Nebo Broadsound and Isaac Connors Study
Final Report

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Front Cover July 2002 photographs:
Lower Issacs River Main Channel, Funnel Land System
Blue Grass/Buffel Grass Downs at Coopers Creek Nebo, Girrah Land System

Inside Front (This Page) July 2002 photographs:
Dryland Fallowed Comet/Alpha Land System, Isaacs River May Downs
Flood Irrigated Corn Silage Crops, Blackwater Land System, Barmont Lower Issacs

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Executive Summary

(**Future Directions**)

SUMMARY

The Isaacs Connors Catchment has a significant amount of un realised irrigation development potential. In overall terms, some 60,000 ha of land is both suited to irrigation and close to streams – most of this area is well suited. A further 211,000 ha is non riparian lands which is also suited.

Current irrigation water use (5,000 ML) is 20% of current entitlements and allocations. The proposed ROP will increase the amount of water available to over 15,000 ML covering areas within the catchment as well as downstream. The increased ROP based allocations in the catchment and immediately downstream are likely to be much less than 10% of the nominal amounts of flow in the system which is above base environmental requirements. The medium term future potential is at least 30% of these flows with current usage less than 5%. However, all water licenses in the Isaac Connors Catchment will not be tradeable and hence cannot be relocated into stream areas where there is both suited lands and adequate unregulated water supplies. There is simply insufficient hydrology modelling data to permit larger releases of water within the catchment or to sustainably manage a water trading system.

Broadsound Shire is likely to be the focus of future irrigation development – centred around the Lower Isaacs/Barmont areas where there is a good conjunction of soils and water. The shire also contains the only potential dam site (Mt Bridget) which offers the chance to provide a large amount of regulated flow for irrigators at a cost which may be competitive with unregulated stream diversions by irrigators.

All other dam sites lie in Nebo Shire. The costs and or yields from these sites and or the absence of quality land close to the sites would preclude their development for irrigation. The fact that most stream flows in Nebo Shire are relatively small, means that Nebo Shire is unlikely to see major irrigation development – based on either public or private investment.

The industries most likely to form the basis for irrigated cropping are sugar cane, cotton and intensive livestock. Cane is likely to be a medium to long term prospect. Incremental expansion in the Prospect (Blue Mountain) and Bolingbroke valleys within the current haulage catchment for the coastal mills should resume once the industry short to medium term prospects improve. Expansion beyond these areas will require a new industry model (eg juice mills/ethanol) and the only area with the conjunction of sufficient water and soils to support such projects is the Lower Isaacs at a considerable distance from the existing milling sectors..

Cotton is likely to also expand into the same Lower Isaacs area once the availability of suited soils and water is confirmed. The proposed ROP arrangements are however unlikely to be of size which could facilitate this expansion. Elsewhere in the state cotton is constrained by both land use conflict and decreasing security of /increasing costs of water supplies. Only those properties which currently hold significant water entitlements on irrigable quality lands are likely to be attractive to the industry. These are relatively few in number.

Intensive livestock is likely to be a pioneer industry for small scale irrigation development – as well as dryland farming. The area is well placed to be attractive to this industry versus feeder livestock production areas, grain and processing facilities. This industry is also under pressure in other parts of the state from community and land use conflict.

There are a number of priority unknowns which need addressing in the short term if the shires and landholders in the catchment are to be able to not only plan investment but also ensure that they retain future equity of access versus downstream potential users of water.

First and foremost, the ROP understanding of flows in the system is insufficient to determine the supply security of any allocated water. Whilst the Lower Isaacs will have the highest level of security, it is the upper parts of the system which have the lower flows and where cane has expanded and/or mining will be a competitor for future allocations – as well as existing flows. Nebo Shire is in a perilous situation without this type of information. The shire has no viable irrigation Dam Sites, possibly over committed groundwater resources and low and irregular stream flows, but is the focus for mining expansion. The shire also appears to have an inordinately high occurrence of errors in the Regional Ecosystems vegetation mapping covering the core better quality pasture and arable lands.

The land and natural resource information available to adequately plan any future development in the Prospect/Bolingbroke and Lower Isaacs area s of Nebo Broadsound and Sarina shires is also seriously lacking. Land Resource surveys of both areas are required to delineate the most suited land areas, whilst groundwater and salinity hazards also require assessment in the Lower Isaacs.

1 Overall Catchment Hydrology Issues

1A The Isaac Connors catchment comprises 15% of the total catchment area of the Fitzroy Basin. The catchment also contains the largest extent of high rainfall lands in the basin within the Connors and Funnel catchments. This contributes significantly to the estimated 300,000 ML of runoff from the catchment which is above base environmental requirements. This 300,000 ML represent over 85% of all such flows in the Fitzroy Basin and approximately 14% of the average flow from the catchment. These flows join the rest of the Fitzroy Basin downstream of the more intensively developed lands in the Nogoa /Mackenzie/Comet River systems and a short distance upstream of the main Dawson River flows to the Fitzroy.

1B Despite the obvious importance of the contribution of surface water flows from the Isaacs Connors to the overall flows in the Fitzroy system, very little is known about how these flows are distributed within the Isaacs/Connors catchment. Analysis of stream flow data suggests that 80% of the flow is generated from within the Connors and Funnel systems. Beyond this, little is known about the reliability of flows and hence the availability of the potentially large amount of water which is above base environmental flow requirements

1C Of almost 200,000 ha of land within 5 km of the major streams in the area and therefore potentially able to be serviced by riparian pumping schemes, 57,000 ha is considered to be both flood free and suited to irrigation development. The Middle and Upper Isaacs River corridor contains over half of this area – unfortunately these areas probably produce less than 10% of river flows in the catchment. Blue Mountain (Prospect Creek), Bolingbroke (Upper Funnel Creek) as well as the Connors River also contains between 4,000 and 7,000 ha of suited flood free lands.

1D The Lower Isaacs/Barmont, Batheaston/Golden Mile, Nebo/Bee/Denison areas contain approximately 210,000 ha of mostly non riparian, flood free and suited lands. Batheaston and Nebo/Bee/Denison areas account for 135,000 ha of these lands – once again these areas are unlikely to be associated with stream systems that have significant available unregulated water supplies to support irrigation. The Lower Isaacs/Barmont area (53,000 ha) occurs at the bottom of the catchment and therefore is likely to have significant amounts of riparian flows which could be accessed.

1E Groundwater resources are extensive throughout the riparian lands of the catchment. However, as with surface water, little is known of its potential other than the fact that current mining and domestic drawdowns on the Nebo/Braeside bore fields are possibly at their sustainable limits. The potential for commercialisation of the ground water associated with the far more extensive braided flood plains system of the Connors and Lower Isaacs remains un quantified.

1F The majority of the Dam Sites identified within the catchment are unlikely to prove cost effective for irrigation development. The one exception is the Mt Bridget Dam Site on the Connors which would provide regulated flow to the Lower Isaacs/Barmont area. The desk based capital costs of this site at around $1,000/ML are similar to the capital costs of land holder constructed off stream storages which would harvest a combination of overland and unregulated stream flows. The costs are similar to the Part A component of water currently being traded in other irrigation areas for crops such as cotton. However, the absence of either riparian or overland flow harvesting modelling data for other than Yatton at the end of the system means that it is simply impossible to attach a reliability of supply figure to regulated water (ex Mt Bridget) versus unregulated flood harvested water.

1G Whilst dryland cropping totals around 65,000 ha, there is less than 1,000 ha of fully irrigated development in the catchment. The current estimated 5,000 ML of water used for irrigation is 20% of the estimated water potentially available under both area based entitlements and volume allocations. Area based entitlements are estimated to comprise 18,000 ML of water if they were converted to volume allocations. The majority of these are sleeper licenses and undeveloped.

Future Directions

In the short term, the ROP for the area will set the future directions for irrigation and other water use in the catchment. In its current draft form, the ROP will have a number of both negative and positive impacts. It will increase the amount of water allocated to agriculture in the catchment by around 10,000 ML. However landowners within the catchment area will face competition from land owners down stream of the catchment for this water. Both this water as well and existing volume and area entitlements will not be made tradeable. Whilst this figure would result in a trebling of existing irrigation if all water was traded into areas where water was available, the estimated 18,000 ML of area based entitlements is unlikely ever to be tradeable. Where these sleeper licenses are located in stream sections which do not meet ROP guidelines for riparian extractions, they will remain largely undeveloped.

When future mining requirements plus future irrigation needs immediately downstream of the catchment are included it is likely that less than 30,000 ML will be made available under the ROP.

There are a number of critical issues which will determine the future direction – even under the current short term ROP planning horizon:

- *the paucity of data on flows in individual stream sections means that there is an urgent need for modelling to be completed for all stream systems. Land owners in the Prospect and Bolingbroke areas currently growing cane, as well as landowners in the Lower Connors/Isaacs/Barmont area growing field and forage crops will require accurate assessment of the reliability of these allocations from unregulated flows before any sensible trading arrangement can develop. Such assessments are simply not in place at the moment.*
- *In order to complete the strategic analysis of medium and long term water supply and management options, the Mt Bridget Dam should also be reassessed in conjunction with the above analysis. If the findings of this report remain valid and Mt Bridget regulated flow water could be supplied at an equivalent cost and higher reliability than unregulated allocations, then any analysis of individual stream hydrology should include the Mt Bridget Dam as an option.*

- *the mining sector which is a highly competitive user of water and able to sustain higher unit costs for water will also need a similar assessment. If the mining industry draws all of its entitlement from the Middle/Upper Isaacs or Nebo and Denison Creeks which are the focal areas for their current pipeline command systems for groundwater, it is possible that only limited residual flows may be available for genuine irrigators in these areas.*
- *the potential for increased groundwater allocations from the Connors and Lower Isaacs system also is worthy of strategic investigation. There is a large number of monitoring sites in these areas, however, the monitoring and yield data is at best discontinuous. Given the current importance of groundwater to the mining industry and its potential role in augmenting off stream storage yields for all types of uses, the historical data set should be properly assessed and a better estimate of sustained yields obtained from the existing installations across the full extent of braided flood plain aquifer systems*

Whilst current usage is less than 20% of water entitlements and allocations, and the projected short term future releases are around 10% of the flows above environmental requirements, it would be an ill advised strategic conclusion that this will result in a significant lead time for resource planners to address water supply availability and pricing issues for the catchment. It remains unclear at this stage how rapidly demands in the catchment area itself as well as the lower Fitzroy (for irrigation and possible future environmental/flow dilution uses) will increase. The currently unallocated flows are of such a local, regional and arguably state wide significance that these types of more detailed assessments should be given priority if future flow management and policy decisions are to be made in a timely manner.

2 Industry Issues

2A Livestock enterprises dominate the study area. Of the shires within the catchment, 35% of Belyando, 77% of Broadsound and 33% of Nebo is classed as suitable to either arable or improved pasture. On a simple areas basis, the livestock industry will continue to dominate these shires.

2B Given the quality of the grazing lands in the shire, the proximity to feed grain and feeder livestock producing areas as well as the excellent road infrastructure and proximity to major meatworks, it is surprising that intensive livestock feedlots to value add to existing enterprises have not developed to any great extent. The area is currently on the periphery of these types of uses. Ultimately, a combination of the above strategic comparative advantages and the fact that intensive livestock developments are becoming constrained by community and environmental concerns in Southern Queensland, may mean that future growth in this industry can be anticipated. The Barmont Station feedlot is an example of such an operation at a medium scale of development which is vertically integrating irrigated forage and grain production around a central core business of intensive livestock. The sector is unlikely to ever be a major user of irrigation water within the feedlots themselves, however, the expertise and experience gained from any associated irrigation development is likely to dispel a number of concerns covering the technical feasibility of irrigated cropping in these areas.

2C Sugar Cane has expanded into the catchment in Nebo, Prospect and the Upper Funnel Creek System. The expansion has been incremental as growers have sought new lands within viable cane haulage distance from the Mackay mills during past periods of expansion. Unfortunately, the areas in Prospect and Upper Funnel (Bolingbroke) offer few productivity advantages over coastal cane lands. The areas of suited flood free soils are scattered over long stream distances and are interspersed with a large amount of unsuited lands. Given the current short to medium term outlook for sugar commodity prices and the focus on increasing production and milling efficiencies from existing investments, the past incremental expansion is likely to cease in the short term.

2D Despite the above current short term considerations, the areas that currently lie outside of the cane haulage network and which have large areas of contiguous suitable soils close to riparian water supplies potentially makes the catchment of strategic importance to the Mackay sugar industry as well as the Queensland industry in general. In the Lower Isaacs area, the conjunction of readily available water supplies and a lack of land use conflicts and soils of similar quality to the best of Australian cane industry suggests that sugar may be considered as a medium to long term proposition. The current constraints, however, would require alternative industry models (possibly based around ethanol and/or juice mills) which would value add to the current Mackay industry.

2E Cotton is currently in a similar non expansion situation to sugar – although the short term commodity price outlook is more positive. Elsewhere in Queensland, there has been an extraordinary large amount of private investment in irrigated cotton – so much so that in areas such as the Condamine, the viability of irrigated cotton appears to be in question as a result of limited overland flow and riparian water security. Whilst cotton as an irrigation development model has a number of limitations, the industry does bring a large amount of investment and land development expertise to bear in a very short time. It is possible that cotton will enter the catchment as commodity prices increase and water supply and community/land use conflict and water resource restrictions affect expansion in existing areas. Such developments, when and if they do arrive, will undoubtedly focus on areas where water supply security is at its highest.

Future Directions

In order for industry to commit to investment in the study area, the overall catchment and sustainability future directions discussed in this executive summary will have to addressed. Whether this commitment to invest occurs at an industry level or at the individual landholder level, security of access to water supplies must not only be possible but should also be demonstrated by appropriate studies. The present WAMP/WRP/ROP process goes some way to fulfilling such a requirement, however, the likelihood of significant water availability in the area vis a vis other catchments in the Fitzroy Basin as well as Queensland overall, needs to be confirmed and detailed in order to attract investment.

In the case of the sugar industry, it is likely that there will be limited scope for short to medium term expansion in the area. However, both the existing incremental expansion and any future major project expansion (for example based on ethanol or juice mills) will require a number of present unknowns to be eliminated (in addition to water availability issues). These include:

- *improved land resource information for the areas in Bolingbroke and Blue Mountain targeted in the past for incremental expansion once there is better information available on water availability for these areas. Whilst the duplication of Mackay canelands soil surveys would be desirable, the more important information is the identification of land parcels with the better quality soils in these valleys so that both current and future land owners can sustainably match water availability to actual land parcels with quality soils. Failure to do this will result in the cane industry revisiting the same land degradation and land drainage problems that have bedevilled the industry on the coastal strip*
- *alternative development models for sugar expansion are also worthy of at least desk top analysis at this stage. Whilst it is understandable that the current focus on local industry planning is on rationalisation of existing production areas, it is unlikely that available land and water resources along the coastal strip will be sufficient to support any major expansion. The potential loss of existing production areas in southern and possibly far northern Queensland as the industry rationalises, plus possible loss of production due to diversification in some cane areas may mean that areas within the Isaac Connors catchment become more attractive than would currently appear to be the case. Again such studies will require better definition of water availability than is currently available. On present data, the focus of any such development would be in the Lower Isaacs area and there would need to be a far better land resource information available to support any investment in this area.*

Cotton, unlike cane, has traditionally expanded by private investment - mainly at an individual land holder level. Cotton, like cane, is likely to favour areas where water security is higher. Again, the focus is likely to be in the Lower Isaacs area.

Intensive livestock is considered to be a likely pioneer industry in the area. Whilst, the water requirements for feedlots are relatively low, their need for consistent quality forage and grain supplies mean that they generate local markets for irrigated as well as dryland cropping. The same land resource and water availability studies listed above, would facilitate informed investment in this industry sector. Shires, however, may need to look at their local strategic planning settings to ensure that any unnecessary impediments to this form of industry are minimised for areas within the catchment that have a strong comparative advantage for these uses.

3 Sustainability Issues

3A Factors which could possibly alienate significant areas from future irrigation development include vegetation and biodiversity values and salinity hazards. The alienating effects of these factors would be implemented under the Vegetation Management Act and its associated Regional Vegetation Management Plans. This study has identified key areas where the regional ecosystem mapping appears to be in error in at least the Nebo Shire area. If the levels of errors identified in this study are confirmed by field work, the regional vegetation management planning process and local authority strategic planning process is likely to be indefensibly flawed. This would impede timely and orderly investment in both land development and sustainable environmental outcomes.

3B Land Tenure and Land Claims are unlikely to be significant alienating factors. Much of the land and water potential areas is already freehold title. Cultural values are largely an unknown, however, their alienating effects are likely to be restricted to specific sites.

3C The mining industry is likely to alienate only a small proportion of the suitable areas – both by mining per se as well as competition for the restricted amounts of unregulated flows available for allocation under the WRP/ROP process. The major impacts are likely to be felt in Nebo and Belyando shires.

3D Remnant Vegetation values are minimal over most of the suited lands which have already been extensively cleared in Broadsound Shire. The exceptions to this are likely to be the braided flood plains and in any areas of regrowth which fall within a nominated salinity hazard area. Using a process somewhat similar to that used in the recent Salinity Hazard Mapping exercise in the Queensland section of the Murray Darling Basin, a significant part of the lands suited to development would be considered to be at risk.

3E Remnant Vegetation values over most of the grazing and arable quality lands in Nebo Shire are not in the endangered category, however a significant area of the core quality grazing and arable lands have remnant vegetation. The current draft biodiversity assessment has raised the status of these non endangered remnant vegetation areas to a state level of significance. This may have major implications for grazing and arable land development and management if this level of classification follows through to the Regional Vegetation Management process.

Future Directions

The primary impediment to sustainability will be salinity. The risk assessment done as part of this study is crude and is insufficient to either eliminate or include particular land systems, parts of land systems or individual land parcels in a 'no development' category. First and foremost the impediment at this stage is one of a lack of knowledge to inform future investment let alone any regulatory approaches.

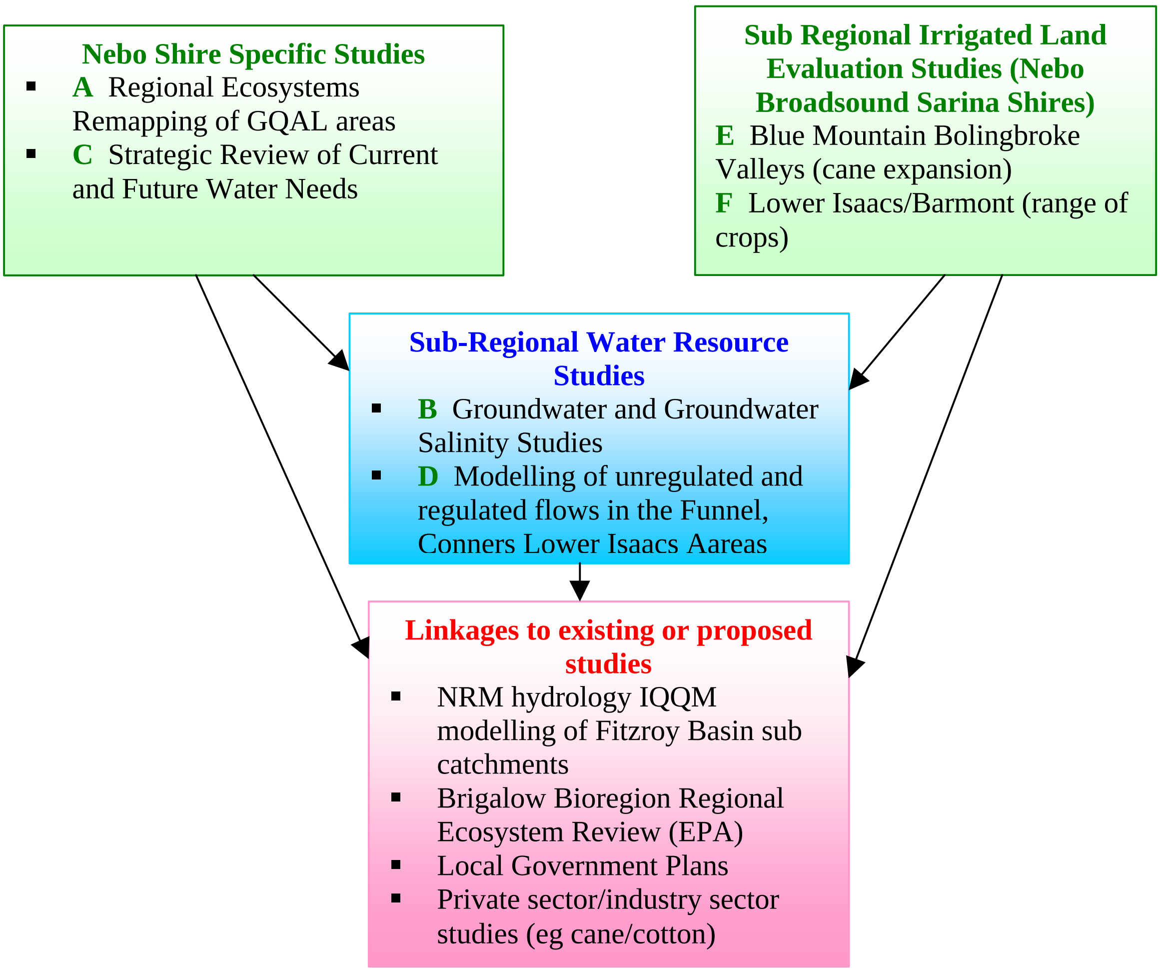
The issue is of sufficient concern to justify more detailed assessments by extending and focussing the current regional set of groundwater monitoring locations to include Land Systems such as Oxford, Girrah, Blackwater and Humboldt which would be the focus of future development as well as Daunia and Bedourie which are currently associated with salinisation in cleared landscapes at Barmont.

4. Studies Required to Inform Future Directions

At a general level, the quality and quantity of land and water in the catchment will not be a significant impediment to sustainable or equitable land and environmental outcomes in the catchment. The area has amongst the largest known reserves of under utilised high quality lands and water in Queensland. These lands are strategically located at the boundary between the coastal and inland landforms with their highly developed forms of agriculture. To the coastal east and to the inland west, the quality and or quantity of both land and water presently constrains agriculture. The constraining factor in the Isaac Connors is simply an insufficient understanding of the likely behaviour of water and land which will allow investors as well as government to properly plan, facilitate and regulate the inevitable pressure for land development that will arise in the future decades. If this weakness is not overcome, land owners and government are destined to make the same mistakes that have been made elsewhere in Queensland.

The required studies are not complex scientific undertakings. They will however require adequate resourcing.

The studies are broadly summarised below.



Study A: Regional Ecosystem Review of GQAL in the Nebo Shire section of the Isaac Connors Catchment.

Objective 1: To update and upgrade the accuracy and consistency of the Regional Ecosystems mapping for all areas of GQAL in the catchment to a minimum level of accuracy equivalent to 70% .

Objective 2: To identify current vegetation management strategies that affect Remnant Vegetation values/status in pastoral land.

Objective 3 To identify broad vegetation management guidelines consistent with sustainable agricultural and environmental outcomes.

Objective 4: To evaluate the Regional Ecosystem classification system Land Zone, Land Unit and Land System correlations for the more accurately mapped areas and assess the resultant implications for classification across similar landscapes in CQ.

Objective 5: To use all of the above to inform both regional and shire land/vegetation planning.

Study Description: The study would use existing data from agencies and the Isaac Connors Study target areas. Field work would result in the identification of the sources and reasons for any existing Regional Ecosystem errors and would allow other areas to be rapidly checked by a combination of air photo interpretation, reconnaissance field work and existing data. During the field work current and past land management practises (including land clearing, weed invasion and regrowth management information) would be assembled from land owners and this data would then be used to evaluate broad land management guidelines for these vegetation communities.

The areas to be re-mapped include most of the better quality arable and pastoral lands of the shire which contain large contiguous areas of Remnant Vegetation with a high proportion of Regional Ecosystems having an "Endangered" or "Of Concern" Status.

Finally, the implications for the study findings in terms of whether classification and mapping errors are likely to have extended across similar landscapes in CQ and the resultant implications for Regional and Shire based planning would be evaluated.

Study Stakeholders: Local Shires, the Regional Vegetation Management Committee and NRM/EPA are the primary stakeholders for this study and would form a logical Steering Committee

Study Team: A multidisciplinary study team incorporating regional NRM land resource and EPA vegetation mapping specialists would be required. An independent study manager/coordinator appointed by the SC with requisite skills in regional natural resource planning and assessment within the Land Systems of CQ should be appointed to manage the study.

Study Timetable: The study would have an elapsed timing of 12 calendar weeks and would require a maximum of 3 to 4 weeks field work. Implementation period would extend from the start of dry season 2003 and be completed by July 2003.

Study Budget: A study budget of $20,000 to $30,000 with in kind contributions from NRM/EPA would possibly be required.

Related Studies: A review of the Northern Brigalow Bioregion is planned for 2003/2004 by EPA. The results of both studies would be a direct input to the shire planning schemes as well as the regional vegetation management planning process. Given that the Bioregion review commences in the Nebo area, the proposed study would provide a valuable and timely contribution to the Bioregion review.

Study B: Review of Groundwater Potential and Use Implications

Objective 1: To compile and review all data on the groundwater systems of the Nebo, Braeside, Lower Funnel, Connors, Lower Isaacs areas and identify sub regional aquifer systems, characteristics and likely sustainable yields..

Objective 2: To identify locations within the alluvial flooded plains systems where additional pump testing and sustainable yield data is required to improve estimates of groundwater potential.

Objective 3 To identify non alluvial landscapes with potential for salinisation concerns in the Barmont/May Downs area and identify locations for exploratory drilling and aquifer characterisation studies.

Objective 4: To commission necessary additional drilling and exploratory work in areas identified from Objectives 2 and 3.

Objective 5: To model long term groundwater outcomes resulting from dryland and irrigation development scenarios at various levels of groundwater extraction from the alluvial aquifer system and assess sustainable land outcomes for combined ground and surface water use scenarios.

Study Description: The study ultimately aims at determining the sustainable groundwater yields from the Funnel, Connors and Lower Isaacs braided flood plain landforms. The current data suggests that substantial reserves of groundwater may exist in this area. Additional exploration drilling and testing is likely to be required before the sustainable use options for any groundwater reserves can be assessed. In conjunction with the above, the possibility of salinity hazards as a consequence of land clearing or irrigation development in the Lower Isaacs/Barmont/May Downs area requires assessment using similar approaches to that which would be required to assess the groundwater potential of the alluvium.

The findings from these assessments are likely to be of significance to a number of industry sectors (particularly mining and agriculture) as they would allow groundwater reserves and allocations to be integrated into the catchment water allocation and management planning processes.

Study Stakeholders: Local Shires, the mining and agricultural sectors are the major stakeholders along with NRM. Both EPA and NRM would also have an interest in this project because of the potential significance for water allocations, salinity risk assessments and the impacts of ground water extractions on the braided flood plain ecology.

Study Team: This project could be implemented by NRM with external assistance where required. The study would need to be integrated with surface water hydrology modelling aimed at improving the understanding of stream hydrology and flows in the Funnel, Connors and Isaacs system.

Study Timetable: Objectives 1, 2 and 3 could be achieved in very short time frame of less than a few weeks if externally contracted. The scope and extent of the subsequent objectives would depend on the outcomes from the initial work.

Study Budget: A study budget of less than $5,000 would be required to achieve Objectives 1, 2, and 3 using data already assembled for the current Isaac Connors Nebo Broadsound Study. Typical costs for additional drilling and testing required for Objective 4 may lie between $20,000 and $50,000. Objective 5 would largely be a desk-based exercise based on results from this and other projects/studies and would have a cost of around $25,000.

Related Studies: This study would supply outputs to Study C (Nebo Shire Strategic Water Demand Assessment) and also form the major basis for salinity hazard assessments and ultimately any property management plans involving irrigation and/or land clearing the study area. The study would also provide critical data for water resource allocation planning in the catchment under any future review of the current ROP.

Study C: Nebo Shire Review of Strategic Water Demands

Objective 1: To compile and review all data on the mining, industrial, agricultural and urban demands for water within the shire, identify current sources of water and usage patterns along with efficiency of use strategies.

Objective 2: To estimate future demands from each sector and develop a draft strategic framework for future allocation and management of water sources.

Study Description: The study is a relatively high priority study. Most land uses in Nebo Shire either presently or in the future are likely to be constrained by water supply – either in terms of its reliability of supply or its cost. Land use in the shire is heavily dependent on the Nebo and Braeside bore fields, which appear to be close to or above their sustainable extraction levels. The limited amount of stream flow data available for the area also suggests that future allocations of unregulated flow will be minimal. The majority of identified Dam Sites are relatively high cost and or inefficient storages. Within the mining industry, water resource planning is currently done on a project by project basis, however, in situations where demand may be approaching or exceed sustainable supply, a strategic sector level assessment is required.

Under the current ROP process, Nebo Shire is unlikely to substantially benefit from any increased allocations and it is unlikely that more detailed modelling (as proposed in Study D) will improve this situation for the shire.

This study aims at collating all available data on current and possible future water demands for the shire to ensure that land use development and water availability is matched within an overall strategic approach. It is anticipated that the study would include assessing the opportunity to improve water supply by improved management of existing resources, identifying other potential sources (such as those from Study B or from out of shire storages) and possibly re-prioritising Dam Sites within the shire to meet future strategic needs.

The study would be largely a desk based study utilising data accumulated during the current and previous studies. The study would require consultation with the mining industry and shire to assess current and future needs.

Study Stakeholders: Nebo Shire and the Mining industry are the major stakeholders – with NRM having a secondary interest in the outcomes of the study.

Study Team: This project could be implemented by NRM or by external consultants.

Study Timetable: An elapsed time of less than six weeks would be required for this study.

Study Budget: A study budget of less than $15,000 would be required to achieve the objectives if undertaken by external consultants.

Related Studies: This study would supply outputs to Study B as well as Study D.

Study D: Water Availability within the Isaac Connors System

Objective 1: To complete enhanced hydrology modelling of the stream flows within the Isaac Connors system under scenarios of regulated and unregulated flows.

Objective 2: Using the results from the above, determine the reliability of supply at various points within the stream systems under both regulated and unregulated regimes.

Study Description: Current IQQM modelling uses the Yatton stream station to model flows within the catchment. There are a number of stations upstream of Yatton on the Isaacs Connors, Denison, Funnel and Bee catchments. Each of these has varying time periods of records.

This study would require the IQQM model to be adapted to use the incomplete data sets from the other stations to assess water availability at various points within these stream systems. Until and unless such data becomes available, there will be no defensible basis for either increasing or decreasing the amount of water which can be extracted from the various stream systems and no mechanism to permit the trade of future allocations. Without this information, there is unlikely to be any significant investment in agriculture in the area outside of the livestock sector.

The second component of the study is to factor into the analysis a number of scenarios for the Mt Bridget Dam Site which would effectively regulate flows in the Connors, Lower Funnel and Lower Isaacs. The Mt Bridget Dam Site has a number of size options – each with differing capital costs and the model should evaluate these options in terms of enhanced security and amount of flow which may be available from the system.

Associated with these outcomes should be an assessment of "out of catchment" needs for regulated reliable water supply from Mt Bridget and the results of this should be factored into the anlaysis. Mt Bridget is one of the last major Dam Sites available in the region and is located at a point in the Fitzroy Catchment where it is able to harvest a significant amount of flows in the basin which are above base environmental flow requirements. It is therefore highly likely that the site will be of increasing interest to service out of catchment needs which require a high reliability of supply (such as urban/industrial).

Study Stakeholders: Nebo Broadsound, Sarina, and all shires downstream of the catchment including the Rockhampton and Gladstone industrial areas would be significant stakeholders in the outcomes from this study. Within the agricultural sector, the livestock cotton, grain and sugar industry would also be significant stakeholders.

Study Team: This project could be implemented by NRM or by external consultants.

Study Timetable: An elapsed time of over six months would be required for this study.

Study Budget: No study budget estimate is available for this study at this stage. The project would require an initial scoping phase assessment to accurately identify the IQQM parameters and module modifications needed to support the study. This scoping phase would take less than 3 weeks with a budget of less than $7,000.

Related Studies: NRM has indicated that more detailed modelling is planned for the area. The inclusion of the Mt Bridget options may however significantly change the NRM proposed approach to the study.

The study would require inputs from other studies which would be able to provide an improved assessment of likely future demand. The Nebo Shire Study C would be able to supply assessment of upper catchment demands (particularly from the mining sector), while Study B (groundwater) and Study E and F would provide refined and more accurate assessments of likely suitable development areas within the Funnel Connors and Lower Isaacs system.

Study E: Enhanced Soil Assessment of Blue Mountain and Bolingbroke Areas

Objective 1: To identify lands within the Prospect and Bolingbroke Valleys that are suited to incremental cane expansion associated with the coastal mills.

Objective 2: To recommend land development strategies for the long term sustainable development in these areas.

Study Description: Approximately 9,000 ha out of 40,000 ha of land within 5 km of the main streams in these areas is believed to be suited to sugar cane. Dryland, and to a lesser extent irrigated, sugar cane has incrementally expanded into these areas. In the short term expansion is unlikely until the current phase of industry re-structure is completed. The areas do however offer the best alternative to cane land expansion within the haulage catchments of the current mills. It is therefore inevitable that cane land expansion will recommence in the future.

Sustainable caneland production will require that only the better quality flood free lands are targeted. The study does not envisage that the detailed soil surveys of the Mackay canelands be repeated in this area. The study involves only the rapid identification of suited land parcels (or parts of parcels) and the identification of the potential flooding risks based on local landholder information.

The outputs from this study should be used to assist in caneland strategic planning as well as in assisting in the allocation of water for irrigation in the valleys. It is highly likely that future allocation conditions will require a land and water management plan for individual irrigators.

Study Stakeholders: Nebo and Sarina Shires as well as the regional sugar mills would be stakeholders in this study. NRM would also be a significant stakeholder as they would be able to use the data to improve future water allocation planning.

Study Team: This project could be implemented by NRM or by external consultants.

Study Timetable: An elapsed time of over six months would be required for this study involving less than 3 weeks of field work.

Study Budget: The project would require approximately $20,000 in budget if executed externally.

Related Studies: This study would provide important inputs to Study D in the form of potential irrigation demands in the upper parts of the Funnel Creek catchment. The outputs would also allow an improved definition of GQAL for the shires to use in planning under the State Planning Policy 1.

Study F: Enhanced Soil and Salinity Assessment in the Connors/Lower Isaacs and Barmont areas

Objective 1: To accurately delineate ares of soilssuitable for irrigation within these areas..
Objective 2: To identify flooding and salinity hazards and recommend appropriate land development guidelines for inclusion in property level land and water development plans.

Study Description: Approximately 70,000 ha out of 250,000 ha of land within these areas (of which approximately 6,000 ha is within 5 km of the major streams) is believed to be suited to irrigation development, subject to more accurate assessments of flooding and salinity risks. Irrigated cropping is currently expanding in these areas and it is likely that they will be confirmed as having the highest level of unregulated stream flow water supply security as a result of Study D outcomes as well as substantial groundwater reserves. The area is also identified as having a possible future salinity risk.

The study aims to rapidly identify individual parcels of land that have the highest level of irrigation suitability, collating local knowledge of the flooding hazards and identifying appropriate salinity mitigation strategies for irrigation development.

The study should also review the range of farming systems and industry models likely to apply in the areas. These would cover but need not be limited to cane juice mills and ethanol, cotton and other fibre cropping systems (eg hemp, Kenaf), horticulture and possibly fresh water aquaculture.

It is highly unlikely that Study D will identify sufficient water (either regulated or unregulated) to justify irrigation of a majority of the currently identified area.

It will therefore be important that future allocations be targeted at areas with greatest potential for sustainable irrigation development.

Study Stakeholders: Broadsound Shire as well as NRM would be major stakeholders in this study.

Study Team: This project could be implemented by NRM or by external consultants.

Study Timetable: An elapsed time of over six months would be required for this study involving less than 6 weeks of field work.

Study Budget: The project would require approximately $40,000 in budget if executed externally. Addittional costs associated with soil and water analysis would also be involved.

Related Studies: This study would provide important inputs to Study D in the form of potential irrigation demands in the Isaacs Connors system. The outputs would also allow an improved definition of GQAL for the shires to use in planning under the State Planning Policy 1.

Contents

1 Introduction

This report is the draft final report of the Isaac Connors, Nebo Broadsound Study. The Overview Report for the Fitzroy Basin Water Resource Plan (formerly the Fitzroy Basin Water Allocation and Management Plan) indicated that up to 300,000 megalitres of mean annual diversion was potentially available for release from the Isaac/Connors, lower Mackenzie and Fitzroy River systems. The unallocated water potentially available is excess of water required to meet the plan’s environmental flow objectives and the water allocation security objectives of existing entitlement holders. The majority of this 300,000 megalitres of potential mean annual diversion is generated from within the Isaac Connors catchment

The catchment area is dominated by livestock grazing with relatively small areas of irrigated cropping. Sugar has expanded from the Mackay coastal lands over the Coastal ranges into the catchment, whilst dryland copping is reasonably common in the south western parts of the catchment.

Two of the streams in the study area (Funnel Creek and Connors River) are well known for major flooding events associated with cyclonic activity – the remainder of the study area streams have much smaller discharge and flow regimes.

This report summarises the findings of various working papers completed over the period May to September 2002.

The working papers dealing with Salinity and Development Issues have been abstracted into this final report. Other working papers presented during the course of the study are reproduced in this draft final report in updated format.

The Future Directions Executive Summary document is included with this final report.

A project CD is available with the Final Report. This CD is self executing and contains:

- all of the reports referred to above
- all mapping of Land Resources at 1:300,000 scale formatted into sheet areas

In addition the CD contains all GIS files in Mapinfo and ARC Shape file formats.

2 Land Systems

2.1 Introduction

A single set of Land Systems were compiled for this study utilising:

- published CSIRO land system mapping for the Nogoa-Belyando and Isaac-Comet regions
- available Queensland Department of Natural Resources and Mines land systems mapping for the Capricornia Coast, and
- new land system mapping undertaken by LRAM Pty Ltd for land north, east and south of Nebo township.

The previous land system mapping was undertaken at scales varying from 1:250,000 to approximately 1:500,000. The new land system mapping was compiled at a scale of 1:250,000. The land suitability for irrigated production of sugar cane, cotton, grain crops, tree crops, vegetables and pastures were assessed. Overall land suitability, Agricultural Land Class and Good Quality Agricultural Land status were determined for each land system. The land suitability and agricultural classification data are assigned to each mapping unit along with data fields describing broad landscape zones and relief[1].

2.2 KEY TO LAND SYSTEMS OF THE NEBO/BROADSOUND & ISAAC/CONNORS STUDY AREA

Land Systems, their associated land zone and the thematic colours are given below. Land Zones (eg Alluvial plains with gidgee scrub) are shown in Map 2.1.

Mountains with eucalypt woodlands

Murray - Mu On granitic rocks (steep to rolling)
On acid-intermediate volcanics
Berserker - Bk Steep to very steep
Croydon - Cd Rolling to steep
Wheeler - Wh On volcanic plugs and trachyte (steep to precipitous)
Percy - P On volcanic plugs/granite and metamorphics (steep to very steep)

Mountains with softwood scrub/vine forest (and eucalypt woodlands)

Blue Mountain - BM On granitic rocks (steep)
Britton – Br On acid to intermediate volcanics (steep)
Jordan – Jo On sedimentary rocks and volcanics (rolling to steep)

Mountains with acacia scrub/eucalypt woodlands

Carborough - Ca On sedimentary rocks (steep)

Hills with eucalypt woodlands

Glassford - Gf On granitic rocks (steep to rolling)
Chalmers – Ch On acid to intermediate volcanics (rolling to steep)
Borilla – Bo On acid to intermediate volcanics/tuffs (steep)
Planet – Pt On coarse grained sedimentary rocks (undulating)

Hills with eucalypt open woodlands

Waterford – Wa On basalt (steep)

[1] The Project CD contains full GIS data sets as well as self executing maps of Land Systems

Hills with softwood scrub/vine forest
Bedourie - Be On basalt (rolling)
Sugarloaf - Sf On granitic rocks (steep)

Hills with acacia scrub
Durrandella – Du On deeply weathered rocks (steep)

Tablelands and plains with eucalypt woodlands
Killarney - Kl On acid to intermediate volcanics (undulating tablelands)
Junee/Lennox – J On deeply weathered material (gently undulating tablelands)
Tichbourne - Ti On deeply weathered material (gently undulating plains)

Low hills and rises with eucalypt and swamp mahogany woodlands
Glensfield – Gl On granitic rocks
Bolingbroke - Bb On sedimentary rocks and volcanics

Low hills and rises with eucalypt woodlands
Strathdee – Sd On granitic rocks
On sedimentary rocks
Artillery – Ar Undulating
Cotherstone/Hope - Cr Rolling

Low hills and rises with acacia scrub
Loudon – L On sedimentary rocks (steep)

Rises and plains with eucalypt woodlands
Hillalong – Hi On sedimentary rocks (undulating)
Monteagle – Mo On deeply weathered material (gently undulating)
Macksford/Nebo LU 2 – Mc On intermediate volcanics and greenstone (undulating)
Nebo LU 1- N On unconsolidated sediments (gently undulating)

Rises and plains with softwood scrub
Racecourse – R On weathered basalt (gently undulating)

Rises and plains with brigalow scrub
Kinsale – K On weathered basalt
Barwon – Bw On folded sedimentary rocks (undulating)
Daunia – Da On weathered sedimentary rocks (gently undulating)
Humboldt – Hu On unconsolidated sediments with duplex soils and clays (gently undulating)
Blackwater – Bl On unconsolidated sediments with non-gilgaied clays (gently undulating)
Somerby – So On unconsolidated sediments with melonhole clays (level)

Rises and plains with gidgee scrub
Ulcanbah – U On unconsolidated sediments with non-gilgaied clays (gently undulating)
Islay – I On unconsolidated sediments with melonhole clays (level)

Rises and plains with grasslands
Oxford – O On basalt
Girrah - Gi On sedimentary rocks

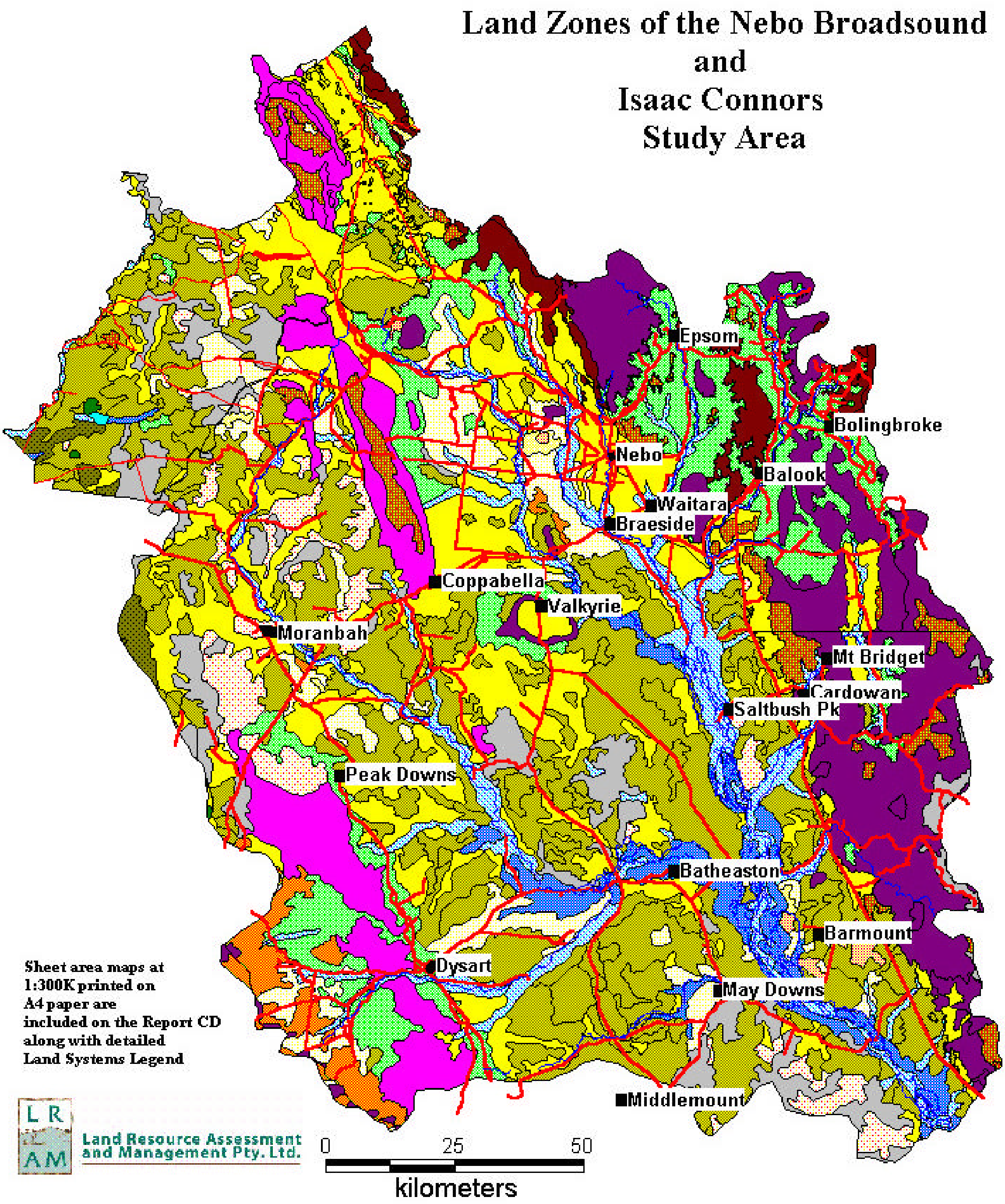
Alluvial plains with eucalypt woodlands
Connors/Alpha – Co Higher plains, minor flooding
Funnel – Fu Lower plains, flooded

Alluvial plains with brigalow scrub
Comet – Ct Lower plains, flooded

Alluvial plains with gidgee scrub
Banchory - By Lower plains, flooded

Notes: 1 Acacia scrub describes lancewood and bendee low closed forests
2 LU is an abbreviation for land unit

Map 2.1 Land Zones *(refer Section 2.2 for colour coded legend)*



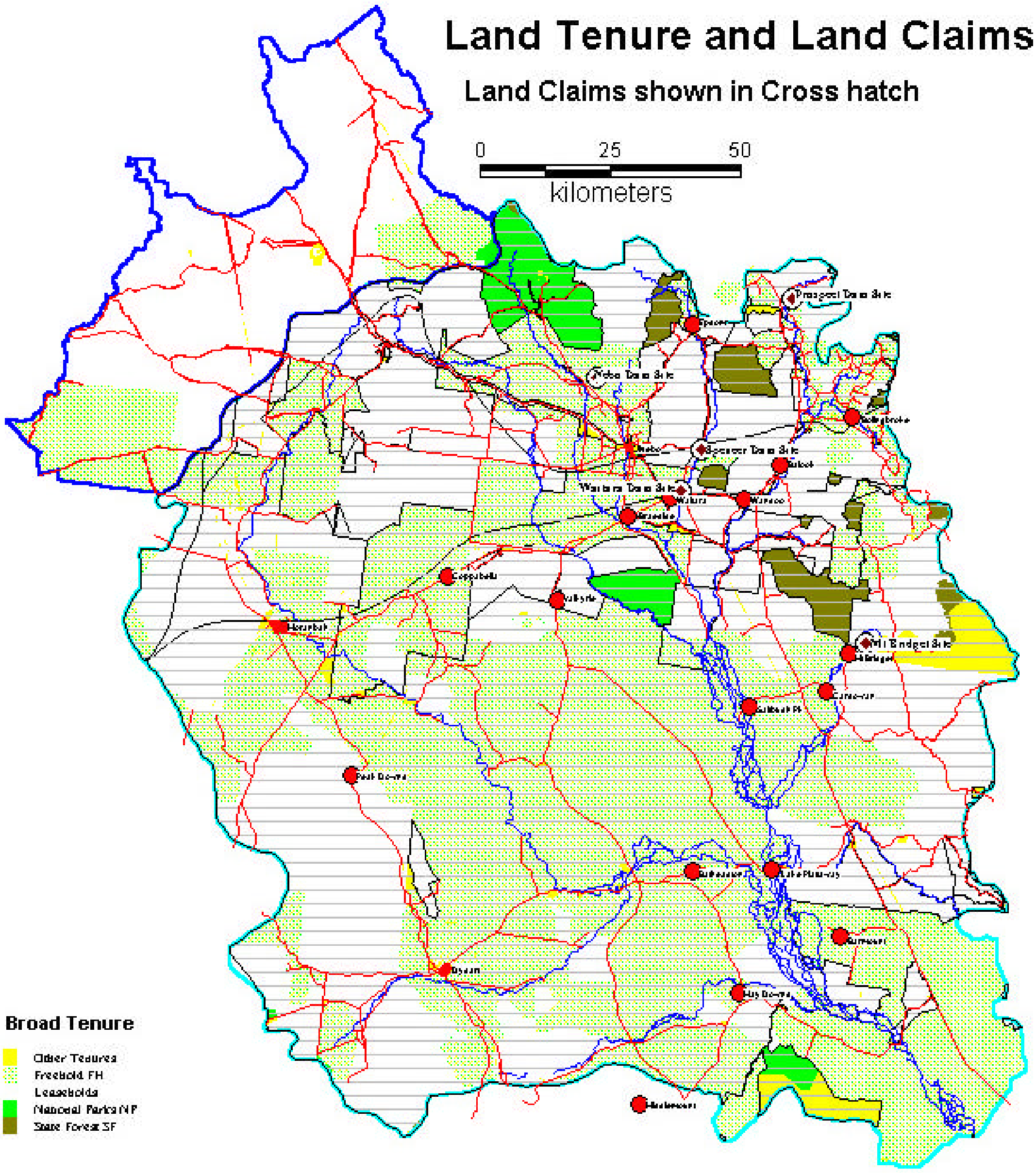
3 Land Tenure and Mining

3.1 Non Mining Land Tenure

Land Tenure across the study area (including that part of Nebo Shire outside the catchment) is dominated by Freehold Tenure. To a large extent the majority the lands of greatest suitability for cropping and improved pasture use (Section 4) are already in freehold tenure with a significant proportion of it already cleared of remnant vegetation.

Land Claims exist over the majority of the area (no data is available for out of catchment areas) with a large number of overlapping claims. Whilst freehold title extinguishes such rights, not all leasehold titles may extinguish such rights. Only small areas of the better quality lands in the study area are likely to be affected by these claims.

Figure 3.1 Non Mining Tenure and Land Claims



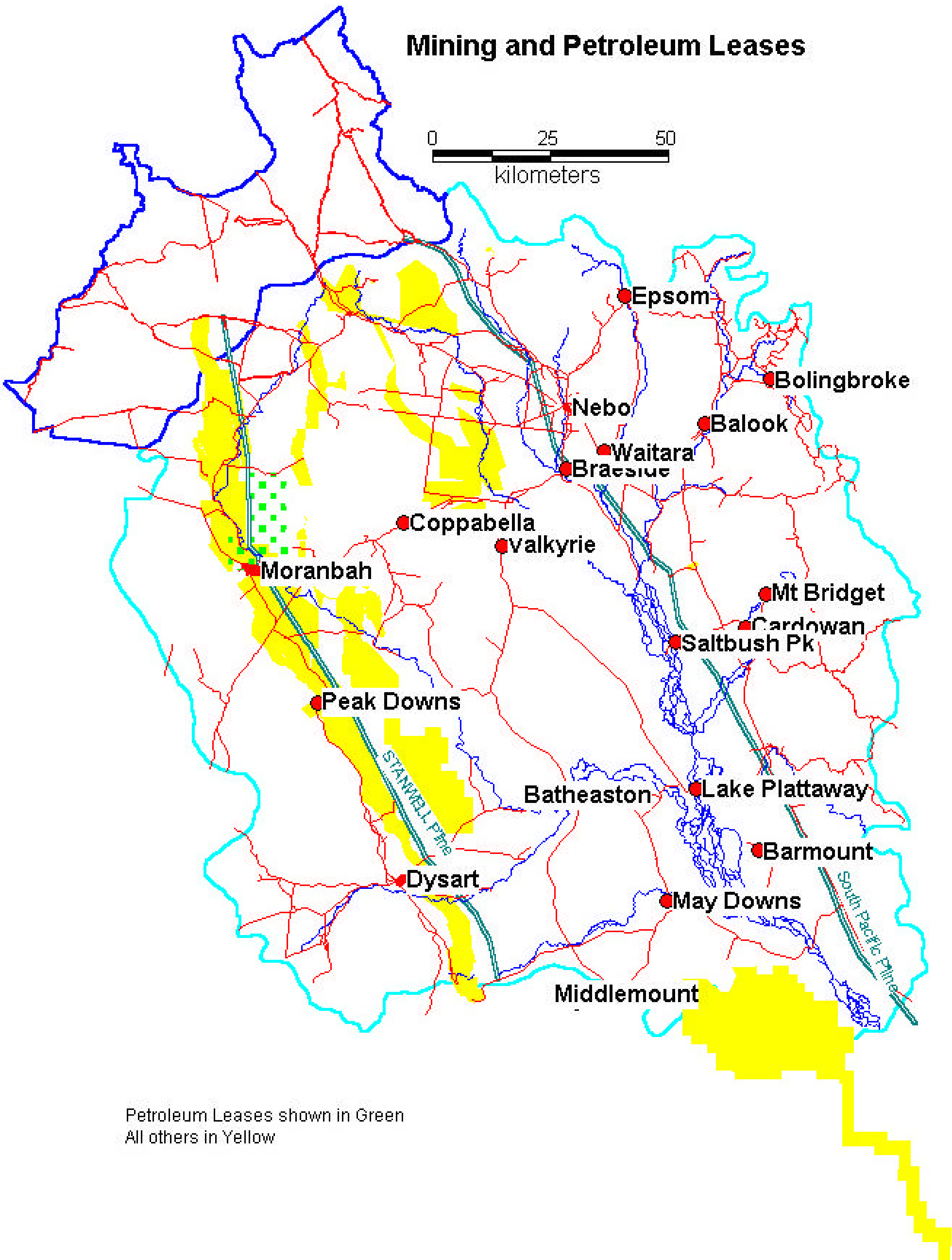
Land Resource Assessment and Management Pty. Ltd.

Apart from the issue of Land Claims, there is some concern that cultural heritage issues may be of concern in various parts of the catchment – although data is particularly scarce.. Such issues are normally addressed at the design and feasibility stages of projects and may be of some import for any infrastructure associated with development. The fact that much of the permanent surface water which may have been culturally significant in the catchment is also associated with land systems that have the greatest potential for agricultural development suggests that there may be some residual cultural values in these areas.

3.2 Mining Tenures

Mining tenure is shown in Figure 3.2.

Figure 3.2 Mining Tenures



Mining tenements, including a number of large coal mines dominate the Middle and Upper Isaac River upstream of Dysart as well as areas immediately west of Nebo. In the Dysart area, the mining tenements are largely associated with lower quality grazing lands. North of Moranbah and west of Nebo in the Bee and Cooper Creek catchments a number of Land Systems with potential for both cropping and high value grazing currently have some form of associated mining tenement. Land use conflicts and alienation of these agricultural resources are likely to take a number of forms:

- at an individual property level, mining tenements if developed may alienate suited lands from further development
- the mining industries reliance on groundwater sources from the Braeside area, potentially competes with rural uses outside of the tenements
- the pattern of mining development may also ultimately affect surface water flows in the area with consequent impacts on future availability of both overland flow and riparian sources of water

These issues are normally addressed within the EIS and EMOS stages of mining projects, however, the extensive nature of the current tenements suggests that the cumulative impacts of any future mining developments (even where nominally separate mining developments are proposed) may require further assessment.

4 Land Suitability

All land resources in Queensland are classified under at least two systems of broad suitability assessment. Land Suitability assessments for individual farming systems or crop types are commonly used for land development planning purposes. Each of the land system mapping units in the GIS files on the project CD has suitability ratings for a number of crop types including cane, cotton, field crops and horticulture.

Agricultural Land Classes normally consist of an amalgamation of land suitability approaches to produce a summary agricultural rating for use in strategic planning by local governments. In shires where cropping is an important agricultural industry, agricultural land classes rated as suited to crops are consider Good Quality Agricultural Land (GQAL). In shires where both pastoral and cropping are important both pasture and crop suitable lands are considered GQAL.

4.1 Good Quality Agricultural Land

The Queensland Department of Natural Resources and Mines (NRM) system for classifying agricultural land within central Queensland has been used to assign Agricultural Land Classes to all land systems within the study area:

Class A	Crop Land – Suitable for rainfed cropping, and/or, suited to irrigated cropping
Class B	Crop Land – Marginal for rainfed cropping, and/or, suited to marginally suited to irrigated cropping
Class C1	Pasture Land – Suitable for sown pastures where either ground disturbance is possible for pasture establishment or has native pastures on higher fertility soils
Class C2	Pasture Land – Suitable for grazing native pastures with or without the addition of pasture species introduced without ground disturbance
Class C3	Pasture Land – Suitable for light grazing of native pastures in accessible areas, otherwise very steep land more suited to forestry, conservation or catchment protection
Class D	Non-Agricultural Land

Mr B.A. Forster, NRM Rockhampton, provided an assessment of Agricultural Land Classes for land systems described in the available published reports. Land systems are by definition distinct patterns of geology, topography, soils and vegetation and thus generally contain a range of Agricultural Land Classes. The NRM assessment process involved initially determining the proportion of various Agricultural Land Classes within each land system and then assigning the Agricultural Land Class comprising the greatest proportion to that land system.

LRAM followed a similar process in determining the Agricultural Land Classes within the newly mapped land systems. An Agricultural Land Class was initially assigned to each component land unit and the estimated percentage of the land units within each land system was used to determine the proportion of various Agricultural Land Classes. LRAM also used this process for land systems described in the available published reports to compare our classification with the NRM assessment.

The comparison revealed differences in the proportion of Agricultural Land Classes assigned to each land system. The NRM assessment estimated a percentage range for Agricultural Land Classes within each land system. The percentage range does not necessarily correspond to the estimated percentages published in the land system reports for the component land units as the percentage range is specific to the Isaac Connors Study Area.

The LRAM assessment also differs from the NRM assessment in three important aspects:

- land units with moderately deep to deep clay soils are considered to have some cropping rainfed potential, provided flooding is not severe (ALC A or B);
- land units with shallow clay and clay loam soils on basalt are considered to have high quality native pastures (ALC C1)
- land units which for rainfed cropping may suffer moisture availability limitations are included as A and B lands for irrigation.

This different classification approach results in five differences in overall land system classifications, shown in Table 4.1 with all Land Systems shown in Table 4.2.

Table 4.1 Differences with NRM and LRAM agricultural land classification

Land system	NRM classification	LRAM classification
Blackwater	C1	A
Barwon	C1	B
Daunia	C1	B
Connors/Alpha	C2	B
Waterford	C2	C1

Table 4.2 Agricultural Land Classes within Land Systems of the study area

Land system	Percentage of land system with						Overall Agricultural Land Class
	Class A	Class B	Class C1	Class C2	Class C3	Class D	
Artillery				>70			C2
Banchory	***90***					***10***	***A***
Barwon	<20	<20 ***55***	>70 ***35***	***10***			C1 **B**
Bedourie			>70				C1
Berserker					>70	<20	C3
Blackwater	<20 ***70***	20-40	40-70 ***5***	***5***			C1 **A**
Blue Mountain					***>60***	***<40***	***C3***
Bolingbroke #	***5-10***	***5-15***		***70***	***5-15***		***C2***
Borilla			***15***		***45***	***40***	**C3**
Britton					>70	<20	C3
Carborough					>70	<20	C3
Chalmers				>70			C2
Comet*	<20 ***25***	40-70 ***50***	***20***	20-40		***5***	B **B**
Connors/Alpha*	<20 ***10***	<20 ***60-75***	20-40 ***10-15***	40-70		***5***	C2 **B**
Cotherstone/Hope				>70			C2
Croydon					>70	<20	C3
Daunia	<20 ***15***	20-40 ***50***	>70 ***10***	***25***			C1 **B**
Durrandella				<20	>70	<20	C3
Funnel *	<20 ***30***	<20 ***55***	***10***	>70		***5***	C2 **B**
Girrah	40-70 ***45***	<20	20-40 ***55***				A **A**
Glassford				>70			C2
Glensfield #	***10***	***15***		***75***			***C2***

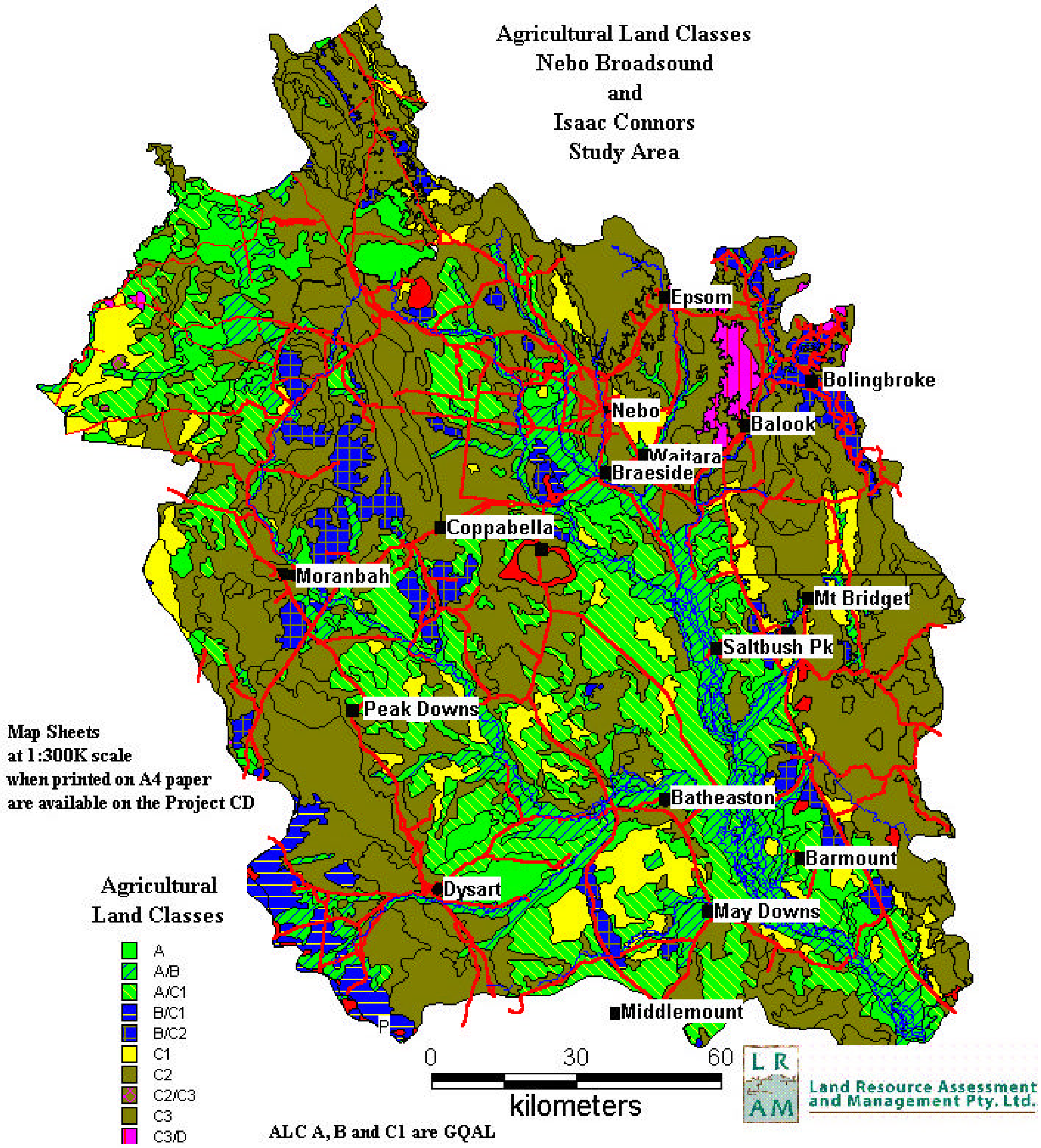
Land system	Percentage of land system with						Overall Agricultural Land Class
	Class A	Class B	Class C1	Class C2	Class C3	Class D	
Hillalong				>70			C2
Humboldt	<20 ***25***	<20	>70 ***60***	***15***			C1 **C1**
Islay			***95***	***5***			***C1***
Jordan					***>70***	***<20***	***C3***
Junee/Lennox				>70	<20		C2
Killarney				>70	<20		C2
Kinsale	***70***	***25***	***5***				***A***
Loudon			***10***	***40***	***50***		***C3***
Macksford/Nebo LU2	***0-10***	<20 ***0-15***	40-70 ***70-80***	20-40 ***5-10***			C1 C1
Monteagle				>70			C2
Murray					***>70***	***<20***	***C3***
Nebo LU1& LU3	<20 ***10-20***	<20	20-40	40-70 ***80-90***			C2 C2
Oxford	40-70 ***60***	20-40 ***20***	***20***				A **A**
Percy					<20	>70	D
Planet				>70			C2
Racecourse	40-70 ***75***	<20	20-40 ***25***				A **A**
Somerby	<20 ***5***		>70 ***90***	***5***			C1 **C1**
Strathdee #	***10***	***15***		***75***			***C2***
Sugarloaf		<20	<20		>70		C3
Tichbourne		***5***		***90***	***5***		***C2***
Ulcanbah		***65***	***30***	***5***			***B***
Waterford	<20 ***5***	20-40 ***20***	***75***	40-70			C2 **C1**
Wheeler					<20	>70	D

Note:
Assessments by P. Shields(LRAM) are shown in ***bold italics*** *for land systems not assessed by Forster (NRM, Rockhampton) or for land systems with agricultural significance where Shields' assessments differ from Forster's.*
Shaded LS and Land Classes are those considered to be suited or moderately suited to irrigated cropping (excluding secondary salinisation and flooding hazards)
** These LS are flood prone over significant parts of their areas. In the absence of flood hazard mapping land units have been raked as A or B ALC, where flooding is the only major limitation*
 # These LS are suited only to cane

The data in Table 4.2 is shown in map form (as 1:300,000 sheet areas) on the CD attached to this report.

The distribution of the ALC's for all of the study area is shown in Figure 4.1. Compound units (eg A/C1) are shown where two Agricultural Land Classes comprise up to 70% of the Land System area. Simple units (A) are shown where one Agricultural Land Class comprises over 70% of the area.

Figure 4.1 Agricultural Land Classes



4.2 Potential Irrigation Suitable Areas

For the purposes of this study areas of land with potential for irrigation development were identified where the land system mapping units were dominated by Agricultural Land Classes A and B.
A long list of 11 potential irrigation areas were identified divided into two broad types:

- areas with suited lands within 5 km of the main stream systems (the riparian areas)
- non riparian areas with landforms possibly conducive to overland flow harvesting – often associated with major stream systems.

The location of these areas is shown in Figure 4.2 with summary data in Table 4.3.

Figure 4.2 Potential Development Areas

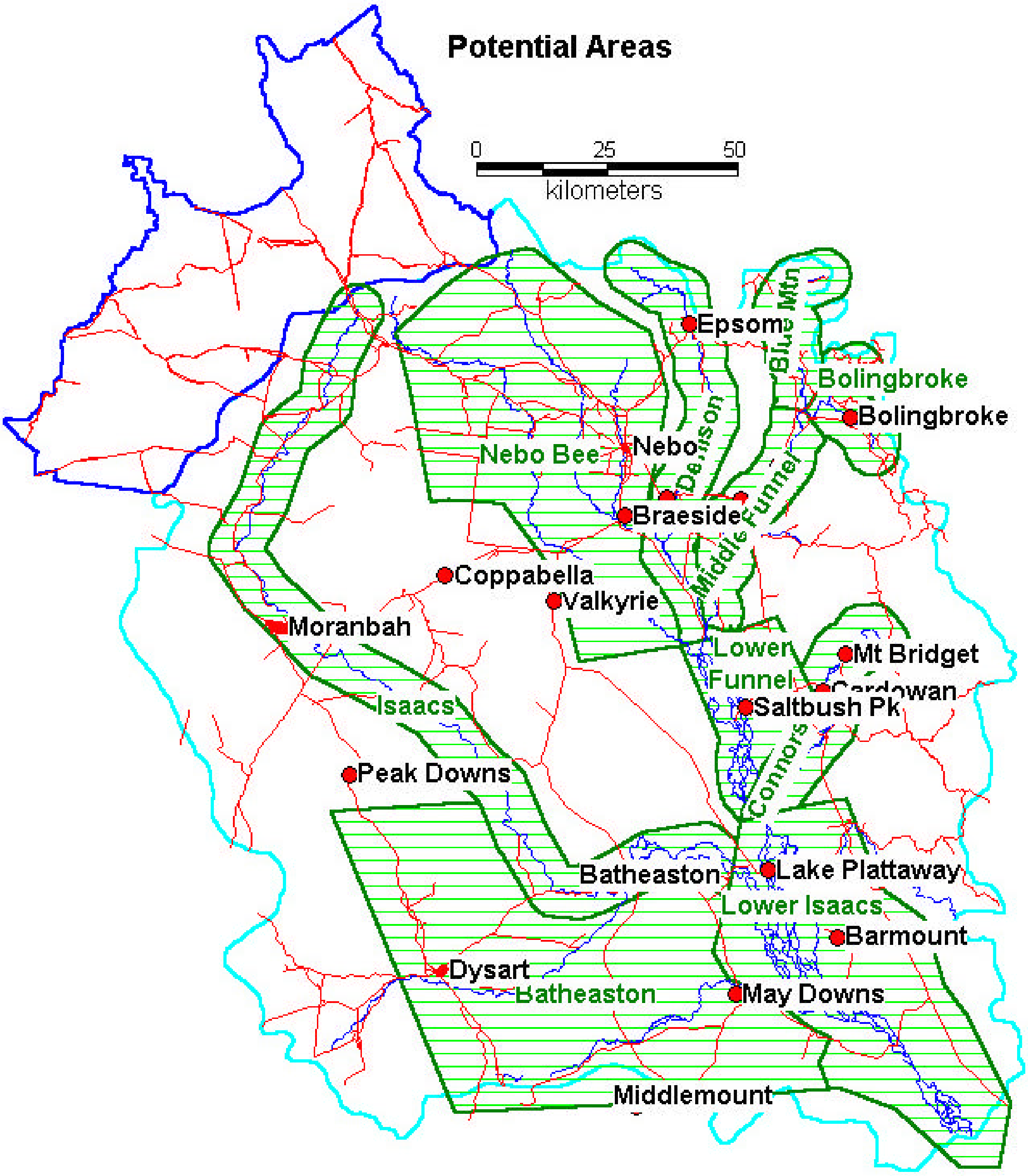


Table 4.3 Potential Development Areas

	Total Area of Land Systems ha	Suited ha	Suited and Flood Free ha	Main Land Systems (refer Sect 2 for Decode)
Riparian areas within 5 km of major stream				
Blue Mountain	18400	5,900	4,600	Bb, *Co*, Gl
Bolingbroke	18500	5000	4,600	Bb, *Co*
Middle Funnel	33200	12200	7,400	*Co*, *Fu*, N, St
Connors	21500	13500	6,600	*Co*, Bl
Isaacs	101800	55200	34300	*Ct*, *Co*, Bl, O, Gi, Hu
Riparian and Non Riparian Areas				
Lower Isaacs/Barmont	151200	78300	52700	*Ct*, *Co*, Bl, Hu, O
Lower Funnel	84100	34900	25200	Hu, Bl, *Fu*, *Ct*
Batheaston	151900	71500	60500	Bl, Hu, O, Gi, *Co*, *Ct*, *Fu*
Nebo Bee	159400	74700	56300	O, Gi, *Co*, Hu, N, *Ct*
Denison	55300	22200	16900	*Co*, *Fu*, N, St

4.2.1 Riparian Areas

Much of the current cropping (to Cane and Pangola grass) in the Blue Mountain area is on the Connors Alpha (Co) Land System immediately adjoining Prospect Creek. Of some 2000 ha of Connors Alpha area which is suited for cropping, almost 1300 ha is assessed as being too prone to flooding for development. The shallower and generally less fertile soils of the Glensfield and Bolingbroke area are not subject to flooding, however less than 25% of the area is assessed as suited to cropping. Cropping other than cane and possibly some horticulture adapted to the higher rainfall environment would not be advisable in this area.

The Bolingbroke area includes both the Funnel upstream of the Prospect Creek junction and is similar in terms of land suitability and land use to the Blue Mountain area.

In the Middle Funnel area, less than half of the alluvial flood plains (Funnel and Connors Alpha) is sufficiently flood free to be considered potentially suited. The majority of the non flooded land systems have relatively small proportions of suited land. This area reports both severe high velocity erosive flooding and long duration floods.

The Connors area extends from the Mt Bridget dam site to the junction with Funnel Creek.

The area suffers similar flooding limitations to the Middle Funnel Creek area and in many respects could be considered similar in potential. The main difference is that downstream of Cardowan, the flood free Land System of Blackwater extends close to the river and could be easily commanded by riparian schemes.

The Isaacs riparian strip extends from May Downs to above Moranbah. Apart from flood prone Connors/Alpha and Comet Land Systems, Blackwater and Humboldt comprise the majority of suited area. Of these, Humboldt is probably the most salinity prone and the high soil variability in this Land System is cause for concern.

4.2.2 The Non Riparian Areas

The Lower Isaacs area contains the severely flooded Comet and Connors/Alpha LS, along with large areas of Blackwater, Humboldt and Oxford. The area is centred on Barmont with extensive cropping and irrigation licenses between Barmont and Lake Plattaway. The Humboldt area needs to be viewed with some concern vis a vis salinity.

Apart from the large area of Blackwater south west of Barmont (approx 4,000 ha), the even larger area of Blackwater and Oxford south east of Lake Plattaway would appear to offer significant potential.

Riparian security of water supply could only be provided by the Mt Bridget Dam site, however, overland flow harvesting and flood harvesting from the longer duration flood events may also be viable alternatives. The area also contains a significant ground water resource within the braided flood plains.

The Lower Funnel area extends on the right and left bank of the Funnel between Denison Creek and Connors River.

The majority of the suited area is within the Humboldt Land System where soil variability and potential salinity effects would be of concern. The remainder of the suited area is within the flooded lands of Funnel, Comet and Connors/Alpha.

The Batheaston area contains over 80% of the current dryland and irrigated cropping in the study area. The area lies south of the Isaac River between Dysart and May Downs. The large area of suited and flood free lands includes almost 36,000 ha of Blackwater, Girrah and Oxford Land Systems that appear to be particularly well suited to irrigation development.

The Nebo Bee Creek area comprises contains large areas of ‘downs’ country (Girrah/Oxford) with large areas of alluvial flood plains. Despite the large areas of high quality soils, these areas are likely to remain largely dryland farming lands with the possibility of some opportunistic overland flow harvesting in areas of suitable terrain.

The Lower Denison area extends from the Mt Spencer Dam Site downstream to the junction with Funnel Creek. The area includes the Waitara Dam Site. Approximately 25% of the suited area would be impounded by the Waitara Dam site. The area currently supports very limited cropping.

The Upper Denison area consists of a narrow riparian flood plain with adjoining uplands of variable soils. There is no cropping in this area of any significance. The majority of the alluvial Land Systems and the better quality upland soils would be flooded by the Mt Spencer dam site.

5 Water Resources of the Isaac Catchment

The Fitzroy Basin comprises 143,770 sq km of which the Isaac Connors catchment study area accounts for 15% of the area [2]. There is a three to four fold increase in rainfall west to east across the study area – increasing from around 550 mm average annual rainfall around Moranbah in the Isaac River sub catchment to around 2000 mm along the coastal ranges in the headwaters of the Funnel/Connors subcatchments. The majority of the area with greater than 700mm rainfall lies within the Funnel/Connors subcatchment.

5.1 Surface Hydrology

5.1.1 Riparian Water Flows

Flow data within the streams of the study area are available for 11 gauging stations (Figure 5.1). The data is summarised in Table 5.1.

Table 5.1 Summary Flow Records for streams in the Study Area

Station (years of data)	Estimated ML of irrigation required for suitable riparian land	Stream Order	Annual Flow ML (as % of Isaacs at Yatton)	
			Mean	Median
Burton (25)	110,000 ML in Isaacs and Batheaston Areas	Isaacs	33,939 (2%)	10,932 (1%)
Goonyella (17)		Isaacs	38,357 (2%)	18,178 (1%)
Deverill (32)		Isaacs	154,041 (7%)	59,135 (5%)
Mt Bridget (37)	35,000 ML in Connors, Lower Funnel and Lower Isaacs Areas	Connors	515,825 (24%)	276,431 (21%)
Pink Lagoon (37)		Connors (below Funnel Junction)	1,778,110 (81%)	1,034,467 (80%)
Yatton (38)		Isaacs below Connors	2,189,035	1,297,875
Colston (24)	15,000 ML in Middle and Lower Funnel Areas	Funnel	62,027 (3%)	41,744 (3%)
Main Rd (37)		Funnel below Prospect Creek but above Denison and Bee Ck	447,914 (20%)	299,399 (23%)
Smiths (17)	80,000 ML in Nebo Bee and Denison Areas	Bee Ck	85,794 (4%)	66,069 (5%)
Nebo (23)		Nebo Ck	58,630 (3%)	33,156 (3%)
Braeside (29)		Denison	188,073 (9%)	107,077 (8%)

Of the total flow from the Isaacs into the remainder of the Fitzroy Basin, some 80% of the flow is generated from the Connors and Funnel systems. Within these systems the Nebo and Denison catchments (which includes Nebo Creek) supply around 15% of the flow. The Middle and Upper Isaacs supply less than 10%.

The differing time periods of records does not allow an accurate comparison of flows using average or median data. However, the wide variation between average and median data does show the exceptionally high variability of annual flows. The data for Yatton shows this effect. In 38 years of

[2] Under this project, there is an addittional 3,300 sq km in the Suttor/Belyando catchment within Nebo Shire which is included as part of the various Land Resource Assessment studies.

record only 8 years record flows higher than the 2.1 million ML average. Of these 8 flows, 3 were years recorded between 7 and 10 million ML of flow. Stations with less than 20 to 25 years of records will not have sampled the majority of these large flow years which occurred over the 1973 to 1978 period.

Figure 5.1 River Stations and Dam Sites

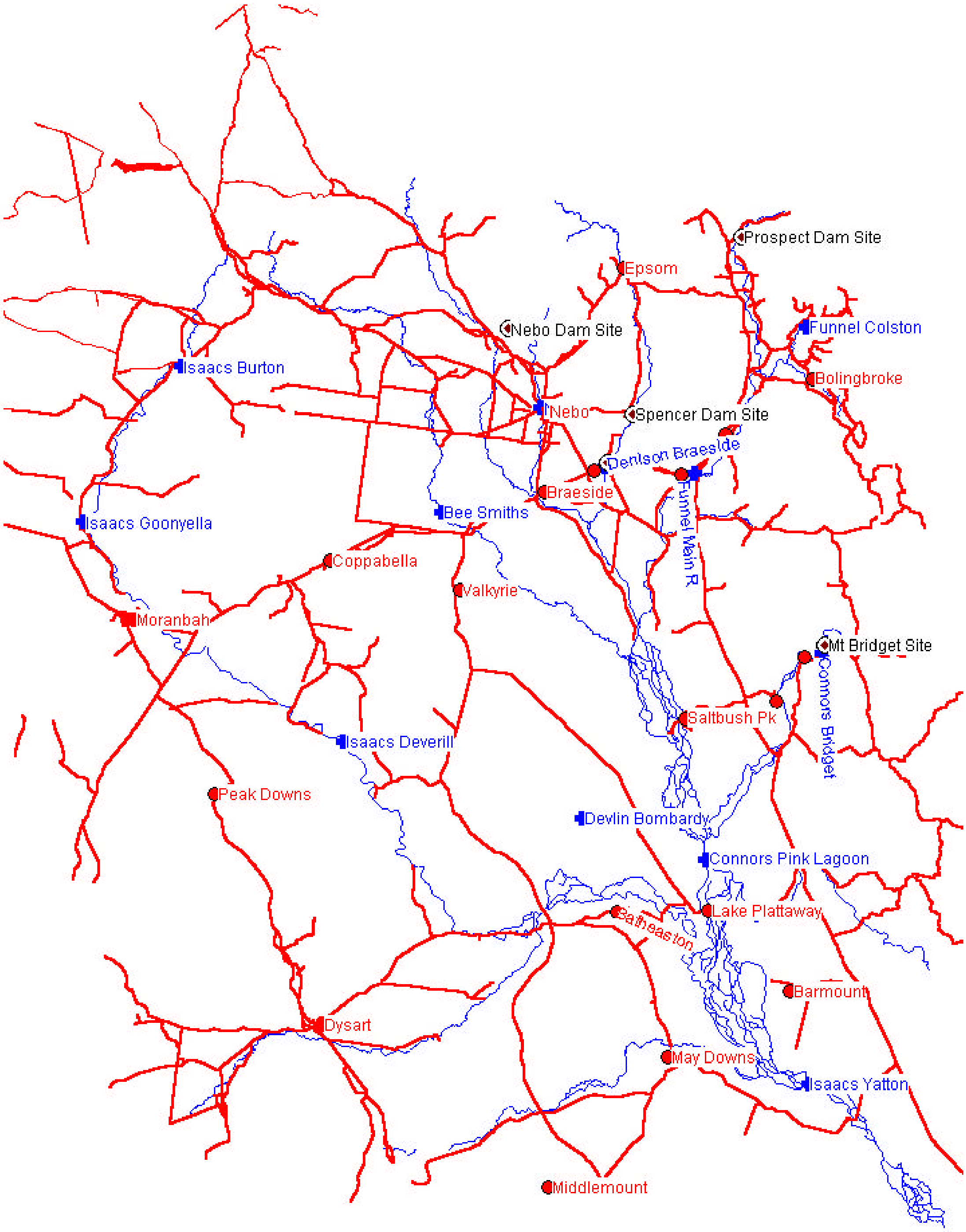


Table 5.1 shows the potential irrigation demands over the stream areas associated with the potential development areas.

- The potential demands in the Isaacs and Batheaston areas are the equivalent of 70% of the average and almost double the median annual flow in the Isaacs at Deverill.
- The Connors, Lower Funnel and Lower Isaacs/Barmont areas have a potential demand of 35,000 ML. This represents less than 15% of the median flows at Mt Bridget Dam Site and under 3% of the flows at Yatton.
- The Middle and Lower Funnel areas potential demand represents 6% of median flows in the Funnel system
- The potential demands in the Nebo/Bee and Denison areas is approximately 80% of the median flows at the Dension and exceeds the median flows in both Nebo and Bee Creeks.

The assessment of what constitutes sustainable levels of extraction from unregulated flows in the catchment has yet to be undertaken by NRM for the individual streams. For the overall catchment the draft WAMP estimated that up to 300,000 ML of mean annual diversion was in excess of base environmental requirements. Further hydrologic modelling will be required before the unallocated water available for diversion in different parts of the system can be confirmed and potential supply matched to potential demand at various locations in the catchment.

The estimated 50,000 ML of potential requirement between Mt Bridget and Yatton is however one sixth of the estimated excess mean annual diversion flows at Yatton at the bottom end of the catchment.

The somewhat simplified summary given above indicate that even full levels of potential development for irrigation in the area from the Middle Funnel to Yatton (and including the Connors River) would result in a relatively low percentage of median annual flows being diverted. Given the episodic nature of runoff in the catchment, the reliability and hence availability of even this relatively low level of diversion of median flows has to be established by detailed modelling.

5.1.2 In Stream Storages

Over the last 30 years, there have been various levels of proposals for 13 in stream storages. All but four of these have been largely premised on the need to provide various levels of water security to the mining sector. Of the 13 mining industry premised ones, one also had some potential for supplying a significant quantity of water for agricultural use. The resultant five dam sites are shown in Figure 5.1 and summarised in Table 5.2. Irrespective of the premise on which these various sites have been proposed, none of them have been specifically included in the WAMP as part of the existing allocations in the Fitzroy Basin. The significance of this is that unlike proposed and approved dams such as Nathan on the Dawson, none of these sites currently fit within the WAMP or its resultant ROP framework.

Sites such as Nebo are very high cost and relatively inefficient sites with low safe yield/storage ratios whilst others such as Waitara would require re-routing of major roads and rail networks. Of all the sites only Prospect would result in regulated flow in areas where the cane industry is currently expanding whilst Mt Bridget on the Connors could be considered as the only large scale storage capable of supplying water to large irrigation areas. Mt Bridget has a number of smaller storage sizes options with less efficient yield/storage ratios resulting costs per ML of yield as high as $1,370.

Irrespective of the cost effectiveness of any of these proposals and their capacity to service future demands, all of these sites would have to pass relatively stringent criteria for in stream works as defined in the WAMP. Apart from the normal impoundment area impacts, these criteria include impacts on in stream environments downstream. None of these sites have been evaluated on the basis of these extended WAMP based criteria.

Table 5.2: Assessment of Potential Dam Sites

Assessment criteria	Potential Dam Site				
	Prospect	**Waitara (1)**	**Spencer**	**Mt Bridget (2)**	**Nebo**
Safe Yld (ML/yr)	7,850	49,000	25,000	96,000	9,400
CAPEX ($'000)	$12,560 (1999$)	$13,720 (1993$)	$75,625 (2001$)	$60,000 (1993$)	$50,760 (2000$)
Yield cost ($/ML)[3]	$1,600	$280	$3,025	$625	$5,400
Use of water	Cane	Mining + Crop	Mining + Crop	Mining + Crop	Cane
Estimated Max ha of crop supported	3,000 ha	7,000 ha	4,000 ha	16,000 ha	1,500 ha
Area most likely to benefit – Areas within 5 km of stream and not flooded	Blue Mountain - 3,900 ha with 690 ha also within flood plain	Upper and Lower Denison – approximately 300 ha with another 5,700 ha within the flood plain – the majority of which would be impounded.		Connors and Barmont Areas 5,200 ha – an addititional 25,000 ha within the flood plain	13,400 ha in Nebo Bee Ck areas with 11,000 ha within flood plain
Overall Rating	Low (expensive water + low volume)	Moderate (cheap water but poor access to land)	Low (costly water)	Moderate (poor access to land)	V. low (high cost of water and low volume)

(1)This is the 1971 figure. No work has been undertaken to determine a present day value for this site. The site is located downstream of the Spencer site on Denison Creek.
(2) This estimate was based on the 1976 SMEC concept design. The design is to be revised to take into account flow requirements to meet WRP environmental flow and water allocation security objectives. This may require the installation of gates resulting in a relatively higher unit cost for water.

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5.2 Groundwater

Most of the alluvial deposits associated with the major streams of the catchment have associated groundwater resources. However, only the Nebo to Waitara section of Nebo Creek appears to have been exploited to any significant extent for other than stock and domestic purposes. Two separate but interlinked bore fields have been developed:

- the Nebo bore field primarily services Nebo township. The current extraction from the field is around 80-100ML/year with some uncertainty about the maximum long term sustainable yield figure
- the Braeside (Waitara) field is a more extensive field (drawing on both Nebo and Denison Creek alluvial aquifers) and provides water via pipelines to the mining towns of Goonyella, Moranbah, Coppabella and Riverside. Current allocations are some 4,450 ML/year of which 80% goes to the BHP coal settlements/mines. The most recent review of the potential suggests that this field is either at or just beyond its sustainable limit.

Whilst the two existing bore fields (arguably one single system) are probably at their limit of exploitation, the largely unconfined and semi confined alluvial aquifers that define these existing bore fields appear to be far more extensive in both the Lower Isaac and the Connors/Funnel system. The

[3] These costs are desk based estimates provided by QDNRM. They represent only the capital costs of providing the yield. Under full cost recovery this cost would be amortised and added to delivery costs.

braided flood plain landforms of the braided flood plains of the these areas (a relatively unique landform in Central Queensland) contain over 20m of unconsolidated alluvium with what appears to be reasonable yields and water quality. No comprehensive hydrogeological assessment of these areas has been completed and the despite the large number of monitoring sites in these areas, the monitoring sequence is discontinuous and of variable quality.

5.3 Current Irrigation, Cropping and Water Licensing Arrangements

5.3.1 Licensing Arrangements

There are three main types of existing (i.e prior to the Water Act 2000) arrangement under which landholders currently access water resources in the area.

- Area based entitlements are tied to a land parcel. These entitlements normally specify the area of land which can be irrigated and have no volume base – except for that which could be inferred by assigning irrigation water use in ML to each ha of land. When converted to an estimated volume of irrigation water, the 3,300 ha of land holding these entitlements accounts for almost 90% of the equivalent volumetric licensing arrangements in the catchment.
- Volume based licenses allow landholders to take up to a specified volume from river flows and groundwater. Such licenses are normally limited by pump size (often in lieu of actual monitoring). There are a relatively small number of these licenses at the moment.
- Overland flow harvesting. Prior to the Water Act (2000), these types of schemes were not regulated so long as they met certain wall height and storage requirements. There are a small number of these in the catchment. The large scale proliferation of these schemes which has occurred in other river systems in Queensland under similar open regulatory environments has not occurred in the catchment to date.

Table 5.3 summarises the existing water entitlements and allocations, and the potential demands for water if available and suited lands were to be developed for irrigation within the potential areas identified in Section 4.

Table 5.3 Estimated water requirements in areas of the Catchment #

	Suitable riparian land	**Current water entitlements***			**Potential usage †**	**Additional requirements ‡**
		Ground	**Surface**	**Total**		
	ha	ML/a	ML/a	ML/a	ML/a	ML/a
Isaacs	10,850	130	480	610	65,100	64,490
Blue Mountain	3,900		1,700	1,700	9,750	8,050
Bolingbroke	4,380		2,736	2,736	10,950	8,214
Connors	1,500		4,572	4,572	9,000	4,428
Middle Funnel	590		100	100	3,540	3,440
Lower Funnel	1,860		960	960	11,160	10,200
Upper & Lower Denison	300				1,800	1,800
Batheaston	7,700		1,700	1,700	46,200	44,500
Lower Isaacs Barmont	3,700	1,800	8,087	9,887	22200	12,313
Nebo Bee	13,400	1480	270	1,750	80,400	78,650
TOTALS				24,015	191,700	167,685

The water licensing data maintained in the NRM Brisbane centralised data base is the source licensing data
* Estimated for area based entitlements assuming 6 ML/ha for grain and 2.5 ML/ha for cane
† Estimated by multiplying the suitable riparian land (within 5 km of source) by 6 ML/ha
‡ Given by difference between potential usage and current entitlements. Does not take account of any allocations to be released under the ROP.

The additional long term uptake of irrigation water could be in the order of 170,000 ML if all land within 5 km of the streams which is nominally suited, were actually developed for irrigation.

The estimated current water use is summarised in Table 5.4. Of the 55,000 ha of land cropped in the area, just over 1,000 ha is currently irrigated. This irrigation is drawn from a combination of area based entitlements and volume based allocations from both ground and surface waters as well a small number of overland flow schemes.

Table 5.4 Estimated current cropping and irrigation areas

Area	**Irrigation Licenses**		**Present Cropping**		**Estimated Water Use**	**As a % of allocations and entitlements**
	Area based entitlements	Volume based	Dryland	Irrigated	ML	
Isaacs	80 ha		7300 ha grain and cotton (east of Batheaston)	50 ha	300	60%
Blue Mountain	277 ha		750 ha (mostly cane)	200 ha – includes groundwater irrigated pastures	450	60%
Bolingbroke	452 ha		520 ha (cane)	100 ha	250	22%
Connors	762 ha	110	720 ha (forage & grain)	50 ha	300	6%
Middle & Lower Funnel			1200 ha (forage & grain)	100	600	Overland Flow and groundwater also used.
Upper and Lower Denison			Minimal	100	600	
Batheaston	200 ha		28,000 ha (grain and cotton)	<50 ha	300	66%
Lower Isaacs/Barmont	1442		13,000 ha (grain/forage)	250 ha but increasing	1500	17%
Nebo/Bee	40		3,500 ha (grain/forage)	100 ha	600	Overland Flow and groundwater also used.

The total estimated water in use from all sources is approximately 5,000 ML – equivalent to around 20% of total surface and groundwater licenses.

Whilst there is substantial land resource potential for irrigation, the current level of irrigation is relatively low by state standards. Area based entitlements have a significant number of what are termed sleeper licenses (i.e. unused) and this no doubt contributes to the low level of utilisation. The predominance of the cattle industry would also account for the low levels of utilisation. With the exception of the Batheaston area and areas around Barmont, large scale cropping has not developed as the main agricultural business enterprise. Irrigation, where it has been adopted, is largely an adjunct to cattle enterprises. Barmont station, arguably the most developed property in the area and the only enterprise actively developing land for irrigation, uses irrigation to value add to the existing feedlot.

The short term future for water allocations in the area is currently unclear. Discussions with QDNRM staff involved in the preparation of the ROP indicate that the short term (<5 years) scenario will be as outlined below.

- Initially only those existing water entitlements from the Fitzroy River above the Barrage; all the Mackenzie River; the Nogoa River downstream of Fairbairn Dam except for waterharvesting above Theresa Creek; and the Dawson River downstream from Glebe Weir (supplemented water only) will be converted to tradeable water allocations;
- In all other areas including the Isaac/Connors River system existing entitlements will remain as water licences that will not be tradeable. Some of these licences may be converted to tradeable water allocations at a later date.

In addition, the release of a maximum of 26,000 megalitres of the unallocated water identified for the Isaac/Connors Rivers and the lower Mackenzie/Fitzroy River systems may be permitted shortly after implementation of the ROP to meet identified short-term needs for water for agricultural and mining uses. Release is proposed as follows:

- Up to 15,000 ML of new water allocations be granted in specific reaches of the Mackenzie and Fitzroy Rivers, through a market based process; and
- 11,000 ML in the Isaac/Connors river system and the tributary streams of the lower Mackenzie River and the Fitzroy River (not including the Dawson River). As water allocations are not yet being established in these areas, each authority to take water will be by water licence , which is not tradeable. No decision has been made as to whether water licences will be granted by sale or an administrative process.

A series of water release planing studies and economic evaluations is required before it will be possible to release most of the water potentially available in these systems.

Given that the above scenario actually eventuates the implications for the Isaac Connors catchment may be as follows:

- Existing allocations and area based entitlements will remain. This means that up to about 24,000 ML of water current assigned to agriculture will be maintained under the ROP.
- Of this 24,000 M of which less than 5,000 ML is currently used, none will be tradable into areas where water may be available for agriculture and other uses. This means that any sleeper licenses (estimated as around 75% of equivalent volume) cannot be traded from one area to another. In effect, the Lower Isaacs and Barmont area, which appear to have the highest irrigation potential in terms of suited lands and likely stream flows, will remain constrained by water availability under these no trading arrangements.
- An additional 11,000 ML will be made available for irrigation out of the unallocated flows for tradable volume allocation. However, this water will be made available to downstream (out of catchment users as well. It is thus very uncertain as to how much of this may be available within the catchment

If the ROP allocations are as indicated above, future expansion in irrigation will be incremental rather than dramatic in the short term and will not be facilitated by the proposed ROP outcomes.

6 Regional Ecosystems and Vegetation Values

Regional Ecosystem mapping from Bioregions 8 and 11 cover the area. This has been compiled and a map showing the Conservation Status under the Vegetation Management Act is shown in Figure 6.1. The vegetation communities which comprise the Endangered and Of Concern areas are summarised in Table 6.1

Figure 6.1 Conservation Status of Remnant Vegetation

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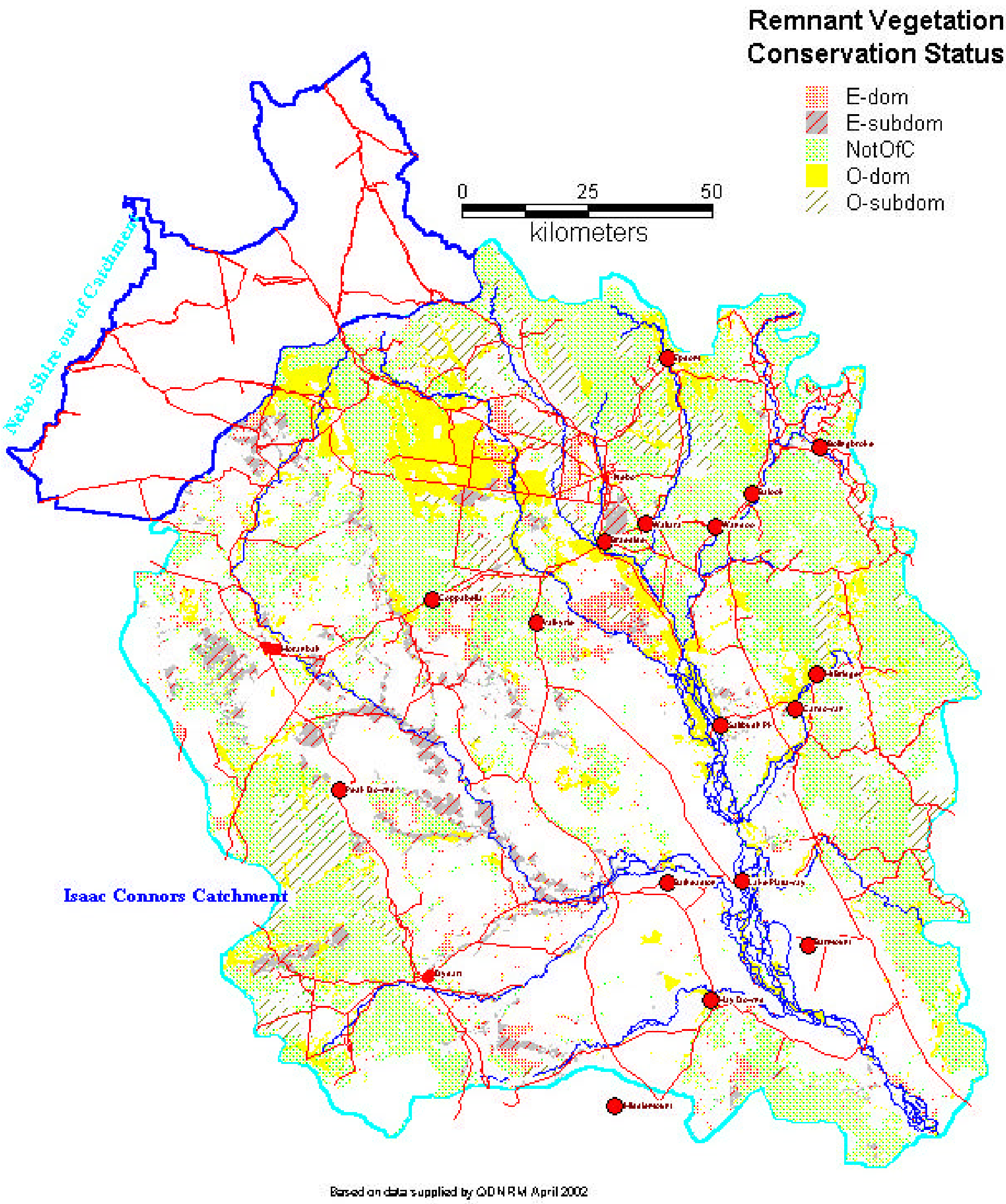

Approximately 4% of the catchment has an Endangered Status with 8% having an Of Concern Status The alluvial and clay plains with open forests and scrubs as well as the open downs grasslands figure prominently in this list – however large areas of these have been cleared or otherwise disturbed and do not have the E or O status.

Table 6.1 Conservation Status of Remnant Vegetation

RE1	Status	Landform	Description	ha
11.11.14	E	Ranges and Low Hills on metasediments	Brigalow, Belah, Wilga Open Forest with/out Belah, Box	54
11.11.18	E	Lowlands on metasediments	Vine thickets and Scrubs	406
11.12.21	E	Hills on intermediate and acid volcanics	Brigalow Open Forest with/out nine thickets	233
11.3.1	E	Alluvial Clay Soil Plains	Brigalow Belah with Wilga, with/out Coolabah, Poplar Box	11214
11.3.11	E	Alluvial Clay Soil Plains	Vine thickets and Scrubs	712
11.3.21	E	Alluvial Clay Soil Plains	Queensland Bluegrass	3370
11.4.1	E	Undulating Clay Plains (Cza)	Vine thickets and Scrubs	1764
11.4.13	E	Basalt Clay Plains	Northern Gum Top Box/Dawson Gum Open Woodland	12550
11.4.6	E	Undulating Clay Plains (Cza)	Gidgee, Yellow Wood, Sandalwood	141
11.4.8	E	Undulating Clay Plains (Cza)	Northern Gum Top Box/Dawson Gum, Brigalow	10862
11.4.9	E	Undulating Clay Plains and weathered Basalt	Brigalow, Yellow Wood with/out Belah scrubby Open Forest	25811
11.5.15	E	Remnant Weathered Tertairy Surfaces (Red Soils?)	Vine thickets and Scrubs	445
11.5.16	E	Sand Plains	Brigalow Belah Open Forest	257
11.8.13	E	Basalt	Vine Thickets	1378
11.9.1	E	Fine Grained Sedimentary Rocks/Lowlands	Brigalow Box Open Forest	946
11.9.4	E	Fine Grained Sedimentary Rocks/Lowlands and Hill crests	Vine Thickets	1599
11.9.5	E	Fine Grained Sedimentary Rocks - Lowland Clay Plains	Brigalow Belah Scrubs	7668
8.3.6a	E	Coastal Alluvial Plains	Blue Gum Open Forests	1213
	Total Rated Endangered			**80621**
11.10.8	O	Sandy Grained Sedimentary Rocks	Vine Thickets and Rainforest	1211
11.11.10	O	Ranges and Low Hills on metasediments	Gum Top Box, Ironbark shrubby woodland	1697
11.11.13	O	Ranges and Low Hills on metasediments	Brigalow low open woodlands with Polar Box, Yellow Wood	1154
11.11.16	O	Fine Grained Sedimentary Rocks/Lowlands	Brigalow Dawson River Gum woodland	216
11.3.2	O	Alluvial Clay Soil Plains	Polar Box open woodland with low shrubs	53147
11.3.3	O	Alluvial Clay Soil Plains	Coolabah over grassland	18924
11.3.36	O	Alluvial Clay Soil Plains	Iron Bark and Polar Box over grassland	1681
11.3.4	O	Alluvial Clay Soil Plains in dissected sandstone	Siver Leaf Ironbark woodland over grassland	34248
11.4.2	O	Undulating Clay Plains (Cza)	Mixed Box and iRonbark woodland with some Brigalow	11943
11.8.11	O	Downs	Queensland Blue Grass	20740
11.8.14	O	Lowlands on Igneous Rocks	Iron bark grassy woodland	40
11.9.10	O	Fine Grained Sedimentary Rocks - Lowland Clay Plains	Brigalow Box open forest	745
11.9.7	O	Fine Grained Sedimentary Rocks/Lowlands and Hill crests	Box shrubby woodland	32413
8.12.10a	O	Hills on intermediate and acid volcanics	High Altitude Exposed Shrubland	255
8.12.16	O	Hills on intermediate and acid volcanics	Low Rainforest	2724
8.12.17a	O	Hills on intermediate and acid volcanics	Mossy Rainforest	1319
8.12.23	O	Hills on intermediate and acid volcanics	New RE	758
8.12.24	O	Hills on intermediate and acid volcanics	New RE	16
8.12.4	O	Hills on intermediate and acid volcanics	Flooded Gum Forests	465
8.12.8	O	Hills on intermediate and acid volcanics - wet uplands	Shrubby Open Forsts	105
8.3.5	O	Coastal Alluvial Plains	Mixed Eucalypt Woodland	1277
8.8.1	O	Tertiary Basalt	Rainforest	163
	Total Rated Of Concern			**185239**
All Not of Concern Units				**885960**
Area without Remnant Vegetation				**1076180**

As part of the process of developing Regional Vegetation Management Plans, the status (as in E N and O) and the habitat and land degradation potential of areas is being taken into consideration. Issues within the catchment which are likely to potentially effect the future development scenarios may include:

- the presence of relic land surfaces which are known to contain flora which is either unique or is covered by the Commonwealth Environment and Biodiversity Conservation legislation (the Junee uplands Downs grasslands are one example).
- combinations of landforms and communities which are considered to have high biodiversity and/or to be of such regional importance that some degree of protection is warranted. It is unclear at this stage whether such areas will be defined in the catchment, however, the braided flooded plains systems of billabongs/lakes and stream lines have been a focus of such attention in other areas. The first desk based draft of this assessment has resulted in large areas of Not of Concern or

Of Concern Remnant Vegetation having a biodiversity status ranking equivalent to the Endangered Conservation Status (ie a State Level of Significance). If land development restrictions are developed for all areas of a State level of significance, then there may be significant impacts for the future management of large areas of mainly grazing quality lands which fall in the Not of Concern or Of Concern categories.

- areas prone to erosion or salinisation if cleared. Whilst it is true that salinisation of *Brigalow Lands* has occurred elsewhere in the state, it remains unclear at this stage whether the combination of climate, soils and landforms of the study area poses a significant risk. The majority of better quality Brigalow lands of the study area have already been cleared (albeit in relatively recent times when compared with elsewhere in the state) and this issue is therefore likely to be of import primarily in areas of regrowth. Such areas have been included with the cleared and disturbed categories with the latter occurring extensively in the Lower Isaac Connors areas. The irrigation development salinity hazard issues are discussed in Section 8 of this report.

In completing this study, an accuracy assessment of the Regional Ecosystem mapping for Nebo and Broadsound shires was undertaken. This analysis is reported separately and included on the project CD. There is a likelihood that accuracy of the Regional Ecosystem mapping is less than that required for planning at the local shire levels and that there is a relatively high frequency of possible errors in the Good Quality Agricultural Lands in the Nebo, Cooper, Bee and Denison Creek catchments where a substantial amount of Remnant Vegetation has been mapped and falls into either the Endangered or Of Concern status categories.

7 Irrigation Development

7.1 Prevailing situation

For landholders, the attraction of irrigation stems from its capacity to make the basic factors of production (land, labour and capital) more productive and thereby generate greater wealth. Irrigation does this by permitting the production of higher value products and by reducing production risks. For local communities and governments, the attraction of irrigation stems from the secondary benefits that spill-over from the primary wealth generation. The secondary benefits normally associated with irrigation include job creation, greater demand for goods and services and more stable and diverse communities.

The feasibility of irrigation depends in the first instance on access to water in combination with suitable soils and climate. An area will only achieve status as an 'irrigation precinct' if the quantities of water and land permit an economic scale of operation to be achieved. However natural resource potential will only convert into development if appropriate economic and social circumstances are also in place. These circumstances would normally include:

- *Access by the particular holding to a 'quality' water product in terms of its volume and reliability*. With a relatively low level of current development at approximately 20% of current licenses (both area based entitlements and volume allocations) access per se would appear not to have been a major impediment to irrigation development. The poor reliability of flows in the Isaacs, Nebo and Bee stream systems above their junctions with the Connors and Funnel would however restrict development in these areas.

    The proposed ROP outcomes will not significantly alter this impediment to irrigation development. None of the existing licenses/entitlements in the catchment will be tradable and hence able to be re-located to areas in the Lower Funnel Connors and Isaacs where reliability of flows is likely to higher. Furthermore the additional 11,000 ML of non tradable water allocations proposed under the ROP will apply over the Isaac system as well as the Lower McKenzie. Whether water allocation become tradable and where in the system at what levels of reliability water can be accessed will not be known until more detailed modelling is completed.

- *Recognised markets for the output*. Producers in Central Queensland have a good knowledge of the markets for sugar cane, grains, cotton and cattle. Established irrigation areas have a tendency to graduate, though time, into more intensive enterprises such as horticulture. A transition of this nature has occurred in the Burnett and was brought about by the failing economics of existing crops and the recognition of opportunities – sometimes by farmers new to the area.

    The main drivers for current irrigation development in the area appear to be past incremental expansion in sugar and in value adding to or vertical integration with livestock enterprises. To date, the area has not experienced large scale development based on new farming/ stand alone irrigation enterprises

- *Local infrastructure*. A comprehensive road network (suitable for heavy trucks) and communication links are essential for supporting intensive production.

    The area as whole is extremely well serviced by road and rail networks with an associated large amount of sunk investment in electricity utilities – at least in western section of the area associated with the mining industry.

- *Services* One of the benefits claimed for intensive agriculture is heightened demand for local services. The services required include labour (skilled and unskilled), technical support, funding agencies (prepared to support capital intensive projects) and community support.

  Off farm services to support irrigation development are at a relatively low level – with the exception of sugar. The skilled and unskilled labour and technical support base within the area is associated with the livestock industry.

- *Expertise, Attitudes and aptitude*. A local mind-set is required that embraces rapid change and the taking of risks that go with exploiting opportunities.

  The dominance of the livestock sector in the catchment is not necessarily an impediment to irrigation development unless livestock is perceived by current and future investors as providing a more secure return on investment than irrigation development.

7.2 Water resource development

7.2.1 Roles and responsibilities

Water resource development, for the purpose of creating regulated supplies, has traditionally been the domain of state governments. The development itself was usually based on construction of large, in-stream dams, often complemented by sophisticated distribution systems on the downstream floodplain.

After many decades of government sponsored dam building, most of the 'choice dam sites' have been exploited. and the environmental standards now applying to large in-stream water infrastructure are more stringent than ever before. Ultimately, the prospects for creating new water for agriculture from large in-stream dams would appear to be diminishing. This does not mean, however, that investigations of in-stream storage potential will or should cease. There will be the occasional discovery of dam sites that exhibit an acceptable combination of engineering, environmental and economic prospects. Of the dams sites known to exist in the study area, the Mount Bridget site would appear to be worthy of further investigation given the extensive areas of better quality lands downstream of the site and the relatively high flows in stream systems in the area.

During the 1990s, a number of key institutional reforms were introduced to water management and marketing. Progressively, the emphasis with respect to water resource planning by government has shifted away from development *per se* and more towards the efficient and effective allocation of a given supply among possible uses. Key elements of the reform process have included the following:

- Determination of the absolute limit to commercial extractions from a given catchment.
- Recognition of riverine health as a priority water use that requires an allocation in its own right.
- Specification of the rights and responsibilities attaching to various water products[4], and recently.
- Inclusion of overland flow in the total catchment yield or discharge thereby making no distinction between in-stream and out-of-stream water for the purpose of determining total extraction limits.

While the traditional approach to development and distribution of regulated water was flawed, the business of replacing it with a superior system is proving more technically difficult, costly and protracted than was generally envisaged at the outset. The use of market forces for distributing water rights among potential users has been a particularly difficult notion for many stakeholders to accept – both inside and outside government. Achieving more sustainable outcomes will ultimately lead to the

[4] Under the Fitzroy Basin WRP, 'water allocations' will be the most highly specified products and these will be tradeable among users This will include what has traditionally known as 'water harvesting' in those trunk streams where water allocations are being established . It is understood that in other areas water harvesting licenses and area based entitlements will be referred to as ' water licences' under the ROP and these will not be tradeable – unless converted at some time in the future into an allocation.

introduction of various market-based incentives that positively influence water usage behavior. Irrigators, as commercially-minded people, will respond to rising water charges and market based incentives by pursuing greater water use efficiency and by adopting practices that minimise the impact of applied water on soil properties.

Under the policy of full-cost recovery, water users are meant to pay for both the capital cost of creating the water resource and the on-going delivery costs that apply once the storage becomes operational. In practice, governments might fund a portion of the capital cost providing a 'community service obligation' can be identified (eg, strategic job creation). But for new storages, where water rights will be strongly defined, it is likely that users will have to meet a significant part of the total cost.

In the case of relatively undeveloped areas, such as the Isaac Connors catchment, it is reasonable to compare the cost of large in-stream storages (that might be built by the government or a corporation) with smaller off-stream storages (likely to be funded by a single business entity) on the assumption that water users will have to pay whatever the yield costs to create. In other words, all new storages, regardless of how or where they are built, should be compared by potential users, on the basis of their cost effectiveness (ie, where possible, $/ML of delivered yield).

There can also be problems with large schemes from the user's perspective. Most large in-stream dams and weirs in Queensland are owned and operated by SunWater – a government corporation. Over the past few years SunWater has embarked on a mission to recover the 'full-cost' of delivering water to users[5]. Delivery costs include operation and maintenance of the structures and the corresponding charges apply to the users' access rights (the so-called Part A charge) and actual usage (the Part B charged in $/ML). Over recent years SunWater charges have escalated rapidly in an attempt to achieve full cost recovery within a given time frame. This has resulted in animosity between user groups and SunWater – which is still viewed as a government agency with monopoly powers.

In the case of private developments (such as off-stream dams) neither the government nor a corporation has made a specific outlay and all the financial risks and responsibilities reside with the owner/operator landholder. But the issue of how a fixed volume of water should be allocated among interested parties remains pertinent. The allocation process remains a government responsibility under the ROP and it should encourage or permit utilisation of the available water at a rate dictated by commercial imperatives. In some areas, water may not be taken up and utilised for many years, if at all.

7.2.2 In stream storage and regulated flow

Several dam sites exist in the Isaac Connors catchment. A preliminary assessment of the commercial prospects in terms of cost effectiveness and likely markets for their yield is shown in Section 5 of this report. The assessment indicates generally poor prospects for the identified in-stream dam sites. If a figure of $1,000/ML of medium priority yield is taken as the current limit to affordability by local agriculture, then only Waitara and Mt Bridget could be considered cost effective.

The Waitara site has insufficient suitable land associated with the storage to justify its construction solely on irrigation grounds. Water from the Waitara storage would have to be released into the Funnel system before it was accessible to lands suitable for irrigation development.

Regulated water from the Mount Bridget site could be released into the Connors, however these augmented flows would only be usable once the water reached the Lower Connors and Isaacs River in

[5] Full cost recovery is being pursued by state governments throughout Australia in accordance with a package of COAG policy directives.

the Barmont area. The site may, however, offer potential for less riparian environmental impact than other sites. The catchment up-stream of Mt Bridget supplies around one quarter of the total catchment flows and less than one third of the Connors at Pink Lagoon where the first significant areas of suited lands occur. Assuming a demand for irrigation water from landholders, the viability of this site would rest on a number of factors:

- whether transmission loses in the Connors system significantly decreases the safe yield at the irrigation farm boundary
- the costs of alternative delivery mechanisms such as channel supply to the Barmont area if yield loses were unacceptable
- whether the costs and security of supply of the water are competitive with riparian flood harvested water. In other words, if the demand did exist and a similar level of yield and cost were associated with riparian flood harvesting, there would be limited justification for public investment in a Mt Bridget Dam site.

Throughout the broader catchment, the poor conjunction between the above dam prospects (as water sources) and land resources, combined with the latter-day problems of gaining approvals for large in-stream storages and funding them on a fully commercial basis, ultimately will mean a focus on private off-stream storages and to a lesser extent groundwater.

7.2.3 Flood harvesting from streams

Harvesting of water is generally less reliable than regulated flows (from a large in-stream storage) but it remains a viable option where the returns from applied water are sufficiently high. The acceleration in development of private storages has been assisted by the relative ease with which land and water resources can be adapted for irrigation, using present day technology – particularly under the regulatory regime of the previous Water Act. The opportunity to capture stream and overland flows can be intermittent and as such the yield reliability of private schemes will suffer from poor reliability if the natural potential for water harvesting is low or too many landholders attempt to exploit the one source[6].

Several properties in the study area have already developed irrigation schemes based on water harvesting from streams within the catchment. These properties currently hold waterworks licenses and this will remain the situation following introduction of the Fitzroy Basin ROP.

7.2.4 Harvesting of overland flow

Scope for harvesting water from overland flow exists on flood plains with long slopes and suitable soils. Based, however, on the experience of the Condamine floodplain, capture of overland flow is often used to supplement flood harvesting from streams, groundwater and riparian diversions and will only be developed after all other sources of water are exhausted. While there is topography throughout the catchment that is well suited to overland flow harvesting it is expected to be some time before substantial areas are brought into irrigation using this means.

[6] The current WRP/ROP/IQQM based process in use in Queensland is unable to separate overland flow from riparian flow. Until such time as overland flow modelling techniques are perfected (possible 3-5 years time), methods for coordinating access to overland flow and hence predicting the likely extend of overland flow harvesting in a given area will remain unclear. The current moratorium on overland flow and/or implements that achieve a similar end is therefore likely to remain in place for some time.
A process has commenced to amend the Fitzroy WRP to incorporate the management of overland flows. This process included the development of appropriate modelling techniques to include the impact of overland flow developments in the IQQM. This amendment process including the modelling is expected to be completed in the latter part of 2003.
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7.3 Costs of Off Stream Options

The cost of developing off-stream irrigation ultimately depends on access to water. Because the cost of yield will depend on how often the storage is filled, and this will vary from farm to farm, it is only possible to quantify costs in terms of the capacity created. Thus the cost of a 1,000 ML square shape reservoir with a 6m high wall is currently about $390,000 or $390 per ML of storage capacity. To this cost has to be added water harvesting infrastructure. Once again this will depend on the capacity sought according to the volume of water available to be pumped, but the total cost could be in the order of $995,000 for a system that can extract and store 120 ML/day[7]. After allowing for storage loses such a storage once full would be able to service approximately 150 ha of irrigated crop using up to 6 ML/ha/year (eg cotton or sugar in the Lower Isaacs area).

The total capital cost which would have to be amortised over the life of the project is thus of the order of $1,000/ML. Considering that amounts of up to $1,000/ML have been paid for access rights to regulated water (i.e non flood harvested water supplied through public infrastructure to the farm gate) in other parts of the state, this figure would appear to be competitive depending on the reliability of the water accessed and the intended use of the water. For the simple scenario discussed above, the project would require between 8 and 10 days of assured water harvesting pumping time per year – unless access to other water supplied (eg overland flow, groundwater etc) were also available.

At this stage, it would appear that the Isaacs above the junction with Connors and the Nebo, Bee, Denison and Coopers subcatchments are unlikely to sustain significant numbers of off stream storages given the low and highly variable flow regimes in these streams (Section 5). The Lower Connors and Isaacs may offer significant scope. The detailed hydrology however has yet to be completed.

7.4 Other Sources of Water

Both overland flow harvesting and groundwater are also potential sources of irrigation water. The former is currently limited by a moratorium and all future developments for overland flow will be dependent on yet to be completed modelling of overland flow and sustainable levels of extraction. This is unlikely to be completed in under 3 to 5 years.

On the limited evidence available groundwater would appear to offer some potential. It is possible that up to four times the amount of groundwater currently licensed in the Braeside/Waitara and Nebo area exists in the major alluvial plains of the Connors and Lower Isaacs – a volume equivalent to the likely new surface allocation from stream flow under the ROP. The most likely role for groundwater would however appear to be as an adjunct to future surface allocations.

7.5 Economic Considerations

The only two industries capable of sustaining irrigation development costs are sugar and cotton – or enterprises which are internally vertically integrated where the irrigation development value adds to an existing industry (eg the Barmont feedlot is an example of an internally vertically integrated operation). The greater majority of the soils in the areas likely to benefit from stream diversions (either under a Mt Bridget Dam regulated supply or by licensed allocation from unregulated flows), would appear not to be well suited to perennial high value horticulture – however annual high value horticulture could be integrated into both cane and cotton as happens in other regions.

[7] This information was supplied to us by Sudholz Pty Limited (land and water development specialists based in Goondiwindi and operating throughout Australia). Note that the costs do not include system design, which would add about 5% to the amounts shown.

7.5.1 Cotton

The estimated capital costs of water are towards the upper end of prices paid by the cotton industry in other regions where water is scarce. The current state of the commodity markets for cotton would preclude any rapid expansion in the area.
For the cotton industry, the soils which occur in the area are not new to the industry. Expansion into the area will require:

- That water supply security is perceived by investors as being superior to other areas in CQ.
- That the inherent transport infrastructure is perceived to be non limiting

The ROP will play a significant role in the first of these perceptions. Landholders will need to be informed as to the maximum volumes that can be extracted and the rights and responsibilities that would attach to any water harvesting entitlements. Where interest in accessing water exceeds the volume available, the ROP should specify how allocations among individuals will be determined. Optimal uptake will be assisted by regular provision of information regarding where water is available, the commercial conditions applying to its usage and the emerging opportunities. Most importantly, the new licensing system must provide an assured level of protection to landholders that future developments will not erode their levels of supply security.

Unfortunately, the size of the likely new allocations in the area and the fact that the majority of the current licenses will not be able to be traded into areas where there is both land and water is unlikely to provide a trigger for large scale private investment.

7.5.2 Sugar Cane

Sugar cane is currently in the perilous position of low commodity prices combined with low levels of efficiency of existing capital (both on and off farm). Much of the catchment where water and soils is likely to be “non limiting” are beyond the access limits for the current industry. Whilst sugar will continue to expand in the Bolingbroke and Blue Mountain areas, this is likely to be incremental and will require commodity prices to improve before further land development costs could be sustained.

Ultimately access to land will continue to limit the Mackay sugar industry. However, expansion beyond the areas in the catchment within cost effective cane haulage distance will require a new industry model. Juice mills and ethanol production are possible models, however the 10 to 20,000 ha of land likely to be required for such industry models would also require between 50 and 100,000 ML of assured water supplies. Such supplies are likely to be only available from the Lower Funnel, Connors and Lower Isaacs areas.

7.5.3 Intensive Livestock

Queensland is well positioned to take advantage of the growth in demand for animal protein as incomes and living standards rise throughout many parts of the world (but most particularly SE Asia).

Queensland’s piggeries and cattle feedlots are concentrated in two river catchments: the Condamine/Balonne and the Burnett. In terms of expansion, this pattern is highly significant as competition for water resources in these two catchments is already intense. Given the intensive nature of feedlots and piggeries, they are able to compete strongly for use of natural resources such as land and water. However, the relatively high environmental costs that apply to intensive animal production compared to less intensive industries means they will not be as competitive for resources in particular areas. In other words, environmental compliance eventually works against (further) concentration of production within an area. It is apparent that the best location for new feedlots and piggeries will change through time as the balance between economic and environmental imperatives change. This implies that catchment such as Isaacs Connors will be better placed in the event of further expansions

There is only one major feedlot in the catchment at the moment (Barmont) and this factor gives it an important commercial advantage. During dry times Barmont feedlot is heavily patronised by local and regional producers who want to ‘finish’ cattle before consigning them to market and this has led to irrigation being used to value add to the feedlot enterprise. Barmont fills a gap in the livestock industry for the catchment as well as areas to the north where high summer temperatures generally limit intensive livestock enterprises.

Given the excellent road access both to feeder steer producing areas to the north and west, relatively close access to major export and domestic works at Rockhampton, close proximity to feed grain sources and the potential to produce feed grains and forage on the soils of the area, future expansion of intensive livestock is highly likely as other areas in Queensland reach their community and environmental limits for these uses.

8 Salinity Issues

Irrigation development is known to be a major cause of salinisation of land and water across the world, and there are numerous examples in Australia; in northern Australia there are examples in the Emerald, Mareeba-Dimbulah, Isis and Maryborough irrigation areas in Queensland and in the Ord River irrigation area in Western Australia. Dryland salinity resulting largely from land clearing is known to occur across Queensland – including, the Burdekin, Lockyer, Fassifern, Darling Downs, Burnett and Central Queensland areas.

Two circumstances must be present for a salinity risk to exist are:

- Presence of stored salt in the soil, regolith or groundwater systems, and
- Increased draining of water beneath the root zone following a change in land use or land management practices.

It is the fate of these salts and drainage which determines whether salinity outbreaks will actually occur under either irrigated or dryland land use systems. Where this drainage of salts and excess water reaches groundwater flow systems, salinisation outbreaks may occur in areas where the groundwater flow systems come close to the land surface. Where the drainage of salts and water accumulates in the cleared or irrigated landscapes, salinisation may occur within that landscape. There are a large number of factors which ultimately determine whether, where and when salinity outbreaks may occur.

8.1 Landscape Salt Stores

The information on salt stores in the region is relatively sparse and mainly at the broad landscape level; regional resource surveys carried out by CSIRO in central Queensland in the early and mid 60's provide comprehensive descriptions of the landscape geomorphology and the soil/regolith relationships. Tertiary weathering and post Tertiary weathering, erosion and soil development control the occurrence of salt stores in the region. Table 8.1 summarises these relationships.

Table 8.1. Geomorphology and Land Systems (extracted and modified from Galloway 1967)

Relationship to Tertiary Land Surface and Weathered Zone	Relief Category	Land Systems in Order of Lithology – Quartzose to Basic
Intact or slightly denuded Tertiary land surface - *with relatively high salt stores in the landscape*	Plateaus	Junee, Durrandella (part)
	Plains	Monteagle, Nebo (part)
Residual Erosional areas within the Tertiary weathered zone – *often with high salt stores in the landscape*	Hills	Durrandella (part), Bedourie (part)
	Plains	Humboldt (part), Daunia (part), **Racecourse, Kinsale**
Depositional areas within the weathered Tertiary zone – *often with high to moderate salt stores in landscape depending on depositional environment*	Plains	Daunia (part), **Blackwater, Humboldt** (part), Somerby.
Erosional areas below the Tertiary weathered zone – *often with low to moderate salt stores within landscape*	Mountains	Carborough, Britton, Percy
	Hills	Planet (part), Bedourie (part), Waterford
	Lowlands and plains	Planet (part), Cotherstone, Barwon, **Girrah**, Hillalong, **Nebo** (part), **Oxford**
Quaternary alluvium – *mostly low to moderate salt stores within the landscape*	Alluvial Plains	**Connors**
		Funnel, Comet, Alpha

The Tertiary materials that covered much of the region were subjected to deep weathering followed by erosion and redistribution of materials. This provided the material for formation of the range of soils identified in the catenary sequence from ridge to valley floors. The very large salt stores that had accumulated in the weathered zones were redistributed also.

8.2 Soil Salt Levels

In order to make a more objective judgement on the salt hazard in the Isaac – Connors for irrigated agriculture, salt data for approximately 150 soil sample sites in and close to the Isaac – Connors study area have been evaluated.

Distribution of the sites in relation to Land Systems is shown in Map 8.1 along with the range in soils Electrical Conductivity (ms/cm). At several of the locations marked there are more than one soil site. Map 8.1 also ranks the Land Systems in relative terms of the likelihood of major salt stores within the landscape including the materials below the soil solum. This ranking is based on Table 8.1. The resultant simplified data summary indicates the inconsistency in relationships between soil salinity levels and landscapes when used to assess potential salinity hazards. The data is simply insufficient to allow accurate predictions of salt loads.

Oxford

Soil data are available for approximately 35 sites in the Oxford Land System; almost all sites had black Vertosols typical of this Land System. Data from a study of the clays of the Oxford Land System show that the salt levels in the profiles are low for all sites from the crest down to the mid-lower slope position. In some sites there is significant salt in the upper 150cm in the lower slope position of the landscape. It is in this part of the landscape that there is often a change in soils to soils formed on deeply weathered basalt or to soils developed on depositional material from the deeply weathered zone of the Tertiary. There is usually a change in the hydraulic characteristics of the soils and often an increase in salt contents. Under conditions of excess soil water entering the upper slope soils in cropped lands, saline discharge sometimes occur in the lower slope positions where soil characteristics change.

In the Emerald Irrigation Area, saline discharge has occurred in mid to lower slope positions largely as a result of excess recharge from leaking irrigation supply channels. The salt in the discharge has probably come from the lower slope soils in which a localised shallow groundwater table has developed.

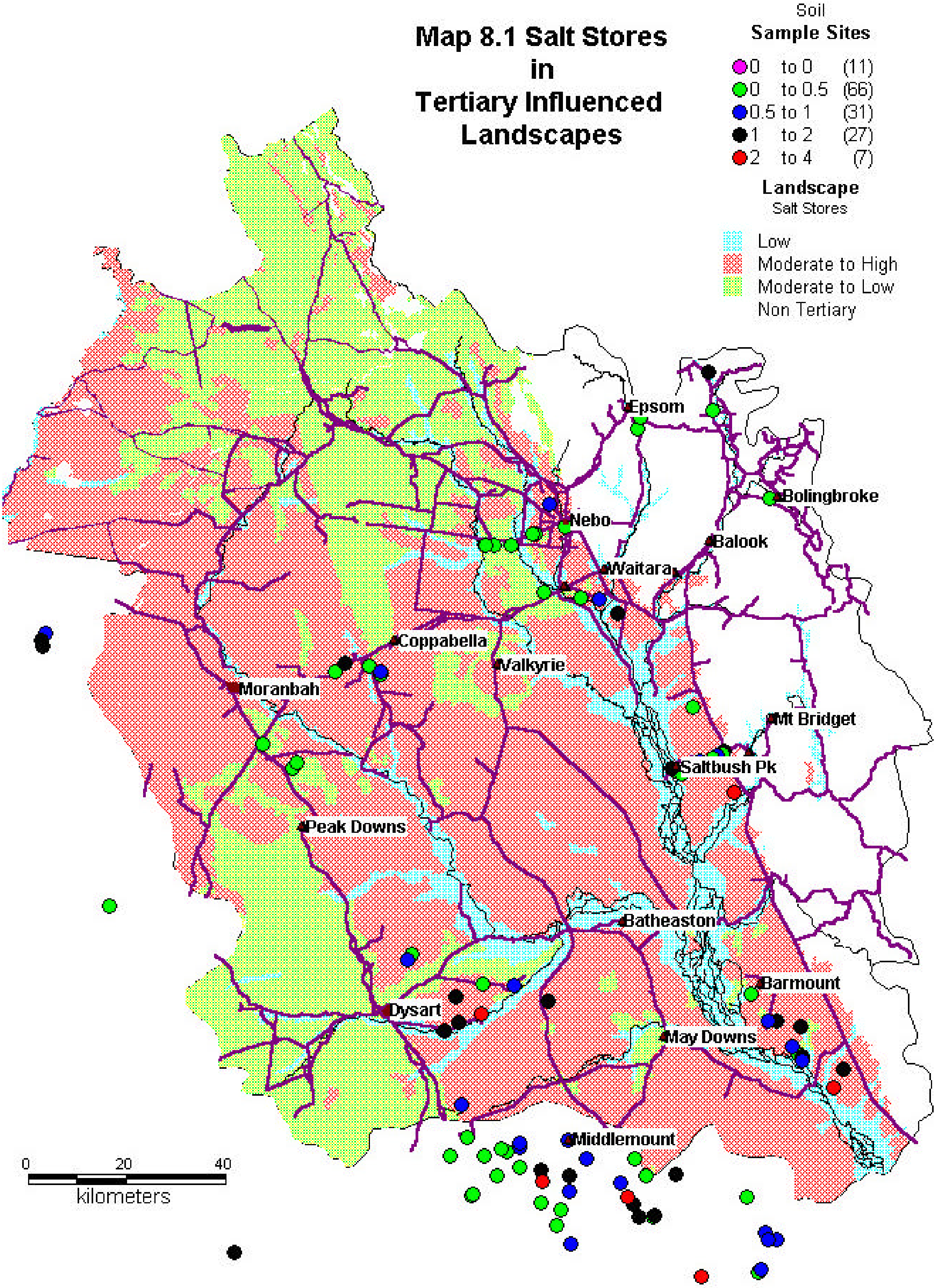
Site information from other resource assessment studies in the have supported the view that the salt levels of the major soils in the Oxford Land System are low, but that there can be salt in the lower slope position where there may be a change of lithology and/or a change in hydraulic conductivity.

Girrah

Soil profile data are available for 6 sites in this Land System. These data show that the salt levels in some of the soils can reach moderate to high levels. A salinity hazard is probable particularly in lower slope positions, but further detailed assessment is required to make any confident conclusions.

Nebo

Data from approximately 14 sites in the region are available for this land system. Salt levels are low to high, in common with the soils of the Girrah Land Systems; on the basis of knowledge about salt distribution in the Oxford Land System they may have higher salt levels in more deeply weathered sites in the lower slope positions. A salt hazard is highly likely in some areas.


Map 8.1 Salt Stores
in
Tertiary Influenced
Landscapes
Soil
Sample Sites
0 to 0 (11)
0 to 0.5 (66)
0.5 to 1 (31)
1 to 2 (27)
2 to 4 (7)
Landscape
Salt Stores
Low
Moderate to High
Moderate to Low
Non Tertiary
Epsom
Bolingbroke
Nebo
Balook
Waitara
Coppabella
Valkyrie
Moranbah
Mt Bridget
Saltbush Pk
Peak Downs
Batheaston
Barmount
Dysart
May Downs
Middlemount
0
20
40
kilometers

Racecourse

This Land System is developed on weathered basalts and commonly has/had softwood scrubs and brigalow vegetation. It occurs in relatively small areas in the Isaac – Connors. The soil data available are quite few (approximately 7), but these indicate high salt levels within the upper metre of the profile. Under irrigation there is highly likely to be a salinity risk.

Kinsale

Data from 2 sites indicate low salt levels. The main areas of Kinsale are in the NW of the study area and are actually part of the Nogoa – Belyando Area survey. This Land System is rolling basalt country within the Tertiary weathered zone, and as such may have substantial salt stores. The most widespread land unit (4) had brigalow scrubs. On the basis of the limited data available, salinity is considered a likely hazard; however a confident judgement about the salinity hazard under irrigation cannot be made without more data.

Humboldt

Soil profile data on 11 sites within the Humboldt land System indicate high salt levels within the upper 1.5 m. Representative sites show high salt levels (1.4 to 1.9dS/m) within 1m of the surface. Other soils profile classes in this Land System have moderate levels within 1m (0.6 – 0.7dS/m). On the basis of this data, salinity is considered a likely hazard

Blackwater

The data from approximately 11 sites on this Land System indicate that salt levels can be high. Several of the soil within Blackwater Land System have salt levels in the range of 1 –2 dS/m in the upper 1m. On the basis of these data and general knowledge of similar soils elsewhere in the region, it is concluded that a salinity hazard may be present in many areas of this Land System under irrigation.

Connors

Only 6 sites provide information on salt levels within this Land System. There is a range of soils and salt levels. The recent coarser textured sands and texture contrast alluvials have little salt. However several of the Vertosols, and Sodosols have significant salt (>1dS/m EC) within 1m. These data indicate that areas with significant salt do occur and better delineation of the soils would be required to define the salinity hazard.

Comet

The few sites available show the Vertosols of the broad have high levels of salt (2.8dS/m in the top 1m); Sodosols which also occur in this Land System also have significant salt levels.

Funnel

Four sites provide some indication of salt levels in soils of this Land System. Black Vertosols of the and Sodosols soil profile class have levels <1dS/m EC in the top 1m. Again, there are insufficient sites to make a confident assessment of the salt stores, but clearly salt does exist in some areas.

Bolingbroke

In the upper Prospect creek catchment, lands within the Bolingbroke Land Systems have been identified as having irrigation potential. On the eastern side (right bank) of Prospect creek the soils are derived from the Carmila Beds. Similar soils developed on the Carmila Beds have been widely used for cane production on the eastern side of the main range. Data from a Vertosol on alluvial flats indicate moderate salt content within the top 1.5m which could indicate salt accumulation in a discharge area. Several Sodosols in the area show only low levels of salinity in the upper 1.5 metres. On the coastal plain, soils from the same geological unit have been long regarded as having a salinity risk.

Glensfield

The soils of this Land System are derived from granite. Soil salinity data for the soils or regolith are extremely limited and show low salt levels. More data would be required to assess the soil salinity hazard with confidence. Currently there is no evidence of dryland or irrigation salinity in the granitic soils of the Glensfield Land system.

8.3 Salt in Groundwater

Groundwater is the other major component for assessing salinity hazards. Where land use changes result in minimal changes to the groundwater systems, there is unlikely to be any change in soil and stream salinity levels irrespective of the levels of salinity that does exist. The role of groundwater in landscape salinisation is understood reasonably well at a generic level and there is some evidence for how groundwaters have responded to land use change available for CQ.

The salinity content in the groundwater system at the moment are however less well known than even that of the landscape generally or the for the soils. It is likely that most Land Systems which are directly derived from Tertiary weathering process or which are derived from weathered Tertiary sediments will contain saline groundwater. There are some 130 groundwater monitoring sites, however as shown in Map 8.2, almost all of these are located in the more recent alluvial plains where landscape salinity levels are likely to be low.

The groundwater data is summarised in Table 8.2 and mapped in Map 8.2.

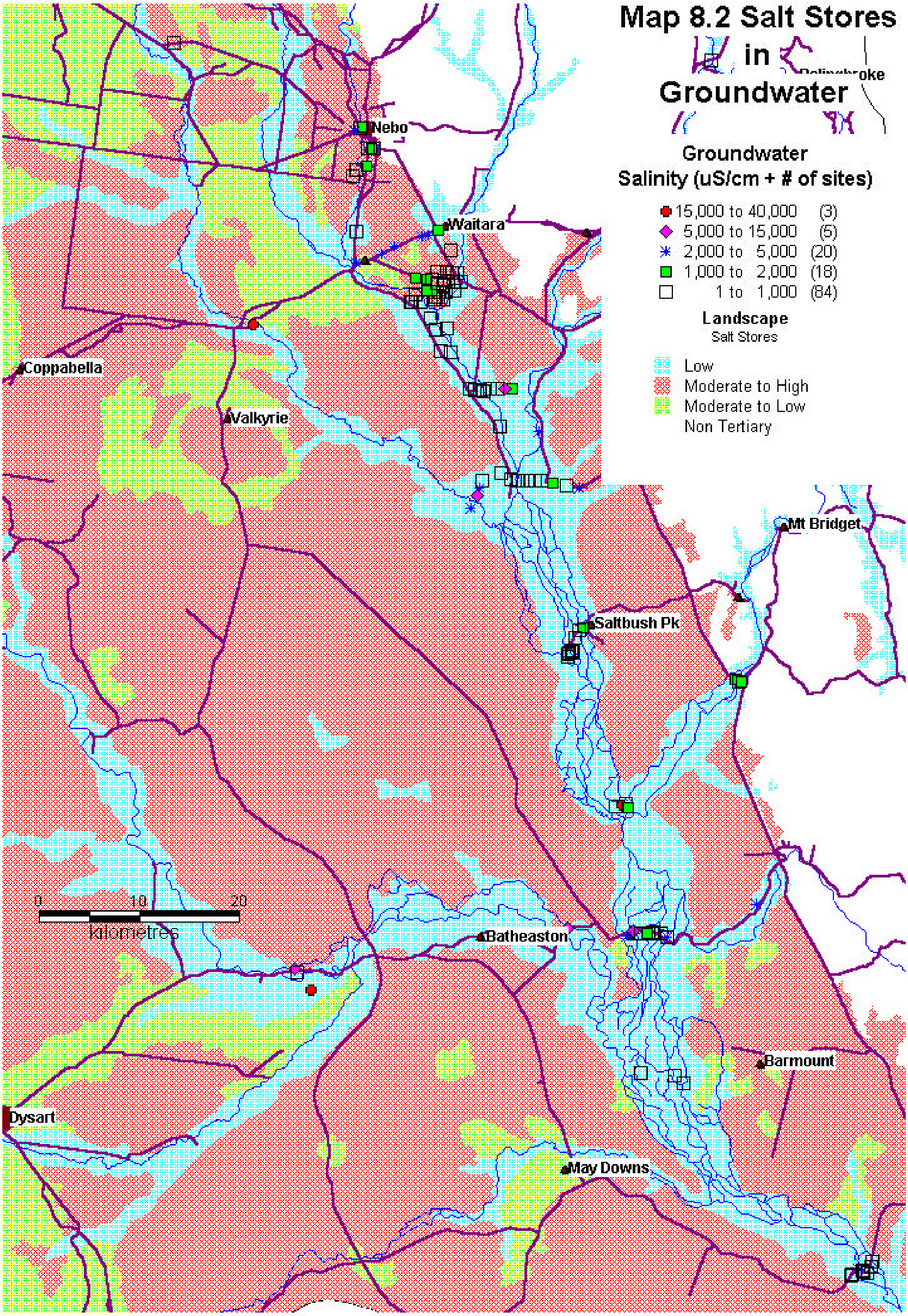
The Nebo Land System has the largest monitoring base – primarily because it and the associated alluviums are the source of the Nebo and Braeside/Waitara bore fields. This Land System is highly variable in terms in ground water quality with almost half of the Land System having water qualities which are unsuited for domestic use and marginal at best for irrigation use.

Table 8.2 Groundwater Salinities

Land System	Number of Sites	Electrical Conductivity mS/cm				
		<1	<2	<5	<15	>15
Comet	15	9		2	3	1
Funnel	27	25		2		
Connors/Alpha	35	26	4	4		1
Nebo	43	22	9	11	1	
Junee/Humboldt	2	1		1		
Glensfield	2	1	1			

The Comet Funnel and Connors/Alpha Land Systems are all recent alluvial landforms that comprise the braided streams of the flood plains. In general those sites with higher salinity appear to be located along the edges of these landforms and/or have weathered Tertiary materials logged in their bore logs at depth.

The depth of the recent alluvium is around 20 to 40 m and increases from the headwaters of the steams to the area below Barmont/May Downs. In general water quality improves with downstream distance and depth to groundwater does not significant decrease downstream. Whilst a detailed analysis of stratigraphy has not been completed, there does not appear to be evidence to suggest that the downstream parts of this aquifer system is collecting and accumulating inordinate amounts of ground water salts.


Map 8.2 Salt Stores in Groundwater
Groundwater Salinity (uS/cm + # of sites)
15,000 to 40,000 (3)
5,000 to 15,000 (5)
2,000 to 5,000 (20)
1,000 to 2,000 (18)
1 to 1,000 (84)
Landscape
Salt Stores
Low
Moderate to High
Moderate to Low
Non Tertiary
Nebo
Waitara
Coppabella
Valkyrie
Mt Bridget
Saltbush Pk
Batheaston
Barmount
Dysart
May Downs
0
10
20
kilometres

8.4 Current Study Area Outbreaks

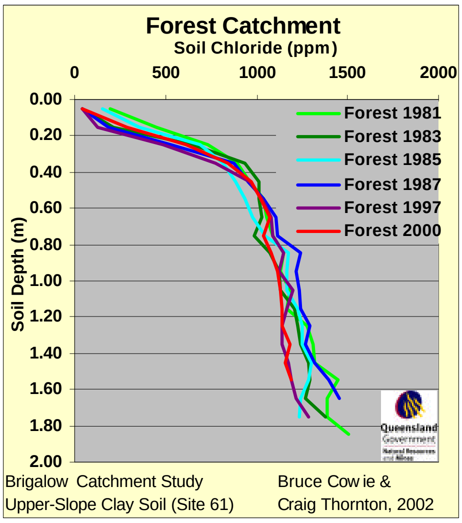
Current salt outbreaks appear to be restricted to the Barmont area of Bedourie and Daunia upland land systems which is producing the initial signs of salt scalding in lower slope positions as well as saline base flow into gullies and creeks in the Two Mile Creek catchment. These two Land System comprise landscapes with a relatively high salt load. In this area, these land systems appear to be directly derived from in situ Tertiary weathered materials – materials likely to have amongst the highest salt loads in the area. Clearing in these areas is relatively recent (less than 40 years) and whilst it is possible that clearing has lead to the seepage, it is also possible that these areas where the Tertiary weathered base geology is exposed in the lower slopes has always had some degree of salinity.

The weathered Tertiary surface is also well represented in the Junee/Lennox and Durrandella Land Systems south and south east of May Downs. The main May Downs road traverses the lower slope positions of these land scapes and saline subsoil conditions are extensively exposed at the land surface in this area.

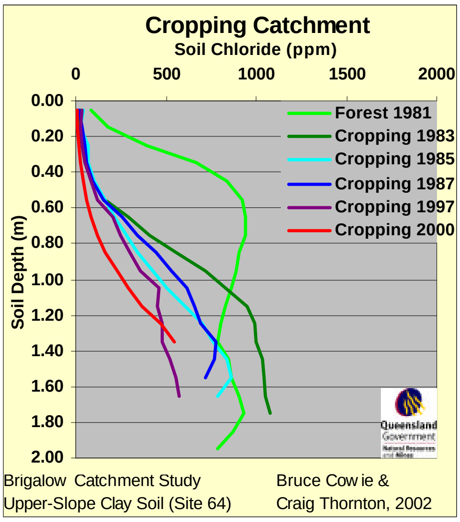
8.5 Recharge and Salt Movement

Evidence of recharge in the Central Queensland region is quite convincing. The most conclusive evidence is saline discharge at a number of sites where the original vegetation has been cleared for dryland and irrigated agriculture.

In the Emerald Irrigation Area, a considerable area on the Oxford land System has shallow watertables at less than 3 metres (Bruce Pearce and Andrew Rosser pers. com.) considered to be the result of recharge from leaking supply channels. Saline discharges also occur from weathered basalt in other non-irrigated sites in the central highlands. Discharges have also been identified from residual Tertiary plateau sediments in the Duaringa, Comet, Middlemount and Moranbah areas.



Long term monitoring at the catchment studies on Brigalow Research Station near Theodore in central Queensland indicates that salt has been leached down the Vertosols and Sodosols soil profiles under cropping and pasture systems since the original forest was cleared in the early 1980's (see Figures opposite).



The soils are very similar to those found in the Blackwater and Humboldt Land Systems in the Isaac – Connors catchments, and there is no reason to expect different processes to be operating there. The main leaching events are thought to occur in years when episodic rainfall in autumn wets the soil profile to depth and results in deep drainage when there is no active crop or pasture growth.

8.6 Deep Drainage

Modelling of water balance components and crop yields under irrigation for a number of soils common in the Comet and Rolleston areas were carried out in 1997 as input to the environmental impact assessment of the proposed Comet dam. The soils were:

- Red Kandosol,
- A number of black Vertosols and a brown Chromosol formed on transported materials in the Blackwater and Humboldt Land Systems, and
- Black Vertosols of the alluvial plains of the Comet River plain.

The soils included in the modelling are very similar to several soils being considered for irrigation further north in the Isaac – Connors catchments. For the Vertosols, the modelling showed drainage estimates (below the root zone) of between 16 and 22mm for Cotton, 27 and 41mm for peanuts, 24 and 36mm for soybeans and 30 and 41mm for grain sorghum. These drainage for the Vertosols formed on basalt all indicate potential recharge under irrigation systems similar to those currently in use.

This overall evidence for increased deep drainage following land clearing with or without irrigation is consistent with that found in the southern parts of Australia where deep drainage has been estimated as increasing from below 10 mm per annum to between 30 and 90 mm per annum depending on climate soil and land use conditions.

8.7 Groundwater Flow Systems

Given that deep drainage is highly likely to be currently occurring under the cleared landscapes of the study area, that it would be increased significantly with irrigation development and that it will result in salt being leached towards water tables, it is the stratigraphy and groundwater flow systems that ultimately receive this drainage which will determine whether this deep drainage produces salinisation in the landscape. There are a number of factors that will govern this process and for most of these factors, there is limited data available for the study area.

In recent years Groundwater Flow Systems (GFS) have been seen as one of three broad types:

> **Local** GFS move over relatively short distances between the recharge areas and the discharge points. In many of the salinity and non saline high water tables which have developed in Queensland in the last 40 years, local GFS are implicated. These are systems where changes in recharge areas which results in changes in rates of recharge produce relatively quick responses in the discharge areas. these types of flow systems commonly have a horizontal scale of less than 5 km, commonly consist of a well defined catena or topographic sequence of a small number of landscapes. Where the discharge point is the land surface or streams incised in the lower landscape position salinisation may result.
>
> Local GFS respond quickly to land use change in recharge areas to produce high water tables and increased base flow in discharge area. They also commonly respond to land use changes that either reduces recharge or intercepts the recharge water before it reaches the discharge area. Groundwater levels in the discharge areas also respond relatively quickly to periods of higher and lower rainfall. It is often relatively easy to identify recharge and discharge area relationships for local GFS. This combined with their shorter response times often means that land use and management changes can produce relatively quick responses in reversing salinity effects[8].

[8] *Land owners who have cleared upland areas throughout Qld often cite the quick response in pasture and in particular stock water supplies in wells and creeks. These quick responses are all associated with increased recharge of local GFS*

Intermediate GFS operate at larger sub regional scales of tens of kilometres. They are common in major alluvial deposits in river valleys, and in fractured igneous and metamorphic rock areas. They respond less quickly to land use change than local GFS, but may show significant rates of response where they receive large amounts of recharge from local systems. Identifying recharge and discharge area components for these systems is rarely as easy for local GFS – particularly where the same landscapes also exhibit local GFS. Response time are also longer, however the areas potentially affected by these larger system are also far greater than with local GFS. Recharge area interventions may not be as easily defined and targeted for these types of systems.

Regional GFS are associated with large extensive deposits (including alluvial as well as fractured harder rock sequences) . They have extremely long response times and recharge area interventions are unlikely to have any significant impact at the current discharge areas.

The small number of discharge sites in the Emerald Irrigation Area resulting from the deep drainage needs to be put into perspective. Whilst it may take a relatively short time for increased drainage to reach the GFS, it may take much longer for this recharge to reach areas where salinity is expressed as land and water degradation. In regional GFS it may take fifty to hundreds of years, depending on the depth to groundwater, aquifer transmission rates, the degree to which the aquifers are confined, and the water content of the regolith below the rooting zone.

Within the study area, salinity which is apparent at Barmont (and other areas in CQ of similar landscapes) is likely to be associated with a local GFS's which start in the local Daunia and Bedourie upland land systems. These same flow systems are likely to occur in the basalt associated land system of Oxford as well as Girrah. As well as being expressed as surface soil salinisation at the break in slope, most of these are likely to ultimately reach the alluvial aquifers of the braided flood plains (Comet, Connors, Alpha Funnel Land Systems) which in the most part are dominated by extensive alluvial aquifers with generally low salinity waters in a mix of local and intermediate GFS.

In the Oxford Land System in the EIA, there is good hydraulic connection between the fractured basalt local GFS and those of the Nogoa alluvium, resulting in transmission from the uplands to the riparian mix of regional and local alluvial systems. In the scant bore log data available for the study area, there is some evidence that salinity is higher in the riparian system wherever it is close to the uplands. Ultimately, the effect of increased salt movement into the riparian aquifer systems through the mixes of local and intermediate flow systems will be dependent on the extent to which the riparian systems themselves are freely draining. On the basis of the present salinity levels from the installed sites there does not to appear be a general build up of salts in the riparian systems. This gives some hope for the future.

8.8 Preliminary Salinity Risk Assessment of Priority Lands

Evidence on salt stores and recharge potential has been used to provide a preliminary evaluation of the salinity risks associated with irrigated agriculture on the priority Land Systems (Table 8.3). Because of the sparsity of data this evaluation is largely qualitative but it provides a basis for prioritising further investigations into salinity risks in potential irrigation development in the region.

Table 8.3 Salinity Assessment Factors for Land Systems

Land System	Hazard		Possible Impacts	Suitability for Development
	Recharge Potential	Salt Store		
Oxford	High	Very low	Elevated fresh groundwater levels in intermediate and local groundwater flow systems. Saline discharge at margins with clay soils of Racecourse, Kinsale, or Blackwater land systems.	Assessed as suited for development given recharge mitigation and discharge area management strategies are developed
Girrah	Moderate	Low to moderate		
Nebo	High	Low	Elevated groundwater levels in intermediate and local groundwater flow systems. Saline discharge at margins with clay soils of Racecourse, Kinsale, or Blackwater land systems.	Highly variable Land System with only small areas rated suited for development. Not recommended for development
Racecourse	Moderate	High	Elevated groundwater levels in local and intermediate groundwater flow systems. Saline discharge at the margins; possible discharge offsite.	Suitable subject to further evaluation of salinity hazards – mostly small areas in study area
Kinsale	Moderate to high	High	Elevated groundwater levels in intermediate and local groundwater flow systems. Saline discharge at the margins; possible discharge offsite.	
Daunia	Moderate to high	High	Elevated groundwater levels in local groundwater flow systems. Saline discharge at the margins; possible discharge offsite.	These land systems contain unsuited soils and are implicated in current saline discharge at Barmont following clearing for pastures and dry land cropping. Not recommended for development – current local saline flow systems may imperil adjoining suited land systems such as Blackwater.
Humboldt	Low	Moderate	Elevated groundwater levels in local groundwater flow systems. Local discharge areas.	Highly variable land system with numerous unsuited soils. Not recommended for further development to cropping
Blackwater	Low	Moderate	Elevated groundwater levels in local groundwater flow systems. Local discharge areas.	Assessed as suited for development given recharge mitigation and discharge area management strategies developed
Connors	High	Low to high	Elevated local groundwater levels. Saline discharge into streams?	As above – however up to 75% of area is prone to severe flooding and the ecological values of the braided stream and freshwater environments require further evaluation
Funnell	Low to moderate	Moderate to High	Elevated local groundwater levels. Saline discharge into streams?	
Comet	Low to moderate	Moderate to High	Elevated local groundwater levels. Saline discharge into streams?	
Bolingbroke	Moderate	Low	Saline discharge in lower slope situations	Probably a relatively low risk given high rainfall and weathered nature of regolith. Only small areas within these Land Systems are suited.
Glensfield	Moderate to high	Low	Saline discharge in lower slope situations	