RECOMMENDATIONS FOR MANAGEMENT OF OOZE IN TUGGERAH LAKES

Prepared for Wyong Shire Council

June 2013

Written by Rebecca Swanson, Angus Ferguson and Peter Scanes

NSW GOVERNMENT | Office of Environment & Heritage

TABLE OF CONTENTS

INTRODUCTION

Four decades of high nutrient and sediment loads from intensive urbanisation of the catchment has impacted heavily on the health, ecology and amenity of Tuggerah Lakes. Nutrient-rich urban stormwater has flowed directly into the lake from the fringing catchment since urbanisation began. Tributaries have delivered high sediment loads to the lake for over a century and consequently seagrass distributions have changed dramatically, altering the ecology and water flow in the lakes. The nearshore zone (first ~50-100 m from shore) is now highly degraded and ooze sediments are widespread, particularly in areas that are protected from wave energy and receive stormwater from large areas of the catchment (for e.g., western shores of Tuggerah Lake). The overarching objective of ooze management should be to address the causes of ooze by implementing multi-faceted strategies that:

I. Improve the quality of stormwater entering the nearshore

II. Transport wrack onto shore to dry aerobically

III. Increase flushing of nearshore waters with the lake basin

What is Ooze?

'Black ooze' forms in the sediments at the worst affected areas - a toxic sludge that contains very high concentration of nutrients, organic matter and sulfidic compounds such as hydrogen sulphide or 'rotten egg gas'. It should be noted that 'ooze' is a loosely defined term and Council and Community are probably talking about different things when they talk about 'ooze'. The most common sediments around the lakes are oozey mud or oozey sand which are widespread in nearshore areas round the lakes. Oozey sediments are likely to be precursors to black ooze as they contain high amounts of nutrients and organic matter concentrated in surface layers, and have a strong odour at close contact (see Appendix 1 for images and descriptions of black ooze, oozey sediments, and sediments that are perceived as ooze but are not).

Why and how does Ooze form?

Black ooze forms in sediments that contain high concentrations of nutrients and organic matter. Under high loads of nutrient and organic matter, the metabolism of sediment microbes that function in the recycling of nutrients switches from aerobic (with oxygen) metabolism to anaerobic (without oxygen) metabolism. Anaerobic metabolism drives the production of sulfidic compounds such as rotten egg gas (H_2S) which is released, particularly when sediments are disturbed (Appendix 2 – Chemistry of H_2S formation).

High concentrations of nutrients persist in nearshore areas where there are stormwater inputs and little mixing of nearshore water with lake-basin water. Shoreward migration of seagrass beds to shallow areas, coupled with large accumulations of wrack, form a barrier between the nearshore and the lake-basin leading to reduced water flow in nearshore areas. Nutrient-laden groundwater is also likely to be contributing to high nutrient loads in the nearshore. High concentrations of nutrients can lead to macroalgal blooms, which results in excess organic material in the nearshore, that in turn fuels ooze formation.

Ooze-rich sediments also contain large amounts of fine mud or silt. Tuggerah Lakes have become progressively muddier over the past century due to high sediment loads entering lakes mainly from the upper rural catchments but also from development in the urban and industrial catchments. Sandy shores have become muddy shores which are more prone to ooze formation because organic matter sticks to fine mud particles, accelerating the production of ooze.

Environmental, ecological and social consequences of Ooze

The environmental and ecological consequences of black ooze in the sediments of Tuggerah Lakes are immense. Black ooze is toxic to plant and animal life due to high concentrations of hydrogen sulphide (H_2S, rotten egg gas), so there are no seagrass beds or burrowing animals found in these areas. Instead, free-floating forms of macroalgae (*Chaetomorpha*, *Rhizoclonium, Cladophora, Enteromorpha*) are the most common macrophytes at the most degraded sites. Black ooze is not widely distributed around the lakes, but the prescursor sediments (oozey mud/sand) are widespread in nearshore areas. If nutrient and sediment inputs persist at current levels then large tracts of nearshore sediments could deteriorate to black ooze and seagrass will be lost from those areas.

Tuggerah Lakes has shifted from a seagrass dominated system to an algal dominated system in response to high nutrient and sediments loads of the last few decades. Seagrass beds provide habitat and food for many aquatic animals,including fish and prawns, and improve water quality by stabilizing sediments and trapping sediments suspended in the water column. All seagrass species are protected by NSW legislation in recognition of the vital role they play in ecosystem function. Seagrass are at great risk from catchment pressures on the nearshore zone. Currently, only a narrow margin of the lakes is suitable habitat for seagrass growth due to deep water turbidity. Deteriorating nearshore condition means that seagrass communities are being squeezed from both sides, being unable to grow in deeper areas of the lake due to poor water clarity. If seagrasses are lost from Tuggerah Lakes, the biodiversity of the system will be dramatically reduced and the condition of the lakes will deteriorate further.

Black ooze and oozey sediments around the shores of Tuggerah Lakes have dramatically reduced the amenity of foreshore areas. There are areas where residents do not open their windows due to the smell of rotten egg gas in the air. Many locals no longer participate in the recreational activities on the lakes (prawning, water skiing windsurfing, boating), or their foreshores (walking, picnicking) due to difficulty in accessing the lakes and unpleasant odours. It is no longer appealing to wade into nearshore areas of the lake where ooze is present as it is not only physically challenging (one may sink up to 0.5m), the smell can be unbearable once the sediment is disturbed. Consequently, a large proportion of the community has become disengaged from the lake environment because of the poor health of nearshore areas.

Wrack and Ooze

Wrack is detached and dying plant material, most commonly seagrass, but also including macroalgae. Wrack alone does not form ooze: it is only one component of a suite of factors that lead to ooze formation. Sodden (water-logged) seagrass wrack accumulating at the waters' edge will generate sulfidic odours if there are large loads of organic matter (macroalgae) and/or nutrient inputs, either from stormwater or groundwater (e.g. Canton Beach), but this is not ooze. Protected shores experiencing limited wave energy tend also to have muddy sediments (western shores of Tuggerah Lake and Budgewoi Lake). Muddy shores, limited wave energy, nutrient inputs and sodden wrack will tend towards ooze formation. Wrack exacerbates the formation of ooze by acting as matrix to which organic matter, silt and nutrients attach.

BACKGROUND

Wyong Shire Council's management of Ooze – past and current strategies

i) Tuggerah Lakes Restoration Project

In the late 80s - early 90s Tuggerah Lakes were eutrophic and widespread macroalgal blooms in nearshore areas were common. In response, the State government at the time funded a once off 'clean-up' of the lakes. The Tuggerah Lakes Restoration Project (TLRP) of the early 1990s dredged large areas of ooze sediments and seagrass/macroalgae from 15 km of shoreline. The majority of 'restoration' work was done in lower Tuggerah Lakes (The Entrance, Long Jetty to Tumbi, Berkeley Vale to Chittaway Bay) where between 50-200 m of polluted nearshore areas were dredged using various methods (wet extraction/dry extraction). An unfortunate legacy of the TLRP was the use of dredged spoil as land fill for a concurrent project which extended adjacent foreshore areas by up to 30 m. Nutrients and other pollutants contained in the dredged spoil would have leached back into nearshore waters in groundwater and may even continue to do so.

TLRP was a mammoth engineering effort which showed little regard for the ecological and environmental consequences of such a large scale dredging operation. Any benefits of TLRP were short lived, because the symptoms (ooze), rather than the cause (stormwater pollution), were targeted in this management strategy.

ii) Saltmarsh rehabilitation & shoreline restoration

It is a common misconception that wrack stranded on shore and in nearshore waters is the primary cause of ooze formation. It has been shown that wrack stranded in saltmarsh promotes the growth and establishment of saltmarsh in highshore environments (Chapman & Roberts 2004) and produces no odour as it breaks down. Council commenced the rehabilitation of coastal saltmarsh around the lakes in 2009 in an effort to harness natural mechanisms to facilitate the breakdown of wrack and reduce ooze. Coastal saltmarsh also provides habitat and food for invertebrates and birds, and reduces nutrient and sediment loads entering the waterway via filtration and uptake. Over 85% of coastal saltmarsh habitat in the Tuggerah Lakes Estuary has been lost to development (Roberts 2001) and the rehabilitation of saltmarsh became a high priority action in the Estuary Management Plan for Tuggerah Lakes. Coastal saltmarsh is listed as an Endangered Ecological Community in NSW (Threatened Species Act 1995), in recognition of its widespread decline and valued role in estuarine ecosystems.

Research and review by NSW Office of Environment and Heritage (OEH)

OEH have conducted many experiments and field surveys to better understand the causes of black ooze formation. We presented some of our findings in OEH Progress Report 2 (June 2012) on the:

- composition of ooze-rich and ooze-free sediments and the origin of organic material within these sediments
- condition of nearshore habitats including the spatial distribution of wrack and ooze at 8 sites
- decomposition rates of wrack in saltmarsh, on shore and subtidally

OEH has evaluated the effectiveness of the TLRP as a strategy for ooze management through qualitative assessment of aerial photographs taken during the TLRP and in the years that followed. Long term outcomes of the TLRP were evaluated by surveying the condition of the nearshore zone and the sediments at sites restored during the TLRP compared to adjacent unrestored sites. Aerial photography showed that 'restored' shorelines experienced recurring macroalgal blooms for several years after the restoration works. Seagrass returned to restored areas within 18 months. The field survey of long term ooze accumulation at sites restored, compared to nearby non-restored sites, showed location-dependant trends. Large accumulations of ooze and oozey sediments were found at all sites along the western shores of Tuggerah Lakes however, significantly less black ooze was found at 'restored' sites compared to non-restored sites. Very little black ooze was found at restored and non-restored sites in Tuggerah Lakes, Budgewoi Lake and Lake Munmorah. Site characteristics largely determine the current condition of sediments, rather than whether or not the site was 'restored'. The southerly aspect of Canton Beach and San Remo is the best aspect with regards to limiting ooze formation, due to higher wave energy and better flushing. The full report on the effectiveness of the TLRP as a strategy for ooze management can be found in the final OEH Progress Report 4, June 2013 (Appendix 2).

OEH has assessed the impact of current strategies of saltmarsh rehabilitation and regraded shorelines on nearshore condition in a field survey of saltmarsh rehabilitation sites at Long Jetty, Berkeley Vale and Halekulani. Saltmarsh rehabilitation and regraded shorelines are likely to be effective strategies for reducing black ooze as none was found at two actively rehabilitated sites, Long Jetty and Lake Munmorah. Wrack is distributed onto regraded shores and dries aerobically rather than staying trapped at the water's edge and contributing to ooze. Large accumulations of black ooze were nevertheless recorded at Berkeley Vale where local conditions encourage ooze formation. Nearshore condition was poor at all sites due to persistent high nutrient inputs from stormdrains and groundwater discharge, and little mixing of nearshore waters. A full report on the effectiveness of this current strategy for ooze management can be found in the final OEH Progress Report 4, June 2013 (Appendix 1).

Collectively, findings from our research have formed the basis for the recommendations that follow.

RECOMMENDATIONS

Strategies to manage ooze in the nearshore should:

- Focus on the fringing urban catchments because it is the stormwater runoff from these areas that fuels ooze formation.
- Be site-specific and multi-faceted depending on the circumstances at each locality.

The **key objectives** of recommendations are to improve the health and amenity of foreshore/nearshore areas by:

- Reducing nutrient and sediment loads entering the nearshore in stormwater runoff
- Transporting wrack onto shore to dry aerobically
- Improving water flow in nearshore areas through increased mixing with lake-basin water

RECOMMENDATION #1

Improve quality of stormwater entering nearshore zone using multiple approaches

There are hundreds of stormwater drains feeding nutrient rich stormwater directly into the nearshore zone. Nutrient and fine sediment loads must be reduced in stormwater entering the lakes by implementing 'at the source' and 'end of pipe' solutions.

I. COMMUNITY EDUCATION AND BEHAVIOURAL CHANGE

Ooze formation is largely driven by nutrient and fine sediment inputs from the fringing urban catchments. Reducing the use of nutrient rich chemicals in the home, and keeping green waste out of stormwater drains, are the simplest ways to reduce nutrients entering stormwater. Council knows that behavioural change in the community is critical to improving the health of the lakes and should maintain their education campaign to promote responsible behaviour and actions in the catchment (i.e., reduce the amount of fertiliser/detergents/chemical used, install rainwater tanks, establish compost bins, dispose of green waste in compost or council bins etc). The community should learn that the health of the lake in 'their patch' generally reflects the actions of residents in surrounding streets.

II. REGULAR CLEANING /MAINTENANCE OF 'WET' STORM DRAINS AND GROSS POLLUTANT TRAPS

Stormwater treatment zones (STZs) are vegetated drains added to the outlets of stormwater channels. They aim to reduce sediment and nutrients entering the lakes. Most STZs are too small to effectively reduce nutrients, however they are effective at trapping rubbish and sediment. The low elevation of the drains means they tend to accumulate stagnant stormwater with very high nutrient and pollutant concentrations. This concentrated stormwater stagnates at the outlet of the drains, causing ooze to form. The amount of ooze on shore, in particular near drain outlets, could be reduced by regularly flushing out wet drains with additional water to dilute the concentrated stormwater and disperse it further into the lake.

Many gross pollutant traps (GPTs) in Wyong shire do not drain properly due to compromised design and the low elevation of the landscape. Council recognizes that 'wet sump' GPTs are potentially causing more harm than good and are being replaced by dry sump GPTs. Wet sump GPTs should be cleaned on a regular basis to prevent toxic ooze forming in the base of traps. This ooze produces bad odours and potentially causes environmental harm in the lakes upon first flush. The stagnant toxic water should be pumped out, dewatered and disposed of appropriately. The site of disposal should be a considerable distance from a waterway so that groundwater does not immediately return the nutrients and pollutants to the system.

Regular cleaning of wet drains and 'wet sump' GPTs will reduce concentrated nutrient inputs in the vicinity of the drain outlet which should lead to reduction in ooze formation. The amenity of the foreshore areas will be improved through odour reduction and removal of unsightly rubbish. Regular maintenance of GPTs will improve their effectiveness at trapping rubbish and coarse sediments.

III. SEAL ROADS AND VERGES

Unsealed roads are a significant source of suspended sediments to receiving waters and continue to generate fine sediments with every rain event. Downstream treatment options are quickly overwhelmed by sediments and are expensive to maintain. The best way to reduce sediments loads in runoff and the maintenance of stormwater quality improvement devices is to reduce the sediment load at the source. OEH conducted a study which monitored sediments loads coming from sealed and unsealed roads, including Footts Rd which was sealed in early 2013. This study demonstrated that substantial reductions in the generation of total suspended sediment could be achieved by sealing roads without major increases in nutrient generation. The study also showed that nutrient delivery to waterways could be reduced by maximising the distance run-off must travel from roadside drains to waterways. Council should continue their efforts to seal roads/gravel verges and upgrade drainage in susceptible areas that have a direct hydraulic connection to the lake. A full report of this study can be found in the final OEH Progress Report 4, June 2013 (Appendix 6).

IV. RETROFIT STORMWATER IMPROVEMENT DEVICES

Retrofit programs aim to improve stormwater quality either by enhancing the performance of existing devices or installing new devices. A range of options for Water Sensitive Urban Design and stormwater treatment measures may be adopted to improve the quality of stormwater entering the nearshore zone.

a. Swales

b. Bio-Retention

c. 'Dry' Gross Pollutant Traps

d. Dry sediment basins

e. Ponds

f. Wetlands

g. Sand filters/Bio-filtration

Adopted strategies are likely to include a number of measures depending on characteristics of the site and the catchment to be treated. Artificial wetlands are highly recommended as they reduce both nutrients and fine sediments entering the lakes. They do need to be of certain size to be effective and are relatively expensive to construct and maintain. Sand filters/bio-filtration reduces both nutrient and sediment loads, however, filters are subjected to blockage and high head losses.

There are already approximately 40 artificial wetlands in the shire, half of which are likely to be underperforming (*'Stormwater Improvement Strategy for Tuggerah Lakes'* SKM report - 2010). It may be cost effective to consider augmentation of some of the 22 existing wetlands identified by SKM as likely to be underperforming (Table 6.1, SKM report 2010). Wetlands tend to trap a lot of rubbish which should be cleaned on a regular basis to improve their effectiveness and public appeal, as well as the visual amenity of the area.

HIGH PRIORITY AREAS FOR STORMWATER MANAGEMENT

'Stormwater Improvement Strategy for Tuggerah Lakes' – SKM report (2010)

The catchments fringing the southern portion of Tuggerah Lake, including Tumbi Creek and Saltwater Creek, the lower reaches of Wyong River (i.e., Wyong town ship) and Ourimbah Creek were identified by Sinclair Knight Merz (SKM) as high priority catchments for stormwater treatments. This assessment was based on a review of current land use and water quality results from the lakes and tributaries between 2000 and 2004.

OEH modelling (Stage 1)

Results of OEH modelling found that the subcatchments of Long Jetty, Lake Haven, San Remo, Gorokan, Lake Munmorah and Buff Point represent the highest cost-benefit for retrofitting water treatment systems. Council has commenced retrofitting works in all of these subcatchments except for Buff Point.

The ecological response model developed by OEH identified the nearshore areas in the vicinity of Chittaway Bay, Tumbi Creek, Toukley golf course and Tuggerah Wharf ruins as having a high risk of environmental degradation from increased nutrient and sediment inputs from proposed future developments. Even though the cost benefit of retrofit in these areas was only moderate, they should also be considered as a high priority of retrofit. Black ooze and oozey sediments in particular are widespread in the protected western shores of lower Tuggerah Lake. Thus it is absolutely imperative to reduce nutrient and fine sediment inputs to these areas in order to reduce the volume of black ooze and oozey sediments.

The nearshore zone at Berkeley Vale represents the worst case scenario of the detrimental effects of stormwater pollution. Stormwater from 500+ hectares of heavily modified catchment (Glenning Valley) is delivered to the lake at Berkeley Vale/Chittaway Bay, in addition to runoff from surrounding streets. Muddy sediments and low wave energy shores trap excess nutrients and sediments in runoff leading to ooze formation. Retrofitting efforts by council on this part of the stormwater network have been hampered by landscape characteristics and large flow volumes which pose a flooding risk to residents. Council should continue to explore new technologies and retrofitting options to improve the quality of stormwater originating from Glenning Valley and entering the lakes at Berkeley Vale.

RECOMMENDATION #2

Rehabilitate saltmarsh habitat and restore low-gradient shorelines round the lakes

OEH recommends that Council continue their efforts to rehabilitate saltmarsh habitat and restore low-gradient sloping shorelines round the lakes. Our research has found that ooze is less likely to form on exposed shorelines of gentle slope and more likely to form in areas with modified shorelines which trap sodden wrack at the waters edge. Restoration of saltmarsh and sloping shorelines may reduce ooze formation by reducing the nutrients and sediments entering the lake and by facilitating the transport of wrack onto shore. Noticeable improvements to nearshore condition have occurred in locations where shorelines of gently slope and saltmarsh habitat have been restored. Local resident, Mark Judge (Trelawney St, Killarney Vale) returned a natural shoreline and saltmarsh habitat to his ‘patch’ of lake and has noticed an improvement in nearshore condition. The depth of oozey sediments has been reduced and they yield less sulfidic odours. Large quantities of wrack have collected on the open shoreline to dry aerobically which attracts crabs and other crustaceans. Residents should be encouraged to restore natural shorelines and saltmarsh habitat in their patch in conjunction with Landcare groups and Council.

Entrance management for flood mitigation has resulted in a relatively constant lake water level of ~0.6m AHD which is very different to natural conditions (before entrance management and modified shores) when lake water levels fluctuated between 0.5m and 2.0m AHD. Under natural conditions, wrack was transported onto shore where it dried aerobically when flood waters receded. This natural mechanism of self cleansing now only occurs after prolonged heavy rainfall and to a far lesser extent. Under current conditions of entrance management and modified shorelines, only a tiny fraction of total wrack can ever be delivered onto shore, even where shorelines have gentle slopes. Other strategies are required in combination with saltmarsh rehabilitation/shoreline restoration to reduce the amount of wrack accumulating in the nearshore.

SALTMARSH AND REGRADED SHORELINES HAVE THEIR LIMITATIONS

Our research has found that rehabilitated saltmarsh and regraded shorelines have little impact on improving nearshore condition in heavily degraded areas such as Berkeley Vale. Large volumes of black ooze were recorded at the active saltmarsh rehabilitation and control sites at Berkeley Vale.

This location experiences all of the conditions which favour ooze formation (i.e., muddy shores, protected site, high nutrient/sediment inputs, no flushing) and the situation is further exacerbated by stormwater runoff from an additional 500+ hectares of highly modified catchment of Glenning Valley.

Degraded sediments were widespread, and macroalgal blooms were common in the nearshore waters in front of all saltmarsh sites including active rehabilitation and reference sites. All sites had concentrations of N and P (well) above trigger values in ANZECC guidelines. This reflects the general pattern of poor water quality in nearshore waters due to the chronic drip of urban stormwater with very high concentrations of nutrients. Currently saltmarsh habitat represents only a small fraction of the shoreline of the lakes.

Efforts to improve the nearshore condition along highly degraded areas such as the western shores of lower Tuggerah lakes need to focus on improving the quality and quantity of stormwater delivered to this area. Once nutrient and fine sediment inputs to the nearshore are substantially reduced and nearshore waters are better flushed with lake-basin water, saltmarsh rehabilitation and shoreline restoration may further improve the condition of the nearshore.

RECOMMENDATION #3

Wrack harvesting

I. STRATEGIC HARVEST OF OFFSHORE ACCUMULATIONS OF WRACK

Wrack accumulations are often trapped by emergent seagrass beds which act as a barrier, significantly dampening water currents and water flow in the nearshore. As a consequence, the lake basin and nearshore zone are effectively two separate water bodies which experience very little mixing. This is a major contributing factor to poor water quality and ooze in the nearshore. Council has obtained approval from NSW Fisheries to double the wrack harvest and must put in place a rational plan for maximising benefit to the estuary. Seasonal strategic wrack harvesting could significantly improve water quality in the nearshore and reduce ooze formation through increased mixing with lake-basin water and improving water flow in the problematic nearshore zone. Strategic wrack harvesting could supplement routine operations that tend to focus on harvesting wrack from public foreshores of high amenity value. The rationale behind strategic wrack harvesting is to collect wrack from locations where prevailing winds will facilitate:

- Improved water flow into nearshore zones, particularly into problematic areas such as the western shores of Tuggerah Lakes
- Dispersal of wrack /macroalgae along shoreline

Wrack harvesting must be done in a way that minimises secondary effects such as damage to living seagrass, disturbance of ooze and oozey sediments, damage to fringing saltmarsh. These issues are addressed further in the Wrack Harvesting Strategy (OEH Progress Report 4, June 2013 – Appendix 3).

II. SENSITIVE HARVEST OF WRACK FROM NEARSHORE AREAS

Large accumulations of wrack in nearshore areas impede water flow and trap nutrients, organic matter and sediments. It is therefore desirable to remove some of the wrack from nearshore areas, particularly from problem areas such as the protected western shores of Tuggerah and Budgewoi Lakes. Saturated wrack trapped at the water's edge (by modified shorelines) which is producing sulfidic odours (due to high nutrient inputs) should also be removed from recreational areas (e.g., Canton Beach) if site conditions allow. OEH has proposed new techniques to be investigated and trialed by Council which include:

- Moving trapped wrack onto shore where site conditions allow
- Skimming wrack from surface waters in nearshore to offshore waters (where the harvester can collect it)

These options are discussed in more detail in the Wrack Harvesting Strategy (OEH Progress Report 4, June 2013 – Appendix 3).

III. COMMUNITY HARVEST FOR COUNCIL COLLECTION

IV. Some residents who live on the foreshore are keen to improve the health and amenity of their patch of lake. Previously, council would collect wrack that was harvested by locals and taken to designated collection points. OEH recommends that Council educate community to minimize secondary impacts from wrack harvesting and then reinstate the policy to:

- Get the community involved with caring for the lakes
- Increase the communities 'ownership' of the lakes
- Help improve the condition of the nearshore zone in front of privately owned land

REALISTIC EXPECTATIONS OF TIMEFRAME OF OUTCOMES OF OOZE MANAGEMENT

Council need to be realistic in their expectation of outcomes arising from improved ooze management. At the worst affected sites, it is likely to take many years (5+ years) to see noticeable reductions in the standing stocks of black ooze and oozey sediments if council adopts ALL of the recommendations for ooze management. Strategic wrack harvesting and reduced nutrient inputs in stormwater could lead to improved water-flow and water quality in nearshore areas within a year or two. Water flow must be increased and nutrient concentrations must decrease before there can be a reduction in volumes of ooze or oozey sediment. If council does not adopt the recommendations in this document in a timely fashion, nearshore condition will deteriorate further under catchment pressure as the population and associated urban pollution continues to increase.

POINTS TO CONSIDER WITH REGARD TO SMALL-SCALE TARGETED REMOVAL OF OOZE FROM NEARSHORE AREAS

There may be some situations where targeted removal of ooze/oozey sediments from the nearshore is Council's favoured option for ooze management. OEH would only support small-scale targeted removal if it were done in combination with other management strategies that will reduce nutrient and sediment inputs to that area. There is absolutely no point in removing ooze/oozey sediments from a site and then continuing to allow stormwater pollution to impact on that site. Measures must be put in place to minimise impact on living seagrass and disturbance of nearby habitat if targeted removal of ooze sediments is planned.

GENERAL CONSIDERATIONS

- 'Ooze' is a very loosely defined term and is used to cover a wide range of sediment types found in the nearshore. Some 'ooze' sediments will contain higher concentrations of toxic or problematic materials, while others will consist largely of inorganic sediments. As such, the risk of adverse environmental impacts of removal should be assessed on a case by case basis by sampling and analysis of the material to be removed.

- Ooze sediments may also occur in areas supporting seagrass and macroalgal habitats. Any targeted removal should consider the direct disturbance of these communities and relevant permission should be obtained from NSW Fisheries.

- Ooze accumulations come and go around the lake on seasonal timescales. Targeted removal is only a short term fix (witness the very brief benefits of the Tuggerah Lakes Restoration Project in the early 1990s).

- The cost of targeted removal of ooze (short term treatment of symptoms) should be weighed against the cost of management measures aimed at reducing urban pollution to the nearshore and strategic wrack harvesting (longer term treatment of causes).

MANAGEMENT OF TARGETED REMOVAL OF OOZE SEDIMENTS

- The nature of sediments targeted for removal should be determined prior to the commencement of full scale works, to ensure it is ooze as defined in Appendix 1.

- The presence of neighbouring sensitive habitats (e.g. seagrass and saltmarsh) should be ascertained, and management strategies carried out to minimise impacts on these habitats.

- Deployment of sediment booms may be beneficial in reducing sediment plume impacts on neighbouring nearshore habitats.

- Prevailing weather conditions at the time of removal will determine the fate of dredge plumes. It would be beneficial to carry out sediment removal when conditions allow for the rapid dispersion of dredge plumes that escape sediment booms. Modelling by NSW OEH would aid in providing detail on this.

- There needs to be careful consideration given to the appropriate disposal of removed material. Due to its potentially high iron monosulfide, nutrient and heavy metal contaminant contents, removed spoil represents an environmentally hazardous material. Spoil that is allowed to drain on the shore, will be exposed to oxygen and become acidic, causing the leaching of contaminants to the surrounding area and groundwater.

CHEMISTRY OF OOZE

Materials of concern in ooze sediments include: hydrogen sulfides, iron monosulfides, high concentrations of nitrogen and phosphorus, and fines. The potential environmental impacts of these materials are covered separately below.

- *Sulfides* – These are produced as the by-product of the anaerobic breakdown of organic matter in the sediments. Hydrogen sulfide gas is responsible for the characteristic "rotten egg gas" smell associated with some ooze sediments. Hydrogen sulfide is toxic to aquatic biota and humans at high concentrations.

- *Iron monosulfides* – These are produced when hydrogen sulfide reacts with iron in the sediments and are responsible for the black, oozy quality. When iron monosulfides are disturbed and suspended in the water column (e.g. by dredging) they rapidly consume oxygen and produce acid. In poorly flushed areas this can result in catastrophic drops in dissolved oxygen and pH, ultimately leading to fish kills.

- *Nutrients* – ooze sediments that contain large amounts of organic matter will also contain high concentrations of inorganic nutrients resulting from the breakdown of organic matter by bacteria. Disturbance of ooze sediments by dredging will result in localised nutrient enrichment of the water column and nearby sediments. Under certain conditions (e.g. high temperatures and clear skies) this may cause localised macroalgal blooms.

- *Fines* – these include all inorganic and organic particles that cause high turbidity when disturbed. Plumes of disturbed ooze sediment will dramatically reduce light penetration to seagrass and macroalgae beds, which if sustained for an extended period (e.g. > 1 week) may result in dieback. Fines will also settle out and may smother some benthic communities.

- *Heavy metal and pesticide contaminants* – given that much of the ooze in Tuggerah Lakes nearshore constitutes a large fraction of urban-derived material it is likely that in some cases there may be potentially toxic contaminants present. It is not possible to make generalisations about this issue aside from saying that any targeted removal in areas where primary contact recreation occurs should be preceded with sampling to ascertain whether contaminants are present.

REFERENCES

Chapman, M.G. & Roberts, D.E. (2004) Use of seagrass wrack in restoring disturbed Australian saltmarshes. Ecological Management and Restoration 5(3): 183-190

Roberts, D.E. (2001) Tuggerah Lakes Estuary process Study. Report prepared for Wyong Shire Council

Sinclair Knight Mertz (SKM) (2010) 'Stormwater Improvement Strategy for Tuggerah Lakes'. Final Report prepared for Wyong Shire Council

APPENDIX 1 – FIELD GUIDE FOR QUICK ASSESSMENT OF SEDIMENT CONDITION AND OOZE TYPE

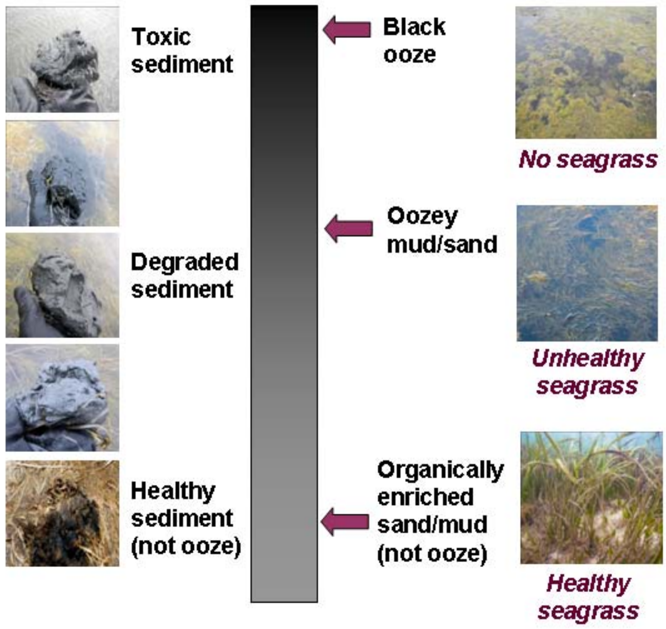

Figure 1 The Ooze Scale showing different types of sediments ranging from healthy sediment at the bottom to toxic sediment (black ooze) at the top of the scale. Black sediment and soft sediments that could be confused with ooze are shown at the bottom of the scale. Macrophytes (seagrass and macroalgae) commonly found in each sediment help to identify sediment type.

PPE Wear booties, latex/protective gloves, wet suit.

This technique is subjective and is suited for quick assessment only. If dredging operations are being considered at the site, laboratory analysis of sediment chemistry and composition is required

To assess the condition of sediments walk offshore and note

- Firmness of sediment, sediment type (sand, mud, clay)
- Depth of sediment. Insert a flat ruler/pole into sediment and record how far in it goes (before it hits hard sand)
- Presence and condition of seagrass and macroalgae

- If seagrass is of poor health then it could be growing in oozey sand/mud
- If seagrass is healthy then (soft) sediment is likely to be organically enriched sediment (may still be a dark colour and smelly)
- If there is no seagrass present, only free-floating macroalgae, then it may be black ooze

Not all soft sediments are necessarily oozey or unhealthy. It is quite common for sediments under seagrass beds to be soft because seagrass leaves trap fine sediments (silt) from the water column which accumulates in the sediment beneath. Similarly, soft sediments often occur near river and creek mouths due to fine sediments carried in tributaries from rural catchments.

IS IT OOZE? WHICH TYPE?

It is likely to be black ooze if

- Sediment releases intense rotten egg gas odour when it is disturbed or brought to the surface

  (If you have to hold it to your nose to smell it then it is not black ooze, it could be oozey mud/sand)
- It looks and feels gluggy. Sand/mud grains not visible
- No seagrass present
- Macroalgal blooms present, live and decaying
- Black plumes in water may indicate ooze (or oozey sediment if not too stinky)

If sediment releases black plumes and a strong odour as it is disturbed it may be black ooze. Black colour is from iron sulfides (FeS) but ooze can also be grey with low levels of FeS. Grey plumes with strong odour may indicate 'black' ooze. Smell is a better indicator of ooze than colour.

Photo 1 Examples of Black (and Grey) Ooze

It is likely to be oozey mud/sand (precursor to black ooze) if

- Very strong H_2S smell up close
- Gluggy/sticky, often darker layer at the surface of sediment
- Sand/mud grains visible

- Seagrass present but unhealthy
  - sparse growth form, epiphyte (algal) growth on leaves, loose attachment
- Macroalgae is abundant

A.  B. 

Photo 2 Examples of oozey mud (A) and oozey sand (B). Note abundance of macroalgae in the background

It is likely to be organically enriched sand/mud if

- Strong H_2S smell at close contact
- Sediment does not appear gluggy although it may be dark/black
- Seagrass present, relatively healthy appearance
  - Lots of leaves, low epiphyte load, firmly attached to sediment
- Macroalgae present but not excessive amounts

A.  B. 

Photo 3 Example of organically enriched sand (A - note healthy *Ruppia* bed in background) and black sediment (not ooze) under wrack drying on shore (B).

It is likely to be black sediment (or black wrack) and NOT black ooze if

- Higher on shore (above high-tide mark), often under dry wrack that is decomposing aerobically
- It does not have a strong H_2S odour. Black colour is from iron monosulfides (FeS) in sediment. Oxygen is available so H_2S is not produced

APPENDIX 2 – CONDITIONS LEADING TO, AND THE CHEMISTRY OF, ROTTEN EGG GAS (H2S) PRODUCTION

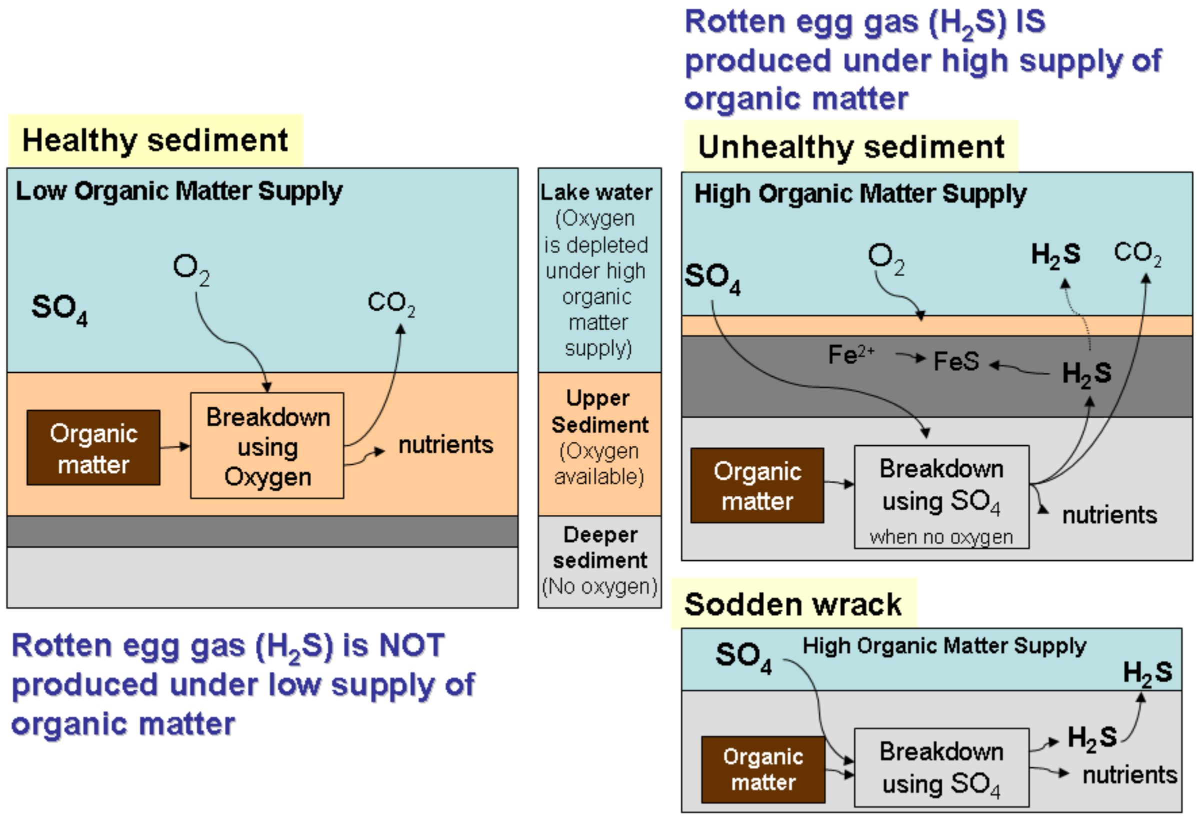

Figure 2 Chemistry of rotten egg gas production under high organic matter supply is shown on right hand side. Macroalgae are a primary source of organic matter in the nearshore