NORTH AUSTRALIAN WATER STRATEGIES

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Flinders Shire Council – "15 Mile" Irrigated Agriculture Project

WATER RESOURCE DEVELOPMENT STRATEGY

Introduction

The Flinders Shire Council's "15 Mile" irrigated agricultural project proposes an initial horticultural enterprise consisting of 120 ha of vine and orchard crops and subsequent development of approximately 220 ha of potentially suitable land within the balance of the 918 ha property.

A substantial volume of good quality water will be required to support the development; both for irrigation and for climate control on crops that may be susceptible to frost or excessive heat. Council's Initial Advice Statement to the Coordinator General indicated that an annual volume of up to 6,640 ML/yr may be required. Now that the Flinders Shire Council, (F.S.C.), has obtained the Land Suitability Study compiled by Natural Resource Assessments Pty. Ltd., (NRA), it is possible to state with confidence that sufficient suitable land is available on the "15 Mile" property to enable an irrigation development of approximately 310 ha in area.

This document describes a broad strategy to facilitate harnessing the currently available water resources, investigate, design and develop the infrastructure needed to access the identified sources of supply and plan the investigation of additional, future water sources in order to increase the reliability of water supply to ensure the long-term success of the project.

Water Requirements

NRA's Land Suitability Study was based upon the project proponent's intention to develop approximately 120 ha of orchard crops; principally table-grapes, citrus and avocadoes. The following estimate of water requirements assumes that the entire 310 ha of available, suitable land will be developed along similar lines, viz. 150 ha of citrus, 110 ha of table-grapes and 50 ha of avocados.

Mean monthly Class A Pan evaporation data has been used to estimate the potential evapotranspiration, (ET_{Pot}), for the proposed crops. It is expected that irrigation will be required on approximately 305 days per year. It is assumed that on days when the maximum temperature is below 30° C, a potential ET_{Pot}. value of 5.7 mm would be appropriate. When daily maxima exceed 30° C, ET_{Pot} value of 7.6 mm is assumed.

<u>Annual Irrigation Requirement – Table-grapes</u>

Applying the above assumptions to grape vines irrigated by a well managed, trickle-irrigation system, (dual drip-lines), indicates that an annual irrigation application of more than 7.0 ML/ha would be required in only 20% of years.

Most table-grape varieties are susceptible to frost and heat-stress. Both of these climatic extremes are usually controlled by provision of a separate over-head mist-spray system.

Frost protection would generally be required for only 1 or 2 days per year. The amount of water applied is usually about 25 mm per frost event. Therefore frost protection would require application of no more than about 50 mm per year, or 0.5 ML per hectare per year.

Protection from heat-stress by provision of evaporative cooling would generally be required for approximately 4 hours per day when daily maxima exceed 35° C, increasing to about 15 hours per day when temperatures exceed 40° C. Misters with a flow-rate of about 1 or 2 mm per hour are generally operated on a short cycle of about 2 minutes on/8 minutes off. It is likely therefore, that a mist-spray system would operate for an average of approximately 165 days per year for a total of about 2000 hours. The amount of water applied is therefore likely to be in the order of 600 mm per year, 6.0 ML per hectare per year.

The water requirement for frost control and evaporative cooling could be expected to be approximately 650 mm per year, or 6.5 ML per hectare per year. Therefore irrigation plus climate control is likely to require approximately 13.5 ML per hectare.

Thus, the assumed **110 ha grape vine** planting would generally require no more than approximately **1485 ML per year** of applied water.

<u>Annual Irrigation Requirement – Avocados</u>

Applying the same assumptions to avocado trees at 9 x 6 metre spacing, irrigated by a well managed, under-tree mini-sprinkler system indicates that an annual irrigation application of more than 10.2 ML/ha would be required in only 20% of years.

Avocado varieties are quite tolerant of frost after the first year. Whilst avocados are susceptible to flower-drop and fruit loss if subjected to heat stress, these climatic conditions may be managed by covering with netting, additional mini-sprinkler operation to ensure adequate soil moisture and a degree of humidity control. There should be only minimal additional water required for climate control in avocados; possibly 100 mm per year; equivalent to 1.0 ML per hectare.

Thus, an assumed area of **50 ha of avocado orchards** would generally require no more than approximately **560 ML per year** of applied water.

<u>Annual Irrigation Requirement – Citrus</u>

Applying the same assumptions to citrus trees irrigated by a well managed, under-tree mini-sprinkler system indicates that an annual irrigation application of more than 9.0 ML/ha would be required in only 20% of years.

Most citrus varieties are quite tolerant of frost, once established. Citrus are also able to cope with heat stress provided adequate soil moisture is available. Both these climatic conditions may be managed by operation of the mini-sprinkler system, so no additional water would be required for climate control in citrus.

Thus, an assumed area of **150 ha of citrus orchards** would generally require no more than approximately **1350 ML per year** of irrigation water.

The above indicates that the annual crop water requirement for the entire **310 ha orchard development** will be met by provision of approximately **3395 ML per year** from the combined water sources.

Current Water Sources

Flinders Shire Council, (FSC), has access to various water sources, none of which will singularly provide a sufficient supply for the entire project; due to issues of reliability, limited on-farm storage opportunity, or simply the volume of water available from individual sources.

Currently available water supplies, their reliability and development status are discussed below.

Flinders River Alluvium – Extensive groundwater investigations in the south-eastern part of the “15 Mile”, (Lot 168 SP262319), in 2015-2017 resulted in construction of 4 production bores that exploit a relatively confined, shallow sand/gravel aquifer of good quality water that lies beneath the upper left bank of the Flinders River. Initial test-drilling resulted in determination of a long-term aquifer yield of 740 ML per year. Three of these bores are located outside the DNRM’s 1.0 km regulated zone. Recent expansion of the drilling programme has resulted in construction of an additional 4 production bores, two of which are located inside the regulated zone. In summary, there are now 5, five, potential production bores in the unregulated zone and three within the regulated zone.

Assessment of pump-test results indicates that the long-term, safe annual yield from the five production bores located outside the regulated zone is 1038 ML per year.

Samples were obtained from the recently constructed production bores and observation bores for water quality determination. Results of laboratory analyses showed that water quality varies from 332 - 960 $\mu S/cm^{-1}$, (approximately 212 - 614 mg/l), total dissolved salts and pH is in the neutral range of 6.3 to 7.5.

Flinders River – Extraction from the Flinders River; either by direct pumping, sand-spears or bores within 1 km of the river bank is regulated by DNRM under the Water Act. Council holds Licence No. 609134, which authorizes extraction of up to 450 ML per year.

Whilst access to minor flows in the Flinders River, or from the bed-sands is possible, it is logistically simpler to access this entire entitlement from the bores that are located within the 1 km regulated zone; regardless of the origin of the alluvial aquifer exploited by these bores.

Summary of Current Water Sources

Identified water sources and annual quantities that are currently available include:

• Bores exploiting the shallow alluvial aquifer located more than 1 km from the Flinders River	100 % Reliability	1038 ML
• Direct pumping from the Flinders R. or bores exploiting the shallow alluvium located within 1 km from the river	100 % Reliability	450 ML
		Total 1488 ML

Potential Water Sources

Several potential water sources have been identified; one or more of which will require to be developed in order to meet the needs of the project in the short to medium term. They will all require significant capital expenditure. These sources include:

1. A bore/s exploiting the Great Artesian Basin, (GAB),
2. A farm dam to harvest overland-flow and
3. Harvesting of Flinders River flood flows into off-stream storage/s.

Great Artesian Basin – F.S.C. has made application for a water entitlement from the Great Artesian Basin, (GAB), General Reserve. It is proposed that this entitlement, should it be approved, will be accessed by means of a bore designed to exploit the Hutton sandstone formation. It is likely that the first GAB bore, exploiting the Hutton formation, will be constructed in reasonably close proximity to the initial horticulture development.

Obtaining a significant entitlement from the GAB is paramount to the success of the project, as all other available sources rely on river flow or run-off and are therefore subject to seasonal variation and may be negatively affected by prolonged droughts. An application has been made to DNRME requesting an entitlement of 720 ML from the Hutton formation.

Various publications indicate that water quality of the Hutton formation is generally less than 1000 mg/l total dissolved salts. It is intended that water from the GAB bore will be mixed with the better quality alluvial or river water sources to produce irrigation water supply of acceptable quality for the intended crops. A water quality monitoring programme will need to be implemented by the irrigation project developers to ensure that the best quality irrigation water is delivered to the crops.

The following SDAP Code will apply to this water storage development:

- operational works – GAB Bore construction

Overland-flow Dam – Preliminary investigation of a potential dam-site on a drainage feature in the north-western part of Lot 168 has been conducted. This site appears to have potential for development of a gully-dam to collect overland flow from the 2200 ha catchment. Initial investigation indicates that on-site materials appear to be suitable for earth-dam construction. Development of the site is limited by the proximity of the Old Richmond Rd. and the presence of permeable, sandy loam in the upper gully banks will limit the available storage depth, however it is considered that a volume of 220 to 250 ML may be achievable. DNRME have advised that as this dam-site is located on a drainage feature, interfering with the flow and impounding overland-flow water in a dam with a volume of no more than 250 ML is acceptable development and therefore exempt from regulation under the Gulf Water Resource Plan and the Water Act 2000.

The following SDAP Codes will apply to this water storage development:

- clearing native vegetation by impoundment
- operational works – earthworks

DAF Fisheries watercourse mapping shows the drainage feature is located in the green zone, so the Planning Act State Code pertaining to Waterway Barrier Works will not apply.

Water-harvesting to off-stream storages – F.S.C. holds Licence No. 618019, which authorizes extraction of up to 5000 ML per year from the river when flow at the Richmond gauging-station, (DNRME Stn. 915008A), exceeds 1500 ML per day. Long-term discharge data from the DNRM website indicates that the mean number of days that flow exceeds the trigger condition is 29 days and the median is 24 days. An extraction rate of about 208 ML per day, (2407 l/s), would be required in order to access the 5000 ML annual entitlement. It is unlikely that investment in a pump-station of such capacity could be justified, as the 80 % reliable pumping opportunity is only about 8 days per year. The original Project Plan proposed a 450 ML off-stream storage, or ring-tank, in close proximity to the bore-field and the initial horticultural development. It is now proposed that a 500 ML fully-enclosed ring-tank will be constructed in the early years of the project's development, as irrigation water demands ramp-up. This facility would be supplied by pumping during Flinders River flood events, (exceeding the water-harvesting trigger level). A typical water-harvesting installation may comprise dual pump-units with a combined capacity of approximately 60 ML per day would therefore be capable of extracting 500 ML per year with 80 % reliability.

As orchard crop development approaches maturation in year 6 or 7 and irrigation water demands reach peak levels, a second similarly-sized storage is proposed. It is considered that the ultimate storage volume of approximately 1000 ML will be achieved by adopting a dual-cell design with a common central embankment. The design would involve fully-enclosed cells sourcing water entirely by pumping flood-flows from the Flinders River under Water Licence No. 618019. The Stage 1 water-harvesting pump-station would be duplicated to incorporate multiple pump-units with a combined capacity of about 120 ML per day in order to be capable of extracting 1000 ML per year with 80% reliability.

The following SDAP Codes will apply to this water storage development:

- operational works – earthworks
- taking water from a watercourse – Flinders River
- Clearing native vegetation

Summary of Current and Potential Water Sources

Identified sources of irrigation water and annual quantities that are known to be available in the short -term include:

1.	Bores exploiting the shallow alluvial aquifer located more than 1 km from the Flinders River	100 % Reliability	1038 ML
2.	Direct pumping from the Flinders R. or bores exploiting the shallow alluvium located less than 1 km from the river	100 % Reliability	450 ML
3.	Bore 1 exploiting the Hutton GAB formation	100 % reliability	720 ML
		High Reliability	**2208 ML**

Identified sources of irrigation water and annual quantities that are expected to be available in the medium-term include:

1.	Farm dam to harvest overland-flow	80 % reliability	250 ML
2.	Water-harvesting (Stage 1) to ring-tank storage	80 % reliability	500 ML
3.	Water-harvesting (Stage 2) to ring-tank storage	80 % reliability	500 ML
		Medium Reliability	**1250 ML**

Total Water Available with Medium-High Reliability – 3458 ML

Possible Future Water Sources

There are several possible water sources that require further detailed investigation as well as significant capital expenditure. These include:

1. Expansion of the alluvial groundwater investigation. Preliminary exploratory work in the central and north-western areas of Lot 168 indicates that, although sand and gravel strata exists, there may be a low probability of obtaining successful irrigation supplies from bores in these areas. More detailed geophysical and test-drilling investigations may be considered in the future to identify the presence and extent of any promising groundwater aquifer/s.
2. Development of a second GAB Bore in the location nominated with a view to access up to 300 ML of entitlement from future releases from the GAB Reserve.

3. Water-harvesting to the bore-field aquifer. Due to the limited land area available to accommodate large off-stream storage sites, there appears to be little chance of

creating sufficient storage volume to fully utilize the 5000 ML entitlement from the river. It is considered that there may be opportunity to utilize some of the entitlement to “top-up’ the alluvial aquifer that supplies the production bores by means of groundwater recharge trenches or wells.

A further development in this vein would be to assess the possibility of water-harvesting flood-flows into currently dry “aquifers” that have been identified in the central and north-western parts of the property.

No significant investigation work has been conducted on either of these aquifer recharge possibilities at this stage.

Summary of Possible Future Water Sources

Potential water sources and annual quantities that may be available in the long-term include:

1.	Expansion of the shallow alluvial aquifer	Volume unknown
2.	Water-harvesting to alluvial aquifer/s	Volume unknown
3.	Access to further releases from GAB Reserve	Volume unknown

Development Strategy

In order to provide a substantial volume of reliable, good quality water to support the 15 Mile Development, FSC and the project partners will need to identify and develop several water infrastructure facilities. This multi-source approach is necessary due to the limited supplies available from any single source, as well as the need to secure a high degree of water reliability to adequately support the proposed permanent horticultural crops.

In order to facilitate the logical development of available water supplies, F.S.C. and partners must firstly harness the currently available water resources. Now that the recent bore construction and pump-testing programs have been completed, it is possible to quantify the reliable yield from the alluvial aquifer, planning and design work may commence on the necessary infrastructure requirements, reticulation system and pumping schedules to utilize the available groundwater for initial crop establishment.

The second phase of the development strategy will be to invest in construction of the first of two large capacity bores to access the GAB. The certainty and reliability of the GAB makes this an important source of supply and a therefore a high priority for the project. This first GAB bore will provide an assured 720 ML annually. As this bore will be an integral part of the irrigation reticulation system, it will therefore be located in close proximity to the existing alluvial bore-field.

An additional GAB bore will most likely be the principal source of reliable irrigation water for development of the central and north-western sections of the property. Thus it is expected that construction of the second and any subsequent GAB bores will be deferred until the development scenario for these areas is better defined.

It is considered that the third phase of the water strategy should be to investigate, design and construct water storage infrastructure needed to harvest the identified overland-flow opportunity as well as the initial stage of the off-stream storage project to facilitate flood-harvesting from the Flinders River.

The fourth phase of the strategy should involve the investigation of additional, potential water sources, or methodology to increase the reliability of the infrastructure facilities developed in previous phases, to ensure the long-term success of the project.

This phase would include groundwater assessment by geophysical and test-drilling programs to identify and quantify productive aquifers in the central and north-western sections of the property and also to examine the possibility of water-harvesting to aquifer storage. Any successful production bores to be developed within these areas will almost certainly be within DNRM's regulated zone. Extraction from these future bores would therefore draw upon the 450 ML Flinders River entitlement.

An important adjunct to this final phase of the project would be to conduct or sponsor research into various aspects of agricultural production in the challenging climate and remote location of this project. Although not a development strategy, as such, one could expect that increasing knowledge and improving efficiency of irrigation operations will serve to make better use of the available water resources. Such topics may include irrigation efficiency, crop water monitoring, evaluation of micro-climate control methods and supply-chain issues.

(Signed**)**_

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