J.H. & E.S. Laxton Environmental Consultants P/L

A.C.N. 002 862 160

170 Warrimoo Ave, St Ives, NSW 2075

Ph: (02) 9449-7846 Fax: (02) 9983-0736

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Mr Scot Hedge
Coast and Estuaries
Warringah Council
Civic Centre Dee Why 2099

Dear Scot,

Review of Draft reports on Curl Curl Lagoon by AWT

After reading the draft report on Ecological Monitoring of Curl Curl Lagoon and scanning of the draft Management Plan I was left with the overwhelming impression that the author(s) did not understand how this lagoon functions as an ecological unit. I would direct their attention to my small report entitled :

> Laxton, J.H. & E.S. 1997. *Gosford City Council. Management of small lagoons.* May 1997.

for an account of how Curl Curl Lagoon may have functioned before the advent of European settlement. Briefly, these small lagoons drained almost completely during a major rainfall event, closed again after 1 or a few days, and then commenced to refill. Water in the lagoon went through a prolonged metamorphosis until a distinctive brackish water ecology developed. The lagoon stayed closed for up to three years before emptying again. The cycle would then begin again.

Curl Curl Lagoon has been modified severely by the activities of man over the past 50 or more years. These changes include :

- Reducing the water surface area of the lagoon by filling the surrounding wetlands with municipal waste.
- Urbanising a large portion of the catchment.

The filling of wetlands and the destructive processes of urbanization has reduced the volume of water that the lagoon can hold. This means that quite small rainfall events can cause the lagoon to open and drain. In dry years Curl Curl Lagoon opens around 7 times a year and in wet years it open around 14 times a year. Once the ecological cycle took 3 years to complete. Now it may occur in less then a month. Unless this truncated ecological cycle of Curl Curl Lagoon is recognised and understood all attempts to devise estuary management plans and ecological monitoring programs are worthless.

As requested I will outline my views on the management of Curl Curl Lagoon. Water quality and hence ecology of this lagoon is affected by the following factors :

- The length of time that the lagoon is closed from coastal waters.

- Water and dissolved substances leaching from the old municipal rubbish tips lining the banks of the lagoon.
- Water currently draining from the catchment and from periodic overflows from the local sewerge reticulation system and the trunk sewers passing through the area.

Duration of Lagoon Closures

At present Curl Curl lagoon closures range from 3 to 6 weeks. Thus every 3 to 6 weeks salinity in the lagoon starts at 35 parts per thousand (seawater) and may reach almost zero (particularly in surface water). The lagoon may be highly stratified with respect to temperature, salinity, pH and dissolved oxygen when it is closed. When the lagoon opens components of the ecosystem that are pelagic (live in the water column) are expelled to the coastal waters. Benthic organisms (live in or on the sediment) over most of the lagoon bed are exposed to the sun for some days before the survivors are progressively covered by water of rapidly decreasing salinity. Also when the lagoon drains large flocks of birds arrive to feed on the exposed benthos and stranded fish and any invertebrates.

The duration of lagoon closures are a function of the surface area of the water of Curl Curl lagoon, the mean depth (between AHD and the top of the entrance sand bar) and the amount of rain that falls. The only way a management plan can lengthen the time that the lagoon is closed is to increase the surface area of the lagoon back to approaching its pre-European condition. This would entail eliminating the sports fields, excavating the old municipal tips and removing other developments that encroach on the former lagoon bed and surrounding wetlands. This is clearly not going to happen so no management plan can alter the frequency of lagoon openings and closings without undertaking extensive and complicated entrance works.

Effect of Old Tips on Water Quality

Water quality in Curl Curl Lagoon cannot be returned to close to its pre-European condition without tackling the leachate problem. As a goal of a management plan this is a do-able objective. The landfill sites along the shores of Curl Curl Lagoon are largely covered by sports fields. Stormwater falling on these fields penetrates the over-burden, saturates the garbage and eventually exits the landfill from diffuse points along the waters edge when the lagoon water level is lower than the water level in the fill. Water from the lagoon can also penetrate the landfill during periods when the water level of the lagoon is higher than that of the landfill. Analyses of leachate from various landfills sites shows that the water and dissolved contents is more benign than would be expected from the types of material interred in the tip would lead one to expect. The most common component is ammonia-nitrogen. Phosphorus and metal concentrations are very low suggesting that they remain bound to soil particles within the landfill.

The leachate problem of Curl Curl Lagoon may be tackled in the following way :

- The surfaces of the landfill sites (beneath the sports fields) must be sealed by proper placement of impervious clay. The sports fields may than be rebuilt.

- An impervious bund must them be built just back from the waters edge of the lagoon to prevent water movement from the landfill to the lagoon and from the lagoon to the landfill.
- Once the landfill has been sealed from stormwater and from the lagoon, wells can be drilled into the landfill and fitted with pumps and float switches. Leachate can be pumped to the nearest sewer with the capacity to receive it. Eventually the landfill will be dewatered and aerobic conditions may then prevail which would allow the garbage to decompose. At the very least, dry anaerobic processes will be established which will produce methane gas which has a value as an energy source.

Improving Stormwater Quality

Once the leachate problem has been solved, attention can be focused on improving the quality of stormwater entering Curl Curl Lagoon. Stormwater enters the lagoon via Greendale Creek or from a number of drains running directly to the lagoon. Water emerging from the upper catchment (sampled at CC1) does not change its composition much in wet or dry weather and contains acceptable levels of TN and TP. The section of Greendale Creek between the brickworks and Harbord Road GPT (sampled at CC2 and CC3) flows constantly in both wet and dry weather (the moderate flows even in drought conditions appeared odd to begin with). Water entering the lagoon from Greendale Creek contains high concentrations of oxidized nitrogen and before the GPT was built, quite low levels of total phosphorus. Since the GPT was built, TP levels appear to have increased markedly. This is, however, an artifact generated by the poor management of the GPT (Laxton, 2000). The source of most of the dry weather flow in Greendale Creek is a substantial leak in the municipal water supply. I have kept the information of this leak to myself because the water provides a significant environmental flow to Curl Curl Lagoon to dilute the leachate in the estuarine section. If Sydney's water storage fell to a critical level I would report this leak and the many others I have discovered in the course of my work. If the leachate problem was solved, repairing of this leak would make a signifcant reduction to total nitrogen levels in Curl Curl Lagoon. It would also help if the GPT was managed intelligently.

The flows from smaller drains entering Curl Curl Lagoon could be treated using small wetlands like the one at Surf Road. These small wetlands do not do much for dissolved nutrients but are good at removing particulate nutrients if they are managed properly.

Lagoon Ecology

Even if there is a gradual improvement in water quality of Curl Curl Lagoon, the rapid opening and closing regimen will still occur. The design of a water quality and ecological monitoring programme to document these changes will have to take these factors into account.

The first step would be to characterise two or more of the ecological cycles as they presently exist (to form a baseline of present conditions). All major elements of the ecosystem would be sampled from the moment the lagoon drained to the moment of the next draining. Drainings at different times of the year would be studied to obtain

information on temporal variation in community structure and behaviour. Studies of each ecological cycle would include the following :

- Hourly changes in water depth, temperature, salinity, pH, dissolved oxygen and turbidity of surface and bottom water.
- Every second day samples of surface and bottom water would be analysed for ammonia-N, TKN, organic-N, nitrite-N, nitrate-N, TN, ortho-P, organic-P, total-P, total suspended solids, inorganic suspended solids, volatile suspended solids, chlorophyll-a (a water sample would be preserved in Lugol's Iodine to permit taxonomic evaluation) and zooplankton (to be sampled at night).
- Each week replicate samples of benthos would be collected from the lagoon bed.
- A seine net would be stretched across the lagoon entrance channel to sample fish and other pelagic organisms leaving the lagoon during the next breakout.

With the implemetation of each step of the management plan, a small number of ecological cycles could be investigated and changes noted.

Between times, the existing lagoon water quality sampling programme should be continued to produce a data set that can be used to follow longer term changes and to detect unforeseen events.

Reference

Laxton, J.H. & E.S. 2000. Warringah and Manly Councils. *Water Quality of Warringah lagoons in 1994-99*. January 2000.

I hope this review and information is of use to you. If you have any questions please ring me on (02) 9449 7846.

Yours faithfully

John H Laxton

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