future agricultural development in addition to infrastructure deficiencies in existing areas. Strategies to minimise the generation of increased rates and volumes of runoff, and to secure adequate outlet capacity in the lower catchment will be key elements of the scheme. These strategies have focussed on preserving the benefits of existing drainage infrastructure in the developed area of the floodplain while also addressing the impacts of future development.

To achieve the overall purpose of the scheme and to ensure its ecological integrity, the SIIP Central Review Committee has developed Terms of Reference to guide the development of the preferred scheme. These Terms of Reference identify a range of environmental considerations and constraints which the scheme needs to address. These relate to the maintenance of essential ecological processes and natural systems, the protection of key natural resources and the management of potential adverse impacts on these systems.

2.1 Scheme Objectives

Based on the overall purpose of the proposed scheme and the issues to be taken into consideration in the project Terms of Reference, a number of objectives have been developed for the scheme, as follows:

Water Management Objectives

- To reduce the period of inundation of existing and potential agricultural lands after flooding;
- To improve residual drainage to allow removal of floodwaters more rapidly from the area after the peak has subsided;
- To ensure that runoff from developing areas does not increase to the point of adversely affecting existing development;
- To maximise the use of the existing drainage system and other existing infrastructure in implementing the scheme;
- To have drainage infrastructure across the area developed and co-ordinated with the natural system capacity.

Environmental Objectives

- To protect and enhance the significant environmental features of the area;
- To maintain and where necessary improve the water quality of the waterways of the floodplain and downstream environment;

- To protect the quality and quantity of the existing groundwater reserves;
- To maintain and enhance land and water habitat for wildlife.

Land Management Objectives

- To encourage the use of suitable soils for agricultural production and avoid the development of marginal or unsuitable lands;
- To ensure the viability of existing farms is not compromised by new land development;
- To ensure the scheme is acceptable to the majority of landholders and other stockholders on the floodplain.

2.2 Strategic Approaches

A number of strategies have been developed to ensure the preferred scheme meets the above objectives. Essentially, these strategies encompass four broad approaches which form the basis for the preferred scheme. They comprise:

- Establishment of an arterial drainage network to maintain and enhance the hydraulic capacity and biological functions of the floodplain;
- Reinstatement and enhancement of natural flowpaths across the floodplain and catchment outlets in the lower floodplain;
- Development of structural and non-structural measures to reduce the adverse impacts of existing and future farm development on downstream lands and systems through:
 - minimising increases in post development runoff
 - co-ordinating drainage inputs to drainage network capacity;
 - establishment of consistent drainage design criteria throughout the area;
- Incorporation of environmental enhancement measures into scheme elements.

2.3 Environmental Considerations

In addition to productivity benefits, the environmental impacts of the elements of the preferred scheme have also been assessed, as required under the project Terms of Reference. Where required, measures to mitigate adverse environmental effects have been incorporated into the works proposed for implementation of particular elements. In some instances, individual elements of the preferred scheme exhibit inherent benefits to the natural systems and ecological processes upon which they impact.

Key environmental issues addressed by the scheme elements, either inherently or by measures incorporated into the works, include:

- Maintenance and enhancement of water quality;
- Protection of groundwater reserves;
- Avoidance of potential acid-sulphate soils and marginal lands for agricultural development;
- Enhancement of instream habitats and riparian corridors;
- Provision for fish passage where required;
- Preservation of significant terrestrial habitats including Mahogany Glider habitat;
- Protection and enhancement of floodplain lagoons and wetlands complexes;
- Protection of significant cultural heritage and archaeological sites;
- Minimising erosion from agricultural development and subsequent sedimentation of waterways and lagoons.

2.4 Elements of the Scheme

Following an extensive period of consideration of engineering, agricultural and environmental factors nine elements of the scheme have been designed. These are:

- Boundary-Brick Creek Improvements
- Boar Creek Natural Detention Area
- King Ranch Wetlands
- King Ranch Detention Area
- Lower Murray Outlet Improvements
- Murray River - Barretts Lagoon Overflow
- Murray River Improvements
- Upper Murray Overflows
- Scheme Area Drainage Improvements

The location of each of the elements is shown on Figure 2.

Each element is a combination of engineering and non-engineering works designed to improve the effectiveness of drainage of floodwaters in an ecologically sustainable manner. It is beyond the scope of this paper to detail these elements and the reader is referred to Connell Wagner (1995) and Department of Primary Industries (October, 1995) for further information.

3. STREAM MANAGEMENT

The success of the Package will depend on establishment and preservation of an arterial drainage network, installation of a network of arterial lagoons, and rationalisation and co-ordination of existing drainage infrastructure.

The establishment of an arterial drainage network will effectively provide a Drainage Master Plan for the area. Key features of the network include Preferential Flow Paths and Arterial Lagoons.

3.1 Preferential Flow Paths

Figure 2 shows those waterways which will be declared Preferential Flow Paths to ensure their preservation as essential features for the discharge of runoff flows from the upper catchment and throughout the floodplain to the outlets at the bottom of the catchment. It is intended that these waterways and their riparian zones will be managed to secure their hydraulic and biological integrity for the future. Reinstatement and upgrading works will be undertaken on waterways where investigations have indicated the need. In addition to these identified works, it is proposed that the functions of all Preferential Flow Paths be preserved and enhanced by on-going management, including the enhancement of their riparian zones. Management measures for Preferential Flow Paths and their adjacent riparian zones will include:

- Prevention of unauthorised modifications or works to the waterways and controls on the erection of buildings or structures which could disrupt flows, eg. access crossings;
- Controls on the discharge of farm drains to Preferential Flow Paths eg. number and spacing of outlets, water quality controls, drainage complying with natural catchment, etc;
- Revegetation of damaged riparian areas in accordance with the value based assessment criteria developed for the scheme (in preference to a "standard" width of vegetation along all waterways). (Malcolm, Laity-Smith, Brownrigg and Merrin, 1995).

3.2 Arterial Lagoons

Arterial lagoons have been included in the scheme to improve water quality. Studies undertaken as part of the preliminary design phase of the scheme have highlighted the need to improve the quality of runoff flows in the area, particularly in those areas where rapid and substantial agricultural development is occurring, to ensure satisfactory water quality is maintained in the waterways and natural lagoons which are important habitats for fish, crocodiles and other aquatic organisms. Recent scientific studies which have monitored the sediment levels in the off-shore flood plume from the 1994 runoff event in the Tully-Murray system have confirmed this need in

relation to the great Barrier Reef lagoon (Steven and others, 1995).

In addition to the measures proposed to preserve and enhance the remaining natural lagoons on the floodplain, it is proposed to construct artificial lagoons at strategic locations on Preferential flow Paths throughout the area to help trap silt and nutrients from agricultural runoff, thereby improving water quality. These arterial lagoons will also be capable of providing additional aquatic habitat, replacing many of the natural areas which have been lost to development in the past. They will be appropriately sized and configured to allow sufficient retention time to trap silt and nutrients from frequent runoff events and to meet aquatic habitat needs where required. Appropriate vegetation in the form of wetland sedges and melaleuca species will be incorporated into lagoon features. Arterial lagoons will be used because:

- There will be a time delay before on-farm measures are implemented on properties with existing development;
- On-farm measures will not be practicable in many situations to manage the quality of all drainage flows to Preferential Flow Paths;
- Arterial lagoons will be controlled by the Water Management Board and can therefore be assured of regular maintenance.

Typically, arterial lagoons will have a surface area of at least one hectare and have a variety of depths to a maximum of eight metres. It is proposed that they be located in low lying areas to minimise loss of productive land as well as excavation cost. Excavated material can be used to "build up" adjacent lands to improve the productivity of these areas.

Once lagoons are established, monitoring will be undertaken to evaluate lagoon performance so that design modifications can be incorporated into future lagoon design, if required.

3.3 Rationalisation and Co-ordination of Existing Drainage

Mapping and analysis of the extensive farm drainage systems currently existing in the Riversdale-Murray Valley area have highlighted the need for rationalisation works to address some of the major deficiencies identified in the system. As a result of the ad-hoc nature of the system development over a long period of time, the result is a system with wide

discrepancies in drainage capacity and very little co-ordination.

Drain capacities vary widely, from a minimum of 5 litres per second per hectare, (L/S/ha), up to 150 L/S/ha. In addition, many drains are excessively deep, with several identified being between two to three metres deep. Such deep drainage has the effect of depleting groundwater supplies in the shallow aquifer which underlies much of the area.

If drainage continues to develop in such an ad-hoc, unco-ordinated manner, it will result in serious consequences in terms of increased runoff and inundation of productive lands, loss of valuable groundwater supplies and water quality problems in waterways and lagoons. For example, when the area is developed to its full potential, landholders along the Murray River could expect to be subject to a full extra day of inundation under the 3 year/3 day design event adopted for the scheme. These impacts have the potential to seriously affect the productivity and viability of many existing farms in the area.

It is proposed to adopt a design modulus of 10 litres per second per hectare (L/S/ha) for all drainage works in the scheme area. This rate is sufficient to remove the runoff from the 3 year/3 day design rainfall event in a 3 day period. Studies by Bureau of Sugar Experimental Stations and others have concluded that yield losses from canelands in the Wet Tropics are not significant where this time requirement is met (Rudd and Crardon, 1977). These studies have shown, however, that where caneland is inundated for periods extending beyond 3 days, losses of the order of 0.5 tonnes per hectare can be expected for each additional day of inundation.

Modifications are proposed to reduce the capacity of existing drains where capacity exceeds the design drainage modulus. This will ensure that all drainage is rationalised on an equitable basis consistent with the capacity of the arterial network. This will involve partial filling of drains over a short distance (say 10 metres) at intervals along the drain.

In addition, control structures will be installed in excessively deep drains which have the potential to deplete shallow groundwater reserves. These structures will consist of a small weir in the bed of the drain, with a control crest set to a level sufficient to prevent excessive groundwater loss.

4. MANAGEMENT ROLES

The Riversdale-Murray Valley Water Management Scheme involves the following key stakeholders:

- The landholders of the Tully-Murray Rivers floodplain;
- Cardwell Shire Council;
- Cardwell Shire River Improvement Trust;
- Department of Primary Industries;
- Department of Environment and Heritage;
- Bureau of Sugar Experiment Stations;
- Tully Sugar Mill;
- Mourilyan Sugar Mill;
- South Johnstone Mill.

Each of the stakeholders has a management role with the leading stream management roles being shared by the Cardwell Shire River Improvement Trust and the Department of Primary Industries. Cardwell Shire Council are in the process of adopting a Development Control Plan at the time of writing. This Plan links strongly with the objectives of the River Improvement Trust which essentially implements works in the waterways on the floodplain. The River Improvement Trust will share responsibility for the improvement and maintenance of the schemes Preferential Flow Paths with the Sugar Mills and landholders.

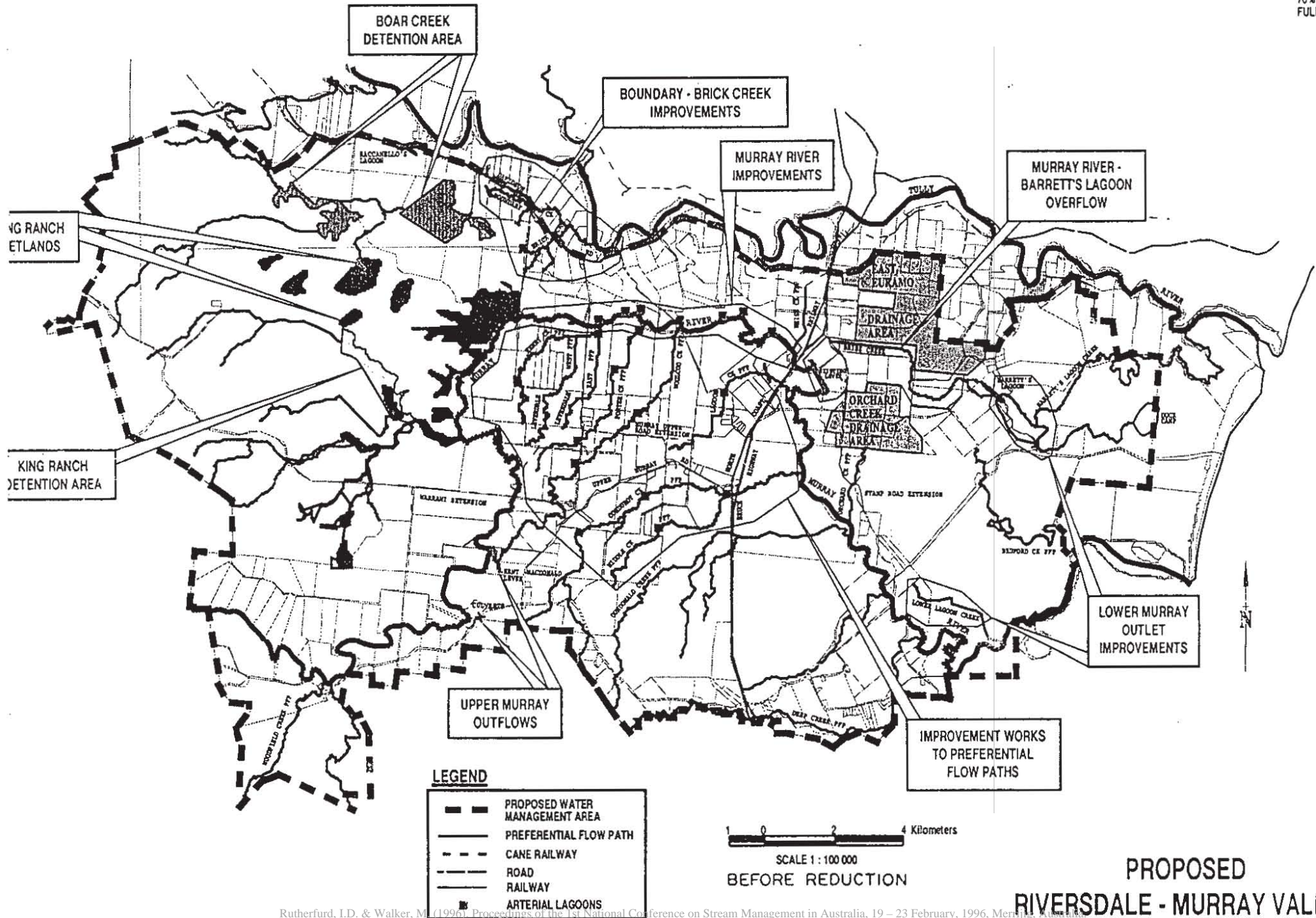
5. CONCLUSION

The catalyst for co-operative water management on the Tully-Murray Rivers floodplain has been the desire for ecologically sustainable development on behalf of all of the stakeholders.

The proposed Riversdale-Murray Valley Water Management Scheme is a good example of a community-driven planning, research and management effort. Waterway management is a key component of the Scheme. The Scheme has raised awareness in the community and management agencies of the vital link between agricultural production, habitat values and environmental needs. The ultimate success of the Scheme will depend on a co-operative approach to floodplain management generally and waterway management in particular.

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