Technical Note

BIOTROPICA AUSTRALIA PTY LTD

To:	**Pat Flanagan**
From:	**Nigel Tucker**
Date:	**13th December 2017**
Reference:	**FLA17.12.01**
Subject:	**Northern Sands DMPA – Comment on the Likely Effect of Elevated Salinity on Sugar Cane and Native Vegetation**

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1.0 BACKGROUND

Biotropica Australia has been asked to confirm impact assessments relating to the Supplementary Report (Bund layout) modelling (see Golder 2017), specifically regarding the effect of elevated salinity variation on native vegetation along the Barron River, and adjacent sugar cane croplands, as a result of developing the proposed Northern Sands DMPA.

Golder (2017) has presented an updated assessment of the intensity and duration of elevated salinity in the area surrounding the Northern Sands DMPA, and assessed the risk of impacts to ground water from potential elevated salinity. This assessment notes that areas with surficial clays <2m depth may be at moderate risk of impact, and such areas are confined to cane growing lands north and east of the proposed Northern Sands DMPA for a maximum distance of ca.150m. The assessment further notes that a maximum salt flux of 700g/s would be distributed along a 1.1km section of the Barron River, during periods when the lake level is high.

2.0 SALINITY EFFECTS ON SUGAR CANE

The main effect of elevated salinity on sugar cane is to reduce that plant's ability to uptake water by increased binding of water to soil, and increasing the energy budgets required for osmosis. This reduces overall crop yield (7.5% per dS/m ECe) and the CCS of extracted cane juice (from 0.27-0.92 CCS per dS/mECe) (Kingston and Anink 2003). However, these documented salinity effects on sugar cane are confined almost entirely to areas where crops are under irrigation (e.g., Burdekin district), and/or grown on soil types more susceptible to the effects of salinity. Neither of these features is relevant in the case of cane adjacent to the Northern Sands DMPA. All sugar cane around the site is grown under natural rainfall conditions, and soils are not prone to saline invasion. Seasonal monsoon rains are sufficient to maintain the soil salinity balance, as evidenced by generally stable boundaries between local cane cultivation and adjacent salt tolerant ecosystems such as mangroves or samphire communities.

There is evidence across the Barron River Delta that sugar cane crops tolerate some level of saline intrusion. Crops directly adjacent to mangroves (e.g., 5m) show few if any signs of salt-induced stress across both dry and wet seasons, and the frequent invasion of cane crop margins by the salt-tolerant marine couch (*Sporobolus virginicus*) indicates sugar cane has (like marine couch), some ability to tolerate salt in the upper soil profile. Intense, regular rainfall events during the summer monsoon, coupled with high tides leads to watercourses such as Thomatis / Richter's Creek, Avondale Creek and Half Moon Creek carrying elevated salt levels, but as noted such pulses are also responsible for ensuring salt-soil balances, and the net effect is to maintain soil pH around 5.5.

Impacts are postulated to occur on cane growing lands north and east of the proposed Northern Sands DMPA, although the effect may be variable due to differences in clay thickness and the subsequent degree of intrusion. In the modelling presented by Golder (2017) the effect on sugar cane is suggested to be reversible, and locally confined. Reversibility is likely to an entirely natural process, dependent on regular soil flushing via natural rainfall. The area of effect is suggested to be no more than 150m from the Northern Sands DMPA, and this relatively discrete area suggest that any potential site remediation is both feasible and likely to be successful. In the event of minor crop losses between detection and remediation, the level of income lost is considered small and appropriate compensation modest.

In summary, sugar cane yield and CCS content are affected by soil salinity, but documented effects are confined to irrigated cane. There is no evidence of the effects of salinity in a wet tropical climate, where regular and intense rainfall events maintain generally stable soil salinity balances.

Local cane crops are subject to regular (annual) inundation by floodwaters with saline influence. This occurrence, coupled with the presence of salt-tolerant native plants (e.g., *Fimbristylis* spp, *Sporobolus virginicus*) extending into cane crop margins, suggests cane is tolerant of mild saline intrusion where drainage is not impeded.

The extent of any effect is likely to be no greater than 150m from the proposed Northern Sands DMPA suggesting the area of cane potentially affected will be minor, and the effect on sugar cane is likely to be reversible, facilitated by flooding associated with the summer monsoon.

3.0 SALINITY EFFECTS ON NATIVE VEGETATION

Both mangrove and non-mangrove communities are present on and adjacent to the proposed Northern Sands DMPA.

The mapped mangrove associations from Northern Sands to the Barron River mouth are as follows:

- Closed Mixed (Dominant)
- Closed Bruguiera
- Closed Rhizophora
- Closed Avicennia
- Samphire-dominated saltpan
- Closed Ceriops

Around Northern Sands, *Rhizophora stylosa* (Closed Rhizophora) is dominant.

A number of effects of salt flux variation have been demonstrated on local mangrove species. Whilst all of these studies have been undertaken in closed experimental systems, they provide an indication of the range of effects which include:

- Reduced photosynthesis in *Bruguiera parviflora* by interference of CO_2 diffusion to chloroplasts (Das et al 2004).
- Significantly different responses to changing salinity levels between mangroves e.g., *Avicennia marina* (Clough 1984), *Aegiceras corniculatum* and *Rhizophora stylosa (*Ball 1988).

However, as noted, none of these studies have been undertaken in open systems so transferability is largely conjectural. Changes in salinity concentrations are usually controlled by internal osmotic adjustment, and these vary between species.

Different species of mangroves exhibit varying levels of tolerance to salinity, as would be expected based on simple mangrove zonation concepts. The appearance at Northern Sands of ubiquitous mangroves such as *Rhizophora stylosa* and *Avicennia marina* var*. eucalyptoides* at both riparian and landward margins suggests these species are tolerant of significant variation in salinity. Both species are common at Northern Sands, particularly where inundation is more likely. This confirms that *R. stylosa* and *A. marina* var. *eucalyptoides* are relatively tolerant of diurnal and seasonal variation in salinity levels. Moreover, the mangrove associations listed above show there is a wide range of mangroves and samphires present between Northern Sands and the river mouth, all with varying tolerance to elevated/reduced salinity. The loss of one species is likely to result, over time, in replacement by another (more salt tolerant) species.

There are three mapped Regional Ecosystems in the vicinity of Northern Sands as follows;

7.1.1 - Mangrove closed scrub to open forest of areas subject to regular tidal inundation (Least Concern)

7.3.10a - Simple-complex mesophyll to notophyll vine forest on moderately to poorly-drained alluvial plains of moderate fertility (Of Concern)

7.3.25a - Melaleuca leucadendra +/- vine forest species open forest to closed forest on alluvium fringing streams (Of Concern)

RE 7.1.1

This RE is comprised entirely of species displaying some form of adaptation to saline conditions. As discussed above, there is significant variation between species tolerance levels with *R. stylosa* and *A. marina* showing adaptations to wider variation, and local varieties of both are common around and downstream of the site. This RE is least likely to be affected although dominance by more ubiquitous species may occur if salinity levels remained elevated over an extended period.

Grey mangrove (*Avicennia marina*) has been successfully cultivated in 75% seawater, indicating it is unlikely to be affected by salinity variation (Clough 1984). Such plasticity does not extend to all mangroves and differential effects are likely. However, any long term negative effect of these pulses is likely to be minor and site recovery relatively predictable, although often protracted.

RE 7.3.10a

This is a non-mangrove RE, although there are species present in this RE at the site e.g., *Hibiscus tiliaceus*, that are more salt tolerant. Some species would be more negatively affected by increasing salinity, and most likely to be replaced by more tolerant species. The duration of such an effect is unknown. It would be likely that mangroves would be replaced by species more indicative of the existing community as salt-soil balances returned to pre-placement conditions however the timing and trajectory of recovery is site dependent, as was observed at East Trinity during terrestrial ecology surveys for the initial EIS (Biotropica 2016).

RE7.3.25a

The dominant species within this RE (narrow-leaf paperbark – *Melaleuca leucadendra*) occurs in semi-tidal ecosystems across the coastal wet tropics, and a common component of the regeneration in partially saline portions of the East Trinity site. Whilst accompanying vine forest species may be more prone to elevated salinity, there are other species present that are likely to invade and occupy such sites (e.g., *Hibiscus tiliaceus, Lumnitzera racemosa*). The duration of such an effect is unknown. It would be likely that mangroves would be replaced by species more indicative of the existing community as salt-soil balances returned to pre-placement conditions however the timing and trajectory of recovery is site dependent, as was observed at East Trinity during terrestrial ecology surveys for the initial EIS (Biotropica 2016).

In summary, mangrove and associated vegetation at the Northern Sands site contains a variety of species with varying tolerances to elevated salinity. Whilst some species may be temporarily or permanently affected by salinity changes, there are species present that are able to colonise sites where other species have been displaced. A sub-set of these species are considered to have sufficient plasticity to withstand the modelled changes.

4.0 MONITORING BORES

Golder Associates (2017) have suggested a borehole monitoring program to document salinity, amongst other parameters. It would be useful to examine soil and water chemistry in the context of vegetation responses to modelled salinity. On this basis, it is suggested that consideration also be given to ensuring some boreholes are established adjacent to native vegetation at Northern Sands. This would allow more informed decision making during the material placement process, and inform both future management and similar campaigns.

5.0 REFERENCES

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DOCUMENT CONTROL SUMMARY

REPORT AND CLIENT DETAILS

Technical Note:	*Northern Sands DMPA – Comment on the Likely Effect of Elevated Salinity on Sugar Cane and Native Vegetation*
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