Department of Primary Industries
Department of Regional NSW

Healthy Estuaries for Healthy Oysters - Guidelines for development near waterways

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Acknowledgments

NSW DPI Food Authority

NSW Shellfish Committee

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For Further Information

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Referral of Local Environmental Plans (LEP) and development applications to the NSW Department of Primary Industries under clause 29 of the State Environmental Planning Policy (Primary Production) 2021 should be addressed to:

North Coast (Hastings River to Tweed River)

Fisheries Office - NSW Department of Primary Industries
1243 Bruxner Highway Wollongbar NSW 2477
Phone: 02 6626 1200

Central Coast (Manning River to Brisbane Water)

Fisheries Office - NSW Department of Primary Industries
Private Bag 1, Nelson Bay 2315
Phone: 02 4982 1232

Sydney North

Fisheries Office - NSW Department of Primary Industries
PO Box 1305, Crows Nest NSW 2065
Phone: 02 8437 4914

Sydney South

Fisheries Office - NSW Department of Primary Industries
1 Water Street, Sans Souci NSW 2219
Phone: 02 9529 6021

South Coast (Shoalhaven River to Wonboyn River)

Fisheries Office - NSW Department of Primary Industries
PO Box 97, Huskisson NSW 2540
Phone: 02 4428 3400

Current and historic water quality data collected under the NSW Shellfish Program may be obtained from:

Manager, NSW Shellfish Program
NSW Food Authority
PO Box 232, Taree NSW 2430
Phone: 1300 552 406
Email: nswsp@dpi.nsw.gov.au

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Purpose

> Oysters have been referred to as the "canary of the estuary" as a decline in their health present an early warning sign of river health problems (Healthy Rivers Commission, 2003, p.5).

The intended outcome of this document is to see development that protects the oyster industry and that estuarine water quality objectives are being met. Where water quality objectives are not being met, development should contribute to the objectives being met over time. For example, management actions must be implemented to address water quality objectives within a specified timeframe and subsequent monitoring indicates that desired targets have been achieved.

These outcomes will also result in improved estuarine health, increased amenity for tourism and improved conditions for recreational and commercial fisheries.

Councils, state government agencies, private landowners and developers use this document to assess and inform conditions on developments in close proximity to estuaries are compatible with the requirements of oyster aquaculture, including aquaculture of other bivalve shellfish such as mussels.

The New South Wales oyster industry is one of the state's most valuable seafood industries with a farm gate production value of approximately $55 million per annum in the 2021/2022 financial year. Oysters may be produced in 37 estuaries from the Tweed River in the north to Wonboyn Lake in the south (Figure 1).

Coastal aquaculture has a positive impact on regional employment, economic growth, tourism, provision of high-quality sustainable seafood, and supports the culture of coastal communities. The NSW general public believes the NSW seafood industry is important for local food security – 94% agree it is important we produce our own seafood in NSW. 96% of NSW coastal residents indicated that the desire to support their local community was a major motivation in purchasing local product (Barclay 2016). In 2021/2022 the industry supported 452 full time equivalent direct on farm jobs. Flow-on business activity was estimated to generate a further 293 full time equivalent jobs. The contribution of the industry to the gross state product (i.e., farming, processing, tourism, trade, food service and transport), including flow-on effects to other sectors of the state economy was $134.3 million (BDO EconSearch 2023).

On average, a farmed Sydney Rock Oyster will filter an estimated 250,000 litres of estuarine river water in its lifetime, removing large quantities of suspended material, chiefly nutrients bound in phytoplankton. This means that oysters are important in maintaining healthy estuaries but in performing this role they are exceedingly vulnerable to poor estuarine water quality.

These guidelines reflect the current objectives of management action (MA 7) of the *NSW Diffuse Source Water Pollution Strategy* (NSW DECC, 2009). This strategy identified pathogen levels exceeding the *Australia and New Zealand Environment and Conservation Council* (ANZECC) *Guidelines* as one of the top three priority problems from diffuse source water pollution in NSW.

In 2017, the Marine Estate Management Authority completed a state-wide evidence-based Threat and Risk Assessment for NSW marine estate (the TARA). The TARA identified water pollution and litter from diffuse sources and stormwater discharge as the number one threat to the marine estate.

Figure 1. Oyster aquaculture occurs in 37 estuaries within NSW. Tray aquaculture (top left), post supported long line aquaculture (top right) and floating bag aquaculture (bottom) are the most common forms of aquaculture infrastructure. Source NSW DPI.

Legislative context

Consent authorities

Under the State Environmental Planning Policy - Primary Production (SEPP PP) 2021, when considering land-based development applications that may affect a Priority Oyster Aquaculture Areas (POAA) or other oyster aquaculture areas, the consent authority (usually Council) must consider any issues that are likely to make the development incompatible with oyster aquaculture and evaluate any measures to avoid or minimise those issues. The consent authority refers development applications onto DPI Fisheries to assess and provide guidelines or conditions accordingly. Development consent may be refused if, in the opinion of the consent authority, the development is likely to have an adverse impact on an oyster aquaculture development that is being carried out in or outside of Priority Oyster Aquaculture Areas (POAA), or impact oyster aquaculture development that may in the future be carried out within a POAA. Broadly speaking, this referral and assessment process is a means to assess and mitigate point and diffuse source waterway pollution entering from catchments and/or land-based works.

The consent authority is also required to take into consideration the provisions of the *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS, Figure 2). OISAS is an Aquaculture Industry Development Plan for the purposes of s. 143 of the *Fisheries Management Act 1994*. OISAS establishes oyster industry best management practice standards which are supported by a commitment to environmentally sustainable practices.

OISAS identifies POAAs in each estuary and sets water quality objectives for these areas in line with the recommendations of the Healthy Rivers Commission (HRC, 2003). OISAS also identifies other oyster aquaculture areas such as leases on the National Park estate and leases on land controlled by the Merimbula Airport. It is a legislative requirement that POAA are mapped on publicly available resources. The DPI Fisheries Spatial Data Portal maps all POAA in NSW, and also provides the NSW Shellfish Program harvest area classification (Figure 4).

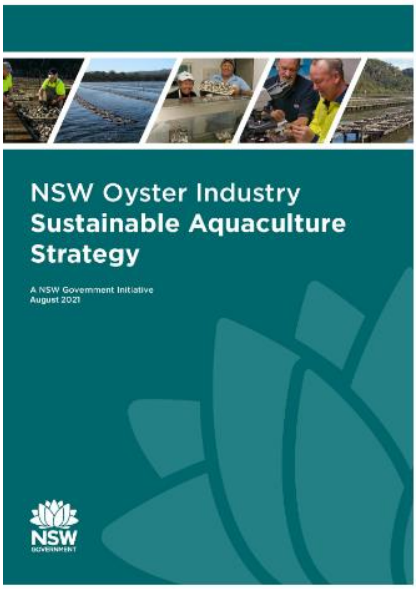

Figure 2. NSW Oyster Industry Sustainable Aquaculture Strategy

NSW Shellfish Program

Oyster production requires water quality that supports healthy oyster growth and results in a product that is safe for human consumption. If water quality declines, strict and costly food safety measures are imposed (e.g., depuration of oysters in tanks of sterilised water). While the causes of declining water quality are beyond the control of the oyster industry, industry operators bear the cost of the resulting food safety measures.

Oyster industry food safety is assured by the NSW Shellfish Program (Figure 3). This program is a compulsory, jointly industry and government funded program that classifies harvest areas on the basis of water quality and pollution source risks; establishes harvest management plans, and mandates post-harvest handling procedures.

The NSW Shellfish Program is based on international best practice and is administered by the NSW Food Authority under the *Food Act 2003*.

Figure 3. Oyster industry food safety is assured by the NSW Shellfish Program (NSW DPI, 2008)

Classification of Oyster Harvest Areas

Harvest area risk assessment (also known as a comprehensive sanitary survey) is the cornerstone of the NSW Shellfish Program. Each initial risk assessment is completed over a period of one to three years and results in each harvest area being classified as either approved, restricted or prohibited according to its sanitary status. The harvest area classification then determines the food safety controls to be applied to shellfish harvest from the area.

Approved harvest areas are not by default always open for harvest. They are subject to closure in prescribed environmental conditions. Specific harvest area management plans are

prepared for each harvest area which clearly identify the conditions under which a harvest area much close, and the conditions under which it can reopen.

Components of the Risk Assessment Process

- a shoreline survey which includes a thorough physical examination of the catchment area draining into the shellfish harvest area in order to identify any actual or potential sources of pollution that may adversely affect water quality.
- a bacteriological survey of the shellfish and growing waters, which provides quantitative data to examine and develop the preliminary findings of the shoreline survey.
- bacteriological and chemical analysis of shellfish from the area.
- an evaluation of the meteorological, hydrographic and geographic characteristics of the harvest area.
- an algal biotoxin risk assessment.
- an annual review of all components listed above to ensure that the classification and management plan remain appropriate

Oysters may be harvested from direct harvest areas and sold directly for human consumption without the additional cost of depuration, if the harvest area is in the 'OPEN' status. These areas are therefore the most valuable and sought-after areas for oyster aquaculture.

Harvest areas are mapped on the NSW DPI Fisheries Spatial Data Portal (Figure 4).

Figure 4. A screen shot of the DPI Fisheries Spatial Data Portal illustrating Priority Oyster Aquaculture Areas (red and yellow polygons) and NSW Food authority harvest area classification (red, orange, green overlay) in Port Stephens estuary.

Risk based framework

The Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (the Risk-based Framework) is a protocol that decision-makers can use to help manage the impacts of urban development and other land-use activities on waterways in New South Wales.

The Risk-based Framework can be used to:

- find out about community uses and values of waterways, and how to meet these values
- identify areas in waterways that need protection from water pollution
- protect aquatic ecosystems from pollution
- work out how to reduce development impacts on waterways, such as improved stormwater management around development sites
- ensure community expectations of waterways are considered in land-use planning
- support management of land-use development to achieve better socially and economically viable environmental performance.

The Framework brings together existing principles and guidelines recommended in the National Water Quality Management Strategy, which the federal and all state and territory governments have adopted for managing water quality. It allows decision-makers to determine management responses, which meet waterway health outcomes that reflect the community's environmental values and uses of waterways.

Management responses could include specific development controls for stormwater management, informing license limits for waterway discharges, or programs that raise awareness of land use activities that protect and enhance the health of rivers and creeks.

Many councils are already implementing some steps of the Framework, often in-house or in collaboration with state agencies, practitioners and industry experts.

Where is the Greatest Risk?

Development and activities that are likely to have an adverse effect on estuarine water quality and oyster aquaculture are best considered from the perspectives of location and type.

Developments and activities located in close proximity to a waterway which is part of the estuary's catchment will be more of a risk than those which are remote from a waterway.

As a guide, any development or activity within an estuary catchment that is located within 10 kilometres of an oyster aquaculture lease, or any development or activity that is located within 10 kilometres from where a waterway or drain enters an estuary that is within 10 kilometres of an oyster aquaculture lease is considered to represent a significant risk. However, some judgement is required. An intense development at 11 kilometres is of greater concern than a low impact development at 9 kilometres.

The following types of development are also more likely to present a risk to oyster aquaculture:

- subdivision of land where the future development created by the subdivision will rely on on-site sewage disposal;
- development that will rely on on-site disposal of wastewater effluent for example septic or pump-out facility systems;
- subdivision of land adjacent to a river or estuary or adjacent to foreshore Crown reserve or on land which is steep or erodible;
- development which involves a significant amount of earthmoving and soil exposure;

- development that includes small or private wastewater treatment plants where effluent might be discharged to or infiltrate to receiving water;
- reticulated wastewater systems with overflows or designated discharge points;
- biosolid, effluent or purified wastewater reuse schemes;
- development where significant volumes of organic or mineral fertiliser will be used or stockpiled in the open such as golf courses, turf farms, soil supplies, landscape supplies, nurseries and composting facilities;
- development that may limit marine access to Priority Oyster Aquaculture Areas (POAA);
- tourism and recreation-related development immediately adjacent to a POAA or other oyster aquaculture;
- marine-related development, including marinas, jetties, wharves, boat-launching ramps, boat repair facilities, charter and tourist boat facilities, boatsheds, moorings for visiting vessels, pump out facilities and commercial port facilities;
- intensive livestock industries, livestock processing facilities, animal boarding or training facilities, animal racetracks and stock or saleyards;
- development that lacks riparian vegetation along waterways;
- dredging or reclamation of tidal or subtidal areas; and
- development involving earthworks on potential or actual acid sulfate soil.

Water Quality Objectives

While sanitary water quality is the most important water quality parameter for oyster aquaculture food safety, a number of other water quality parameters are important to provide the necessary conditions for healthy oyster growth.

OISAS adopted the following water quality objective for oyster aquaculture areas in NSW:

Protecting water quality for safe human consumption and viable production of edible oysters.

The water quality guidelines for the production of oysters established in OISAS are designed specifically to meet this objective (Table 1).

Table 1: Water quality guidelines for oyster production in aquaculture areas.

Parameter	Guideline	Source
Faecal (thermotolerant) coliforms	90th percentile of randomly collected Faecal coliform samples do not exceed 43MPN/100ml or 21 MF/100mL	ASQAP Operations Manual (2019) and NSW Shellfish Industry Manual (2015)
pH	6.75 – 8.75	Schumway (1996)
Salinity	20.0 – 35.0 g/L	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000).
Suspended solids	<75mg/l	
Aluminium	<10µg/L	
Iron	<10µg/L	
Other parameters	For other parameters please refer to Section 4.4 and Section 9.4 of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)	

The oyster industry priorities for action are based on achieving a continual improvement in the classification and/or management regime of their harvest zones, improved oyster health and growth and reduced costs in operating the NSW Shellfish Program.

The priority of works to improve estuarine water quality that will benefit the oyster industry are:

1. works to prevent an imminent threat to downgrade estuary harvest classification to 'Prohibited';

   Under this scenario the Incident Response Protocol: Aquaculture Estuaries in NSW is triggered and a government led response activated;
2. works in areas where there is high potential to upgrade the estuary harvest classification to 'Approved';
3. works in areas where there is a low risk of a downgrade the estuary harvest classification to 'Prohibited' and high potential to ameliorate the risk; and
4. works in areas where there is a risk of downgrade the estuary harvest classification to 'Restricted' and high potential to ameliorate the risk and maintain 'Approved' status.

Resource	*Content*
NSW Department of Primary Industries (NSW DPI) 2021 *NSW Oyster Industry Sustainable Aquaculture Strategy* (OISAS). NSW DPI	The OISAS document and estuary maps are all available for download from this website.
NSW Food Authority 2018 *NSW Shellfish Industry Manual*, NSW Food Authority	All oysters and mussels in NSW are harvested in accordance with the NSW Shellfish Program, which has adopted the Australian Shellfish Quality Assurance Program (ASQAP) as a minimum standard.
Healthy Rivers Commission 2003 *Final report – HRC Review of the Relationship between Healthy Oysters and Healthy Rivers*. Healthy Rivers Commission, Sydney	This report investigates the relationship between estuarine health and the oyster industry and makes five recommendations essential to the health of oyster growing catchments.
Clarence Landcare 2011 *A Community Resource – Clarence Coast and Estuary Resource Kit*. Clarence Landcare	The kit explains basic estuary function and includes a detailed discussion of oysters as indicators of estuarine health.
NSW Office of Environment and Heritage and Environmental Protection Authority 2017 *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions*	This framework presents a structured approach that decision-makers, such as councils and environmental regulators, can use to help manage the impact of land-use activities on the health of waterways in New South Wales.

ESTUARY PROTECTION IN ACTION

DRAMATIC IMPROVEMENT IN WALLIS LAKE WATER QUALITY

Two decades ago, water quality in Wallis Lake deteriorated to the point where oyster harvest was prohibited. Business and the community suffered as the all-important tourism and seafood industries were abandoned by their customers. Now Wallis has some of the best water quality on the coast with all oyster harvest zones classified for direct harvest and average rainfall closure times reduced from ten days to four days. The turnaround is thanks to a sustained effort by Great Lakes Council with help from the then Catchment Management Authority as well as state and federal funding. Projects include a new on-site wastewater management inspection and compliance system, stormwater treatment and improved agricultural land use.

Risk Types and Mitigation Measures for New Developments

> Estuaries support a diverse range of functions and uses, and no use is more dependent on clean water and susceptible to pollution than oyster cultivation and harvest because its health is determined by the health of the water in which it grows (English, 2007, p12).

On-site Treatment and Disposal Systems

Applications for subdivision or development which rely on the on-site land application and dispersal of domestic wastewater in the vicinity of POAAs must be referred to NSW DPI. Poorly designed or incorrectly sited on-site systems may have an adverse impact on water quality and consequently, on the health of oysters or the consumers of those oysters.

These types of development applications must be accompanied by a detailed report which outlines the outcomes listed in Table 2. If this information is not provided, NSW DPI Fisheries may recommend that the consent authority refuse the application. This checklist and other information in this Section is based on Geary (2011).

On-site sewage management systems should be designed in accordance with *On-site Sewage Management for Single Households* and *AS/NZS 1547-2012 On-site Domestic Wastewater Management*.

When considering hydraulic load, the designer should conservatively use the higher potential rate if the household is connected to a reticulated water supply. A larger land area for the dispersal of effluent on-site is therefore needed in these circumstances (Table 3).

On-site wastewater systems should:

- have disinfection;
- have sub-surface dispersal of effluent;
- be located on hill crests or convex slopes;
- be greater than 100 metres from waterways;
- have a minimum depth of 600 millimetres to the water table;
- have high sun and wind exposure; and
- be located so as to not be affected by flooding, surface wetness or erosion.

Table 2: On-site wastewater management system checklist.

Does the on-site wastewater management system report provide:	Y	N
• Details of the relevant development control plans (DCP) or regulatory guideline used in the preparation of the report.		
• A detailed land capability study that determines the type and depth of soil, the hydraulic properties of the soil, the location of the water table, the slope of the land, the 1:100 year and 1:20 flood contour.		
• Details of the type of on-site wastewater treatment system being proposed, the means of utilisation or dispersal of the final effluent, the basis for selection relative to other available systems,		
• The hydraulic load to the system, the design loading rate (DLR) or the design irrigation rate (DIR).		
• Identify the proposed land application area for the treated wastewater and show how this area was calculated.		
• A dimensioned site plan (to scale) showing:		
o the location of the proposed system, dispersal area and diversion drains or soil berms;		
o soil types;		
o property boundaries'		
o the distance to any POAA or other oyster aquaculture and waterways;		
o topography and the 1:100 year and 1:20 flood contour;		
o any visible signs of surface dampness, such as moisture-tolerant vegetation and seepages, soaks and springs;		
o any signs of erosion e.g. rills, gullies, mass movement, slope failure; and		
o an analysis of the potential impacts of the on-site wastewater system on the sanitary water quality of any POAAs or other oyster aquaculture areas.		
Is the design loading rate (DLR) or the design irrigation rate (DIR) for the effluent from the proposed on-site wastewater system appropriate for the type of soil described (refer to **Table 3**)		
Is the proposed on-site wastewater system likely to have a limitation associated with flooding?		
Does the dispersal area have high sun and wind exposure?		
Are there proposed stormwater management measures in place, including any proposal to divert stormwater around the site?		
Are there mitigation measures proposed to prevent any adverse and cumulative impacts to the sanitary water quality of POAAs?		
Does the system and dispersal area meet minimum buffer distance of 100 m from waterways?		
Is there a minimum depth to groundwater of at least 600 mm below the dispersal area OR is raised mound proposed?		
Are the treatment system, tanks, vents, openings, and electrical components above 1 in 100 year flood contour and is the dispersal area above 1 in 20 year flood contour?		
Is disinfection included in the proposed system or is the exclusion of disinfection justified?		

Table 3: Typical Conservative Design Loading Rates (Source: Adapted from AS/NZS1547:2012).

Soil Texture	Land Application System Type			
	Absorption trenches and beds (mm/day)	Evapotranspiration beds (water balance calculation required) (mm/day)	Surface mounds (mm/day)	Irrigation (DIR) (mm/week) Different unit
Gravels and sands	20	N/A		35
Sandy loams	15 - 20	N/A	24	35
Loams	10 - 15	N/A	16	28
Clay loams	4 - 10	5 – 12	8	25
Light clays	* - 5	5 – 8		20
Medium heavy clays	*	5	*	15

Resource	*Content*
Standards Australia 2012 *AS/NZS 1547-2012 On-site Domestic Wastewater Management*.	Sets out the requirements for primary and secondary treatment units for individuals and agencies involved in the management of domestic on-site wastewater. Accommodates current legislative requirements.
NSW Ministry of Health 2018. Secondary Treatment System Accreditation Guideline.	This guideline sets out the minimum requirements for accreditation, by the NSW Ministry of Health, of a type of secondary treatment system which are generally available for purchase by retail. Treated sewage is recycled for types of irrigation.
NSW Department of Local Government 1998 *Environment and Health Protection Guidelines - On-site Sewage Management for Single Households*	Developed to help local councils assess, regulate and manage the selection, design, installation, operation and maintenance of single household on-site sewage management systems.
NSW Department of Local Government 2000 *The Easy Septic Guide (Septic Safe)*. Social Change Media for the NSW Department of Local Government	Guidelines for individual property owners on the installation, operation and maintenance of on-site sewerage systems.

Waterless Composting Toilets

Waterless composting toilets use the principle of composting to break down human excreta to a humus-type material. The liquid fraction is evaporated or directed to an appropriate management system.

Households relying on waterless composting toilets require a separate system for the treatment and dispersal of greywater. NSW DPI recommends that these systems meet the requirements for on-site treatment and disposal given in Section 2.1. Any liquid discharged

from a waterless composting toilet should be processed and disposed of through the greywater system.

Composted humus must be managed according to *Onsite Domestic Wastewater Treatment Units Part 2: Waterless Composting Toilets* (ANZS 1546.2-2008) and must not be buried within a 100-metre buffer distance from waterways.

Resource	*Content*
Standards Australia and Standards New Zealand 2008 *AS/NZS 1546.2-2008 Onsite Domestic Wastewater Treatment Units Part 2: Waterless Composting Toilets*	Sets standards for waterless composting toilet construction, operation and humus management.
NSW Health *Waterless Composting Toilets (WCT) Accreditation Guideline* 2010	Provides a set of performance statements which define the requirements for WCT's; a performance evaluation test against which any WCT, conventional or innovative, may be assessed; and details for manufacturers of WCT's to enable product accreditation by an independent third party.

Pump Out Wastewater Management Systems

Pump out systems are those where effluent is collected in an on-site tank (or tanks) for periodic removal by a tanker truck. Pump out systems may be operated on the basis of a pay for use scheme i.e. the cost is based on the volume of effluent removed or on the basis of a flat rate charge for a regular removal service.

The former option may be prone to abuse as homeowners or occupiers are charged as long as effluent is generated and removed from the household. This system provides an incentive to householders to discharge effluent illegally, particularly following periods of high water usage or when there is a shortage of money in the household. Pump out may also be an issue if the property is later sold and occupied by a tenant who does not wish to or has difficulty paying for effluent disposal from the household.

A flat rate charge for a regular removal service effectively removes many of these problems and is the preferred pump-out management system. However, this system will inevitably be more expensive for low use households and does not encourage water conservation.

Any applications which rely on the regular pump-out removal of effluent from the property will need to demonstrate to NSW DPI that there are no other feasible on-site land management or dispersal options and that the removal of effluent by pump out can be appropriately managed for the longer term.

To reduce the risk of over flows affecting oyster aquaculture the top of any pump out tank must be clear of the 1:100 year flood level and the tank must be fitted with a high water alarm.

Reticulated Wastewater Management Systems

New reticulated sewage treatment systems within the same catchment or within 10 kilometres flow to a POAA or oyster aquaculture should:

- be designed so that they do not discharge to waterways due to overflows in dry weather and wet weather overflows should be minimised; and
- incorporate measures such as telemetry, storage, back-up systems and power sources. As well, operators should have emergency response systems in place and ensure that sufficient spare parts are available to ensure that breakdowns can be fixed before overflows occur.

Resource	*Content*
NSW Environment Protection Authority 2003 *Licensing Guidelines for Sewage Treatment Systems*	Large sewage treatment plants and reticulation systems are a scheduled activity under the *Protection of the Environment Operations Act 1997* (POEO Act). An EPA licence regulates both sewage treatment plant discharges and discharges (overflows) from the sewage reticulation system. Smaller systems also require a licence if they discharge to waters.

Subdivision and Development Adjacent to a Waterway

Development adjacent to any estuary or estuarine waterway may have a detrimental impact on that waterway through soil erosion; the removal of vegetation, particularly riparian vegetation; disturbance of acid sulfate soils and faecal contamination associated with poorly performing and/or poorly designed on-site wastewater disposal systems. The close proximity of development to receiving waters, steep slopes and erosion prone soil all increase the risk of impact.

The design of the subdivision layout is critically important to protecting water quality. Road and street surfaces readily convey sediment and nutrients into waterways when they slope downwards towards drainage lines and gullies. To minimise the risk, the road and street network should follow the contours of the land to the greatest extent possible and reduce the number of waterway crossings to the minimum required for safety. Where waterway crossings are unavoidable, the approaches to the crossing should slope uphill so that runoff water is directed away from the waterway.

The quality and width of riparian vegetation is a key factor in protecting against these risks. It slows the overland movement of water, and traps sediment and attached nutrients before they reach the waterway. Riparian vegetation can also take up and remove some of the nutrients being transported. This vegetation also uses significant quantities of sub-surface waters and can therefore influence groundwater flows and the nutrients, salt or other substances that may be entering waterways by this route.

In general, development should not occur on or within a buffer zone to the banks of waterways, or on adjacent areas to the bank up to the highest astronomical tide, unless there

is a specific requirement for it to be there. This mitigates potential impacts from development on mangrove and saltmarsh systems which are important in bank stabilisation and water quality.

To reduce the risk of subdivision and development adjacent to a waterway impacting on estuarine health and oyster harvest zone classification and management:

- where possible an environmental protection zone adjacent to estuarine foreshores should be established in the Local Environmental Plan;
- any new subdivision adjacent to an estuarine waterway (to Highest Astronomical Tide) should include a minimum 100 metres vegetated riparian zone buffer;
- removal of native riparian vegetation should be avoided where possible. Any planted riparian vegetation associated with subdivision and development should comprise locally appropriate Australian native species;
- subdivision should incorporate Water Sensitive Urban Design with particular emphasis upon stormwater capture and treatment prior to discharge;
- Water Sensitive Urban Design (WSUD) measures should be maintained to manufacturers specifications over time, including the post development period;
- new subdivisions should not be designed to rely on historical farm drains for drainage. Such drains often intersect acid sulfate soils. New urban proposals should aim to install new appropriately designed drains that do not have adverse impacts for oyster aquaculture and other estuarine uses that rely on favourable water quality;
- subdivision should utilise a reticulated wastewater management system where possible. The system should be designed and constructed so that overflows into waterways (particularly in proximity to oyster aquaculture areas) are avoided;
- subdivision and development involving excavation should be avoided in areas with high potential for acid sulfate soils, or an acid sulfate soil management plan should be prepared and implemented if this can't be avoided;
- a water quality monitoring program should be designed and implemented to demonstrate that OISAS water quality objectives (refer to Table 1) are met pre- and post-construction;
- plan and implement erosion and sediment control and consider independent auditing of large subdivision sites.

The subdivision of rural land to create rural residential lots usually results in an intensification of land use. New residents to these areas need to develop the skills to manage land within its capability so that denuded and/or overstocked areas that produce rainfall run-off high in sediment and faeces are avoided. Improving landholder's knowledge of best practice construction and maintenance of unsealed tracks and driveways is also important. Technical and extension advice on animal husbandry, land management and dam construction should be sought from NSW DPI, other agencies (e.g., Local Land Services) and consultants.

Some resources relevant to the importance, establishment and management of riparian vegetation and rural residential sub-division are listed on the next page.

Resource	*Content*
NSW DPI Local Land Services 2020 *Rural living handbook*	A guide aimed at rural landholders that takes you through some of the major aspects of buying and managing a property as well as living and working in a rural area.
Lovett, S. and Price, P. 2007 *Principles for Riparian Lands Management*. Land and Water Australia, Canberra	Best Practice guidelines for river and riparian management. These are central reference documents for most catchment management organisations in Australia. They are aimed at a more technical audience.
Staton, J. & O'Sullivan, J. 2019. *Stock and Waterways: a NSW Manager's Guide*	This Guide has been developed in conjunction with farmers and practitioners in different parts of New South Wales to improve the on-farm management of riparian land (the land that runs alongside waterways).
Bennett, J. *et al* 2002 *Guidelines for Protecting Australian Waterways*. Land and Water Australia, Canberra	The guidelines are available through Land and Water Australia's National Riparian Lands Research and Development Program. Land and Water Australia is a statutory research and development corporation within the Department of Agriculture and Water Resources.
NSW Department of Primary Industries 2020 *Living and working on a riverbank*.	This fact sheet provides general guidelines about responsible use of the riverbank including for development and when managing livestock.
Department of Planning and environment – Water. *Guidelines for controlled activities on waterfront Land - Riparian corridors*	Provides information about rules applying to development classified as a controlled activity in the riparian corridor, and approvals.
NSW Department of Primary Industries 2005 *Degradation of native riparian vegetation along NSW watercourses*. Primefact 12	Summarises requirements associated with listing of 'degradation of native riparian vegetation along NSW water courses' as a key threatening process under the *Fisheries Management Act 1994*.

Biosolid or Effluent Re-use Schemes

The re-use of effluent and biosolids has many benefits such as replacing water that otherwise would be taken from rivers and wetlands, improving soils, reducing pressure on landfill sites and reducing the need for mineral fertilisers.

However, biosolids and effluent may contain chemicals, endocrine disrupters, hormones and pathogenic microorganisms that pose a risk to estuarine health, public health and oyster harvest zone classification and management unless they are managed appropriately.

These risks can be minimised by ensuring that:

- the level of treatment of the effluent/biosolids is consistent with the protection of a highly sensitive receiving environment. An added risk reduction measure in close proximity to oyster aquaculture is to provide disinfection;
- effluent irrigation is only undertaken in areas that are deemed suitable for irrigation based on an analysis of soil capability, surface flows and groundwater conditions;

- separation distances and buffer zones are consistent with the protection of a highly sensitive receiving environment and should include a minimum 100 metres vegetated riparian zone buffer;
- good practice includes utilising irrigation schedules that are based on measurements of soil moisture and knowledge of the water requirements of the crop in order to avoid the application site being overloaded, where possible;
- stormwater and tailwater leaving the irrigation area is collected in an appropriate collection system for reuse; and
- the system has adequate capacity to store effluent during wet weather.

Regular water quality monitoring both pre- and post-development may also be required to ensure that the OISAS water quality objectives set out in Table 1 are not compromised.

Guidelines for the appropriate design, operation and monitoring of biosolid and effluent re-use schemes are listed below.

Resource	*Content*
NRMMC, EPHC and AHMC 2006 *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*	Details a proactive risk management approach to protecting public health and the environment in the design of a recycling scheme.
NSW Department of Primary Industries 2004 *Landform and Soil Requirements for Biosolids and Effluent Reuse*. AgNote ISSN 1034-6848	Provides four landform and soil suitability tables which aim to identify appropriate sites for biosolids or effluent reuse and eliminate inappropriate sites.
Department of Environment and Conservation 2004 *Environmental Guidelines: Use of Effluent by Irrigation*	Details principles and objectives that should be considered when establishing an irrigation system that uses effluent. The environmental objectives include protection of surface waters, groundwater, plant and animal health, and prevention of public health risks.
NSW Environment Protection Authority, 2000 *Environmental Guidelines: Use and Disposal of Biosolids Products*	Guidelines for the reuse of biosolids from municipal sewage treatment processes in direct land applications (the direct application of biosolids to large tracts of land). For use by regulators, producers and users of biosolids.

Development that relies on Fertilisers or Pesticides

Fertilisers exported from a development in run-off may result in algal blooms, native vegetation dieback and weed growth in waterways. Similarly, pesticides can affect aquatic ecosystems by killing or affecting the growth and life expectancy of non-target plants and animals. If pesticides are misused they may bioaccumulate in the tissues of some organisms, including oysters.

The use of organic fertilisers such as manures has the added risk of being high in pathogenic microorganisms that pose a risk to estuarine health and oyster harvest zone classification and management.

These risks to aquatic ecosystems and oyster aquaculture can be minimised by ensuring that:

- a fertiliser and pesticide management plan is prepared by the proponent for approval by the consent authority and consideration by DPI Fisheries;
- pelletised processed organic fertiliser is preferred over raw manures. Raw manures should not be applied within 250 metres of a water course or drain;
- fertilisers and pesticides are applied according to product instructions and applied in appropriate weather conditions;
- fertilisers and pesticides are not applied within riparian buffer zones;
- apply fertiliser only if required, based on land capability assessment and soil test results;
- if applying nitrogen fertiliser use small amounts applied frequently to ensure appropriate absorption (rather than large amounts infrequently);
- groundcover is maintained in all areas, especially where phosphorus is being applied because it binds strongly with soil and can be readily transported into waterways; and
- contingency procedures be established for the event of failure of management procedures including remedial and restoration action.

Detailed guidelines regarding the appropriate use of fertilisers and pesticides are listed below.

Resource	*Content*
NSW Department of Primary Industries 2004b *Managing Soil Amendments and Fertilisers for a Cleaner Environment*. Agfact AC.29	Guidelines for managing soils, fertilisers and soil amendments to minimise detrimental environmental effects.
NSW Department of Primary Industries 2010 *Organic vegetable production - soil management and crop establishment – Prime Facts 803.* NSW DPI	Nitrogen and phosphorous are particularly prone to leaving the farm through leaching into groundwater and through direct run-off into waterways from heavy rainfall or over-irrigation so their use requires careful management. Appropriate management requires an understanding of the chemical and physical nature of soil type and its nutrient needs.
NSW Department of Primary Industries. 2005 *Fertilisers for Pastures*.	Guidelines on the use of fertilisers for farmers. Recommendations are made about the type and amounts of fertilisers required, nutrient interaction and environmental impacts. For example, small frequent applications of fertiliser nitrogen are recommended to minimise environmental and animal health problems.
Swan River Trust 2014 *Environmental Guidelines for the Establishment and Maintenance of Turf and Grassed Areas*	Provides information on the environmental issues associated with the establishment and maintenance of turfed and grassed areas such as golf courses, sports grounds, public open space etc.

Urban Stormwater

Urban catchments typically contain large areas of impervious surfaces that don't allow rain to soak into the ground. Rainfall then runs off quickly and takes with it suspended and dissolved contaminants (detergents, oils, pesticides, leaves, garden clippings and animal droppings) that are picked up in streets and gutters. In the worst case, urban stormwater can have similar levels of faecal contamination as raw sewage. Urban stormwater therefore poses both a chemical and pathogenic risk to estuarine water quality.

Stormwater is often not treated and usually flows directly into waterways. Gross pollution traps may be used to capture some of the sediment, sludge and solids but they do not stop dissolved contaminants entering the waterway. Constructed wetland treatment systems may be used as an additional level of treatment.

The other approach to the urban stormwater issue is to try to counteract the effect of the impervious urban landscape by using infiltration systems, grass swales instead of gutters, rainwater storage, stormwater storage and re-use systems.

This approach to urban development is a component of Water Sensitive Urban Design and its principles can be used to reduce the risk to estuarine water quality and oyster aquaculture from urban stormwater. The key principles are to:

- protect natural drainage systems;
- integrate stormwater treatment into the landscape;
- protect water quality;
- reduce run-off and peak flows; and
- minimise drainage infrastructure costs of development.

The majority of local councils have prepared guidelines and fact sheets about the concept of Water Sensitive Urban Design and how it can be implemented.

Specifically, to reduce the risk to oyster aquaculture:

- New urban development should be designed to ensure that stormwater management objectives are being met, and avoid reliance on existing post-agricultural draining infrastructure, or unkept infrastructure. Stormwater management objectives are outlined in *Managing Urban Stormwater: Council Handbook* (NSW EPA, 1997).
- Where possible, new urban development should be sited so that areas with higher export rates of pollutants are replaced with urban development incorporating best practice stormwater management. This approach can result in a net improvement in water quality;
- Prior to seeking development approval, a stormwater management plan should be prepared that details the drainage requirements of the area and design specifications for the planned stormwater management system. The system should include both measures to reduce the generation of contaminated stormwater and treatment systems for any discharges; and
- The stormwater management objectives should be referenced and the plan should demonstrate how these objectives will be met once the stormwater system is in operation.

Construction Erosion and Sediment Control

Uncontrolled run-off from construction sites can carry high concentrations of sediment into waterways. Sediment causes reduced light penetration through increasing the suspension of fine particles and turbidity. This in turn inhibits the growth of aquatic plants and algae; it can overwhelm filter feeders like oysters with inorganic particles and damage or clog their gills; smother bottom-dwelling animals and plants; and it can also act as a means of transport for other pollutants such as paints, oils, nutrients and pathogens.

The land forming stage of urban development is the highest risk stage, and often sediment controls are not adequate. It is therefore important to stage works, so that smaller areas of earth are exposed at the one time, implementing use of appropriate temporary basins and monitoring.

The *Protection of the Environment Operations Act 1997* (POEO Act) makes it an offence to allow waste materials to leak, spill or escape from a construction site or to place it where it may cause harm to the environment. *Managing Urban Stormwater: Soils and Construction* (*The Blue Book)* (Landcom, 2004) is one of the key guiding documents for the management of construction sites. NSW Department of Planning and Environment (2006) has also published *A Resource Guide for Local Councils: Erosion and Sediment Control* that provides practical information and resources for on-the-ground implementation of the *Blue Book*.

Many individual councils have prepared guidelines for the preparation of Erosion and Sediment Control Plans (ESCP) or Development Control Plans (DCP) that detail how sediment and erosion will be managed during construction.

Several Councils have taken part in the NSW DPI Fish Friendly Councils program workshops. The workshops look at ways Councils can manage and build structures and undertake works in and around waterways that are friendly for fish and protect water quality. The Fish Friendly Council program is a Marine Estate Management Strategy 2018 -2028 funded program.

The risks to aquatic ecosystems and oyster harvest zone classification and management from construction activities can be minimised by ensuring that:

- Erosion and sediment control measures are designed in accordance with *The Blue Book* (Landcom, 2004) and any sediment and erosion control guidelines or DCP produced by the relevant local council;
- All erosion and sediment controls in areas that may impact on estuaries and oyster aquaculture areas are designed with special reference to the sensitive nature of these environments;
- Councils recognise the high risk of construction sites located in these areas and give them a high priority for compliance inspections.

Resource	*Content*
Landcom 2004 *Managing Urban Stormwater: Soils and Construction.* Volume 1 (Fourth Edition) (Blue Book)	Provides guidelines regarding sediment and erosion control with the aim of mitigating the impacts of land disturbance activities on soils, landforms and receiving waters.

Development Affecting Acid Sulfate Soils

Acid sulfate soils are soils that contain iron sulfides. They are often found in low-lying areas such as floodplains surrounding estuaries and coastal lagoons (NSW DPI, 2007). If these soils are exposed to air though excavation or lowering of the water table, they can react with oxygen and produce sulfuric acid which in turn may be transported to the adjacent waterway. Direct impacts of these acid discharges to oysters include increased mortality, reduced growth, shell dissolution, reduced feeding activity and soft tissue damage (Dove & Sammut, 2007a; 2007b). Also, associated with acid discharges is high levels of iron and aluminium that may be toxic to oysters. It is also worth noting that some soil types (e.g., Yellow Pinch Soils in Bega Valley Shire) can discharge aluminium and significantly reduce pH even though they are not classified as acid sulfate soils.

Acid sulfate soil pollution is best managed at its source. This is continuing to be addressed in New South Wales through a cooperative approach between government, floodplain landowners, industry and researchers. Additionally, the majority of affected local councils have planning controls in place in the form of policies and LEP/DCP requirements.

To reduce the risk to oyster and estuary health, it is recommended that:

- Potential acid sulfate soils or other problematic soil types are identified at the proposal stage of developments;
- Disturbance or drainage of areas with high potential for acid sulfate soils is avoided;
- An acid sulfate soil management plan is prepared for developments that are likely to disturb acid sulfate soils. The plan should include:
  - A description of the soil and water attributes of the site;
  - A description of the acid sulfate soil management strategies to prevent oxidation of pyrite (avoiding disturbance of acid sulfate soil by excavation or changes to groundwater levels);
  - Treat or manage the acid sulfate soil (including burial, neutralisation and separation and treatment);
  - Prevent, control or minimise the escape of acid sulfate leachate to the surrounding environment;
  - Allow for the neutralisation of acid leachate from acid sulfate soils;
- A monitoring program for soil, surface and groundwater quality is implemented with sampling occurring both pre- and post-construction; and
- Contingency procedures be established for the event of failure of management procedures including remedial and restoration action.

Resource	*Content*
Dove, M.C. and J. Sammut 2007a Impacts of estuarine acidification on survival and growth of Sydney Rock Oysters *Saccostrea glomerata* (Gould, 1850). *Journal of Shellfish Research*, 26	Results of studies on the impacts of acid sulfate pollution on oysters.
Dove, M.C. and J. Sammut 2007b Histologic and feeding response of Sydney rock oysters, *Saccostrea glomerata*, to acid sulfate soil outflows. *Journal of Shellfish Research*, 26 (	Results of studies on the impacts of acid sulfate pollution on oysters
Johnston, S., Kroon, F., Slavich, P., Cibilic, A. and Bruce, A. 2003 *Restoring the Balance: Guidelines for Managing Floodgates and Drainage Systems on Coastal Floodplains*. NSW Agriculture, Wollongbar	Guidelines for local Government authorities, landholders, industry and community groups to improve environmental performance (reduce drainage of acidity) of coastal floodplain drainage systems.
National Working Party on Acid Sulfate Soils 2000 National Strategy for the Management of Coastal Acid Sulfate Soils	Economic, social, environmental and technical acid sulfate soils issues requiring a national approach, roles and responsibilities of various levels of government and community, and resources required.
NSW Acid Sulfate Soil Management Advisory Committee 1998 *Acid Sulfate Soils Manual*	Guidelines regarding planning, assessment and management of acid sulfate soils.
NSW Department of Planning and Environment *Acid Sulfide Soils Planning Maps*	Maps produced by the NSW Department of Planning and Environment and other relevant local councils.
NSW Department of Primary Industries 2007 *Oysters and Acid Sulfate Soil Pollution*. Primefact 591	A brief description of the effects of acid sulfate soil pollution on oysters. Includes suggestions for oyster industry on how to minimise effects.

Dredging and Reclamation

Dredging and reclamation works in an oyster producing estuary have the potential to affect oyster health and growth through increased turbidity and through the mobilisation of toxins if they exist in the disturbed area. Wild oyster spat collection operations can also potentially be affected by these activities. Re-suspension of sediments may also increase the levels of pathogenic microorganisms (such as *Vibrio sp.*) in the water column and subsequently in oysters.

Increased turbidity and the deterioration of other water quality parameters can lead to direct oyster injury and also to oyster stress which may result in secondary infections and oyster disease. Dredging and reclamation may also alter flow and tidal patterns and affect the suitability of an area for oyster aquaculture.

Note that a permit from NSW DPI and a licence from Crown Lands may be required for dredging and reclamation. NSW DPI's *Policy and Guidelines for Fish Habitat Conservation and*

Management (2013 update) sets out the assessment and licensing requirements associated with these activities.

To reduce the risk to oyster harvest zone classification and management, it is recommended that:

- A detailed assessment of the potential environmental effects on oyster aquaculture is undertaken;
- Dredging/reclamation be approved only where the activities are unlikely to:
  - Cause a deterioration in water quality;
  - Damage or destroy marine vegetation;
  - Damage or destroy riparian vegetation; or
  - Interfere with oyster aquaculture activities;
- Dredging and reclamation is not undertaken during oyster harvest periods (direct consultation with local oyster farmers will be required);
- Material to be dredged be tested for contaminants;
- Dredge spoil is not disposed of in the waterway but at a suitable offshore or onshore location;
- Spoil is not stockpiled within 50 metres of sensitive aquatic habitats and structures such as settlement ponds be constructed above mean high water mark and be secure from 1 in 10 year flood levels to ensure that entrained silt is not returned to the waterway;
- Dredging in shallow areas does not exceed a depth of -2.5 metres AHD. The bottom of the dredge area should be even, battered to a slope of 1 in 6 or less, and be free of holes;
- The dredging method used minimises environmental impact. For example, a cutter suction dredge generally causes less impact than a dragline; and
- Reclamation is not permitted if it covers marine or estuarine habitats such as mangroves, seagrass, saltmarsh, wetlands or rocky reefs.

Marine-related Development

Marine related development such as jetties, marinas, breakwalls, groynes and levees often requires foreshore reclamation, dredging or other works that disturb the natural aquatic habitat. NSW DPI's *Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update) sets out the assessment and licencing requirements associated with these activities.

Marine related development also has the potential to affect the activities of oyster aquaculture by affecting water quality or through increased adverse boating interactions such damage from boat generated wash.

To reduce the risk to oyster harvest zone classification and management, it is recommended that:

- New public and private wharves (unless for the purposes of oyster aquaculture in the subject lease), boat ramps, marinas or any other similar marine related development should not be located in areas where increased or concentrated boat traffic will affect access to, or operation of, oyster areas. A minimum distance from oyster aquaculture areas for these developments is 50 metres;

- Vessel sewage pump out facilities on public boat ramps and marinas in oyster growing areas are readily accessible, to encourage responsible waste disposal;
- New mooring areas or specific watercraft operation areas be located a minimum of 50 metres from any oyster aquaculture area;
- New designated swimming areas or public recreation areas be located a minimum of 50 metres from any oyster aquaculture area;
- Local oyster farmers are directly consulted about any other developments that may have an impact on their ability to carry out farming activities; and
- Marinas be designed so that there is a high rate of water exchange and have a water quality management plan.

Stormwater Management Plans

Council stormwater management plans and specific development stormwater management plans should take into consideration the protection of the local oyster aquaculture industry and make reference to OISAS water quality objectives. Stormwater management plans must also address soil management by undertaking a detailed soil analysis if the development is within 10 km of a Priority Oyster Aquaculture Area.

The presence of oyster aquaculture is a strong justification for prioritising stormwater remediation activities in that area.

Resource	*Content*
NSW Department of Primary Industries 2021 *Domestic waterfront structures strategies*.	A series of strategies, and video, that provides a new streamlined approach to assessing and granting consent for domestic waterfront structures.

Tourism and Residential Development

Residential or tourist developments that overlook existing oyster aquaculture areas need to consider the potential for conflict between the established oyster industry and new residents and visitors.

The oyster industry is an established part of the estuarine landscape in many estuaries in NSW (Figure 4) and is important to many regional economies. Historically, there have been issues with untidy and derelict lease infrastructure. The industry understands that this is an unacceptable practice and is working with NSW DPI and other agencies (e.g., Local Land Services) to rectify the problem. Between the years 2009 to 2016, 487 hectares consisting of 422 leases had been cleaned up, remediated and returned for public use.

Developers, new residents to the coast and visitors need to accept of the right of the oyster industry to continue to operate. Community members still have rights of access to the area for fishing and boating, however, it is an offence for a person to interfere with or damage lease structures or stock on the leased area.

It is recommended that:

- Developers of proposals in the visual catchment of oyster aquaculture be made aware that priority oyster aquaculture lease areas, whether occupied or vacant, have existing use rights and they will not be removed or altered as a result of subsequent residential or tourist development;
- Domestic waterfront structures (e.g., jetties) will not be permitted in POAAs, or within 50m of POAA;
- Any proposed development cannot impact on the current or future activities required to viably farm oysters in that area. This may include for example, reducing access or increasing marine related impacts; and
- The proponents of new development that overlooks oyster aquaculture areas must consider either filtering or blocking views in that direction or making a feature of it.

Intensive Agricultural Industries

New or expanding intensive agriculture industries have the potential to have a detrimental impact on water quality in oyster harvest areas, mainly through faecal contamination but also from sediment, fertilisers and pesticides, as well as hormones and antibiotics which can be endocrine disrupters.

All effluent management systems and other pollution controls in areas that may impact on estuaries and oyster aquaculture areas should be designed with special reference to the sensitive nature of these environments.

Under the Fisheries Management (General) Regulation 2019, it is illegal for livestock of any type to graze and trample marine vegetation (including saltmarsh and mangroves). A maximum penalty of $110,000 for an individual or $220,000 for a Corporation applies.

Specifically, it is recommended that:

- All runoff from production areas be diverted into a controlled drainage and effluent management system (this should include shed leachate, spent litter, manure storage areas and carcass composting areas) in order to prevent contaminated water entering streams;
- All clean water from overland flow or roof run-off be diverted away from intensive animal production areas in order to minimise contaminated runoff;
- Irrigation of treated effluent should be managed to avoid surface ponding and soil saturation which could lead to contamination of groundwater;
- A vegetated buffer zone be maintained between intensive animal activities and all waterways; and
- Where possible, stock should be removed from grazing pastures in wet conditions for 5-10 days in order to minimise pasture and soil damage, and erosion.

Resource	*Content*
NSW Department of Primary Industries 2004 *Managing Soil Amendments and Fertilisers for a Cleaner Environment*. Agfact AC.29	Guidelines for managing soils, fertilisers and soil amendments to minimise detrimental environmental effects.
Meat and Livestock Australia 2012 National Guideline Review *(3rd Edition)*	Provides a framework of acceptable principles for the establishment and operation of feedlots in Australia. Details environmental performance objectives regarding effluent and manure utilisation, land protection, groundwater and surface water protection and community amenity.
NSW Department of Primary Industries 2012 *Best Practice Management for Meat Chicken Production in NSW – Manual 1 – Site Selection and Development & Manual 2 – Meat Chicken Growing Management*	Guidelines for the planning, design, construction, operation and management of meat chicken farms in NSW. Addresses issues such as land-use conflicts between farmers and residents and increased potential for environmental impact as a result of increased intensification of production technology.
NSW Department of Primary Industries 2019 *Planning Guidelines – Intensive Livestock Agriculture Development*	Details requirements for a development application for intensive agriculture in NSW. Details environmental issues that will need to be addressed.
NSW Department of Primary Industries 2021 Primefact Responsible Pig Ownership. Primefact 712, Fourth edition	Provides a guide to legal requirements for keeping pigs, including links to information on how to manage effluent without pollution.
NSW Department of Primary Industries 2008 *Environmental management guidelines for the dairy industry*	Provides detailed information about planning process in NSW, design and best practice advice for managing the environmental impact of dairy facilities.
NSW Local Land Services. 2020 *Erosion and sediment control for blueberry growers. A best management practice guide*.	A guide that has been developed for the blueberry industry of the north coast of NSW, focusing on the management of soil and water resources, and erosion and sediment control.

ESTUARY PROTECTION IN ACTION

HAWKESBURY OYSTER FARMERS GET STUCK INTO IT

Hawkesbury River oyster growers are proving their estuarine stewardship credentials with clean-up and other estuarine restoration works under the Tide to Table Project. The local growers have been involved in the removal of derelict materials from abandoned oyster farming areas and the restoration of riparian vegetation with the local National Parks rangers. These clean-up activities have occurred in numerous estuaries across NSW.
A separate project is installing toilets in an uncontrolled camping area close to their most important oyster harvest zone. These projects are on top of their personal commitment to use only environmentally sustainable cultivation equipment and methods.

Rehabilitation of Existing Issues

> "Clean, unpolluted waters capable of sustaining and producing products acceptable to the domestic and overseas markets are an asset of inestimable value to an area" (submission to HRC, 2003, p2).

On-site Wastewater Management

Poorly performing on-site wastewater systems can introduce nutrients, pathogens and other micro-organisms into nearby waterways. Pollution incidents resulting from such systems have caused the closure of major oyster harvesting areas in some estuaries.

The *Easy Septic Guide (Septic Safe)* explains how to check if a septic system is working effectively and how to maintain a healthy system. It also describes the various septic systems available on the market.

Councils should aim to educate individual system owners on the effective operation of an on-site system. Some councils have developed specific fact sheets to do this (e.g., Bega Valley Shire Council and Griffith City Council have 13 factsheets available through their 'Get Septic Smart' campaign). Key requirements for effective operation are:

- Having septic tanks de-sludged every three to five years to prevent sludge build up, which may block the pipes and absorption trenches;

- Having grease traps cleaned out regularly;
- Keeping a record of pumping, inspections and other maintenance;
- Being aware of the location and layout of the system and land application area;
- Ensuring household products are suitable for use in an on-site system;
- Ensuring biodegradable liquid detergents are used (those with low phosphorus and low sodium); and
- Regularly maintaining the disposal area (long grass and weeds reduce the evapo-transpiration efficiency).

NSW Government regulations require that every septic system is registered with the relevant local council. This allows the council to manage and monitor the overall impact of septic systems in the drainage catchment.

On-site Sewage Management for Single Households by the NSW Department of Local Government (1998) addresses the environmental and public health performance requirements of on-site systems for councils. The document also provides administrative and technical guidance on how to comply with these requirements.

Local Council On-site Sewage Management Strategies

With limited resources, councils face challenges in the implementation of appropriate on-site sewage management (OSM) strategies. While all councils have an OSM strategy they differ greatly in effectiveness.

This Section details the common features of a *best practice* approach for councils that have the job of managing large numbers of onsite disposal systems within close proximity to POAA and demonstrates some innovative strategy features that councils have implemented.

Risk classification

Septic Safe is based on a risk management approach. OSM systems that are located in the same estuary catchment as a POAA, are within 10 kilometres of a POAA or other oyster aquaculture and are in close proximity to a waterway must be classified into the highest risk category.

A high performance system must still be classified high risk in these areas as the consequences of a failure are high.

Inspections – prioritising high risk systems

Inspection frequency must reflect the level of risk that a system poses. For instance, a high risk system should be inspected annually, while lower risk systems can be inspected less frequently.

If a system fails its inspection, the time in which the owner is required to complete upgrade works must also reflect the risk of a system. Owners of failing high risk systems should be given no more than 30 days to complete upgrade works.

Owners of high risk, or even medium risk, systems must never be allowed to self certify their own systems. If self certification is permitted for low risk systems, a targeted audit program should be introduced to ensure compliance.

Effective record keeping and information sharing

Perhaps the most important component of a successful OSM strategy is effective and efficient record keeping as the number of OSM systems in a Local Government Area can number in the thousands.

Whilst considering limitations under the *Privacy Act 1988*, such information must be made available to the NSW Food Authority.

Managing pump-out systems

DPI supports avoidance of domestic pump-out systems, unless in specialist circumstances and no other effluent management options exist. It is imperative to keep track of pump-out volumes and pump-out frequency so that compliance can be monitored and compliance action appropriately targeted.

If pump out is the only option, it is recommended that audio and visual alarms be installed on effluent collection wells, to alert occupants for the need of a sewage pump out, and that the collection well is no less than 100 m of a waterway, and installed by a qualified plumber, appropriately maintained to manufacturers specifications and operating as designed.

Funding the strategy

The implementation and operation of an OSM strategy that successfully protects public and ecosystem health can be a costly exercise and finding a reliable source of funding is a significant challenge for most councils.

The most straightforward way of sourcing funds is by requiring premises with OSM systems to contribute to the program (i.e. a fee system). However, the problem here obviously lies in gaining public support and acceptance. Educational initiatives would be crucial in gaining support from owners who are unlikely to appreciate added or rising costs to their OSM systems.

Impetus and support

Mid Coast Council (then Great Lakes Council) received strong community support when they introduced their OSM strategy, as it was done when immediate action was required to address the serious sewage contamination that occurred in Wallis Lake in 1997. This major public health incident resulted in the closure of significant oyster harvest areas, had a significant impact on the local tourism and seafood industries and proved to be a valuable lesson for regulators – that problems caused by failing OSM systems can quickly become a whole-of-community issue.

Taking a preventative approach to the management of OSM systems is paramount.

Reticulated Wastewater Management Systems

Overflows from existing reticulated wastewater management systems may occur during high rainfall events when rainwater infiltrates the pipes, as a result of pump or pipeline failure, or during electricity blackouts when pumps stop working. Most sewer systems are gravity systems and pipelines and pumping stations are often located close to waterways. As a result,

sewer overflows may introduce large volumes of untreated sewage directly into an estuary. Sewer overflows can be reduced by:

Overflows from existing reticulated wastewater management systems can be reduced by:

- cleaning and maintaining the system;
- reducing infiltration and inflow by fixing leaking or broken sewers lines;
- enlarging or upgrading sewers, pumping stations and sewage treatment plant capacity; and
- constructing wet weather storage to temporarily store flows.

Other actions that can be taken to manage overflows include:

- develop a 24 hour emergency response plan that includes immediate notification to the NSW Shellfish Program;
- use telemetry or dial-up systems to provide early advice of failure;
- use back-up pumps and controls;
- have standby/alternative power available; and
- ensure that spare parts are readily at hand (NSW EPA, 2003).

Further information is detailed in the resources list.

Urban Stormwater

Types of pollution transported by stormwater include soil particles, chemical substances such as detergents and oils, gross pollutants (e.g. paper, plastics and bottles) and natural material such as animal faeces, leaf litter and garden clippings. Many local councils undertake community education programs in an effort to make people aware of the impacts their activities can have on water quality. Taking care with everyday activities undertaken in an urban setting can substantially reduce the risks to sanitary water quality.

It is recommended that local councils and other relevant agencies inform the public to undertake the following activities routinely:

- collect and dispose of leaves, grass and other natural material so that it does not enter street gutters and drains;
- apply fertiliser and topsoil appropriately so that it does not blow or wash into the stormwater system;
- avoid the use of raw manures as fertiliser;
- dispose of litter appropriately;
    - wash cars, boats and caravans so that detergents and dirty water does not enter the stormwater system; and
    - collect and dispose of pet droppings appropriately so that it does not enter the stormwater system.

In most cases retrofitted stormwater treatment will be required. Gross pollutant traps may be used to capture gross pollutants and some of the sediment, sludge and solids but they do not stop dissolved contaminants entering the waterway. Constructed wetland treatment

systems, biofiltration and other water sensitive urban design devices may be used to add an additional level of treatment. These devices/measures should be maintained to the manufacturer's specifications where relevant, to ensure effective stormwater treatment over time.

Great Lakes Council and the Office of the Lake Macquarie Catchment Co-ordinator have implemented water quality improvement programs for Wallis Lake and Lake Macquarie respectively that have achieved impressive results. These two examples show what can be done with a concerted effort from government in partnership with the community. Refer to the resource list below for details of each of these programs.

Resource	*Content*
Great Lakes Council 2007. Healthy Lakes Program: *Structural Solutions for Urban Water Quality. Constructed wetland factsheet*	Improving water quality in Wallis, Smiths and Myall Lakes is the focus of the Coastal Catchments Initiative, a Federal Government funded project. The Coastal Catchments Initiative is a project managed by Great Lakes Council (now Mid Coast Council) that focuses on improving water quality and reducing pollution at the source.

Riparian Management Issues

Riparian vegetation acts as a filter strip, significantly reducing the amount of sediment and nutrient that reaches waterways. Maintaining these areas will ensure their long term beneficial effects.

Of particular importance in close proximity to oyster aquaculture is the management of stock in riparian zones. Uncontrolled access can lead to the area being denuded and defecation entering directly into the water. The pollution of waters is an offence under the POEO Act. Ideally, stock should be excluded, and alternate watering and shade provided well away from the riparian area.

The Department of Planning and Environment (DPE Water) is an independent regulator with a focus on water regulation, that administers the *Water Management Act 2000* (WM Act). The Water Group is required to assess the impact of any proposed controlled activity in the riparian zone, to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. Controlled activities are actions carried out on waterfront land, as defined in the WM Act. Waterfront land includes the bed of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary. This means that applicants must obtain a controlled activity approval from DPE

Water before commencing the controlled activity.

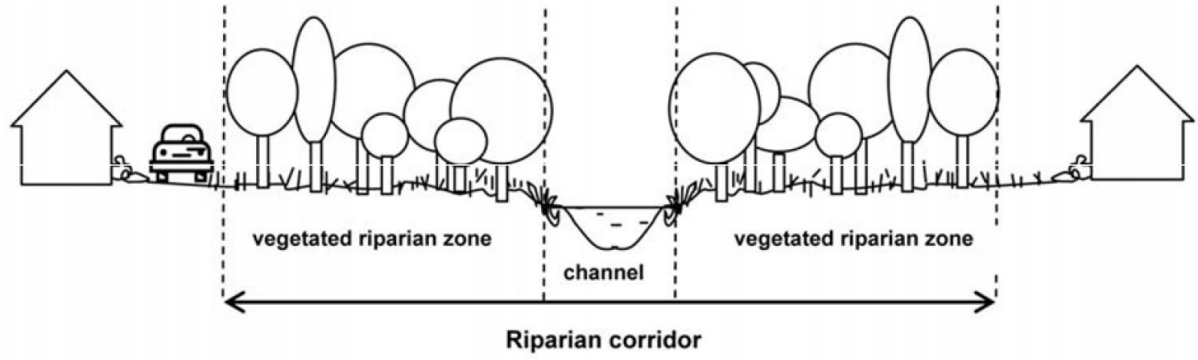

Figure 5: The riparian corridor. (Source: Department of Planning and Environment - Water).

For estuarine riparian zones, it is recommended that:

- Riparian areas be managed to maintain the health of existing native vegetation, encourage recruitment of juvenile trees and shrubs and incorporate weed control.
- The minimum width of Vegetated Riparian Zones (VRZ) is determined by the stream order (e.g., 3rd order stream have a minimum of 30m riparian zone, measured from the top of the high bank (the bank crest);
- Areas where little or no vegetation remains, be rehabilitated by replanting or by encouraging natural regeneration;
- Stock access to riparian areas be managed, alternative watering points be provided and alternate shade be provided; and
- Exotic vegetation be replaced with native vegetation (NSW DPI, 2005a).

A list of useful references and guidelines regarding the establishment and management of riparian areas is provided in Section 2.5.

Recreational Boating

Discharges

The *Marine Pollution Act 2012* and the *Marine Pollution Regulation 2014* (Marine Pollution Regulation) aims to improve the management of sewage pollution from vessels and simplify requirements with regard to sewage holding tanks.

Under the Marine Pollution Regulation, it is illegal to discharge raw sewage into the waters of NSW. Additionally, certain areas have been declared “no-discharge” zones for treated sewage. These include all inland waterways, intermittently opening lagoons, aquatic reserves and marine parks, and all waters within 500 metres of aquaculture, bathing, mooring and anchoring areas, persons in the water, beaches and marinas.

The Marine Pollution Regulation also requires that Class 1 (passenger-carrying commercial) and Class 4 (hire and drive) vessels be fitted with toilets and toilet waste holding tanks or have an approved plan of management for the disposal of waste. Recreational boaters with an onboard toilet should also install a holding tank.

Raw sewage from a holding tank or portable toilet should be deposited at appropriate pump-out facilities and never into NSW waterways. Public pump-out facilities are provided in many locations throughout NSW. Some marinas also provide private pump-out facilities for clients (NSW RMS, 2020).

Recreational vessel operators must ensure that they do not pollute waterways. Sound environmental practices on and around waterways include:

- option to include onboard, or small portable toilet with a holding tank. Houseboats must have an onboard toilet with a holding tank;
- collecting your rubbish on board and disposing of it properly ashore;
- wiping cooking utensils and plates clean with a paper towel before washing;
- using low or non-phosphate soaps in sinks and showers;
- keeping bilges clean to prevent pollutants being discharged overboard;
- removing your boat from the water and clean it in places where debris can be captured and disposed of properly and;
- avoiding the installation of courtesy moorings with 50m of POAA

Under the *Protection of the Environment Operations Act 1997,* NSW Roads and Maritime Services officers can issue on-the-spot infringement notices where cases of pollution from boats are detected.

Suggestions regarding how boat users can minimise their impacts are contained in *Leave Only Water in Your Wake* (NSW RMS, 2015). Suggestions include: avoiding spillages when filling fuel tanks, installing a holding tank or an approved on-board sewage treatment system and disposing of all rubbish properly ashore.

In areas where boating discharges are having a detrimental impact on water quality and the classification and management of oyster harvest zones it is recommended that:

- the need for holding tank pump-out facilities be considered, including during boat ramp upgrades;
- the need for providing on-shore toilets be considered;
- educational and warning signs be erected; and
- compliance activities be targeted to the areas if the problem persists.

Collision and Tie-up

It is an offence under the *Fisheries Management Act 1994* to interfere with aquaculture infrastructure on an aquaculture lease without the consent of the lessee. Tying a boat to posts, rails or any other infrastructure within an oyster lease is therefore prohibited. Collision and contact between boats and oyster lease infrastructure is also prohibited. Any damage must be reported to the local NSW DPI office as soon as possible.

Agriculture

Agricultural practices such as cropping and grazing can increase the rate of sediment production and the amount of sediment that enters waterways. Clearing and drainage can also affect the hydrological balance of catchments, the frequency and severity of flooding, the distribution and velocity of surface runoff, and groundwater levels. These activities will eventually have an effect on the ecological health of an estuary. Other practices such as allowing cattle to graze and water in the riparian zone, the use of dairy laneways, effluent reuse and the application of fertilisers and pesticides can also result in contaminated water reaching waterways.

General recommendations include:

- All agricultural activity in estuary catchments should be undertaken with reference to the sensitivity of the estuarine receiving water;
- Land-based farmers should get to know their local oyster farmers and Local Land Services Officers to work out ways all parties can benefit from improved land and riparian zone management;
- Vegetated buffer zones should be established adjacent to all waterways, rivers and drains by fencing;
- In mapped acid-sulfate soil areas, modify floodgates to allow exchange with estuarine water during non-flood periods;
- In mapped acid-sulfate soil areas, make drains shallower. Shallow dish drains minimise the potential of disturbing acid sulfate soils;
- Land based farmers should be aware of the increasing constraints from sea level rise on farm drainage within the lowest parts of the coastal floodplain and increasingly consider alternative land use options such as Blue Carbon initiatives.
- Construct and maintain farm roads, tracks and laneways to minimise run-off and soil erosion;
- Manage irrigation systems according to the soil's infiltration rate and other relevant factors in order to minimise soil-surface run-off;
- Where possible, avoid grazing and cultivation of steep slopes and rotate grazing pastures regularly to prevent stock camps and tracks forming;
- Establish off-stream watering points and design on-stream watering points to keep livestock off marine vegetation, and prevent damage to riparian vegetation and banks; and
- Maintain ground cover as much as possible to minimise run-off and erosion.
- Identify eroding gullies on properties and undertake specific earthworks options for stabilising active gully head erosion.

CLEAN COASTAL CATCHMENT PROJECT

Funded by the NSW Government Marine Estate Management Strategy (2018 – 2028), the Clean Coastal Catchments project aims to reduce nutrient and sediment run off from key coastal agricultural industries by working with growers, peak industry bodies and other key industry players to refine and promote best management practices for nutrients, water, and sediment in NSW coastal agriculture. An example of project outcomes is the incentive program to encourage adoption of Integrated Orchard Management Techniques that are key to improving drainage and groundcover and ultimately reducing erosion and sediment loss. Despite unprecedented rainfalls causing the 2022 floods in NSW, one case study site displayed no evidence of erosion, and run of water remained clean due to 100 percent living ground cover on orchard floors.

Resource	*Content*
Davies, H., Keating, J., Perry, M., Fraser, M., McPhee, D. and Presland, C. 2007 SPAT: *Southern Producers Achieving Together*. Southern Rivers Catchment Management Authority, NSW.	Case studies of land-based farmers, local oyster farmers and Local Land Services Officers working together to achieve improved land and riparian zone management.
Marine Estate Management Strategy 2018 – 2028 Clean Coastal Catchments website	Background about the Clean Coastal Catchments projects, and links to latest news, events, the Fertiliser Stewardship Newsletters and webinars.
NSW Department of Primary Industries Fish Friendly Farms website	See 7 Key Tips for a Fish Friendly Farm and also information on wetlands on farms
Department of Land and Water Conservation (DLWC) 1994 *Guidelines for the Construction and Maintenance of Tracks* (Brochure)	Outlines the principles of planning, constructing and maintaining tracks to minimise soil erosion and to control runoff.
Northern Rivers Catchment Management Authority 2005/2006 *Soil Erosion Solutions – Helping North Coast landholders reduce soil erosion* (*fact sheet)*	Guidelines to minimise erosion on farm roads and tracks.
NSW Department of Primary Industries 2019 *Sustaining the basin irrigated farm modernisation. Case studies in irrigation infrastructure improvement*	Case studies of water efficiency technologies, and economic and social benefits that have flowed through to irrigation farmers and rural towns and communities.
NSW Department of Primary Industries 2004 *Soil management for commercial vegetables and small crops*	Details how the correct rate and amount of water can be calculated. This is dependent upon the soil's infiltration rate. Too high an application rate will result in soil surface runoff.

Resource	*Content*
NSW Department of Primary Industries 2005b *Maintaining Groundcover to Reduce Erosion and Sustain Production*. AgFact P2.1.14	Explains importance of groundcover and how it can be used to minimise runoff and erosion.
NSW Department of Primary Industries and the Department of Natural Resources 2006 *Best Management Practices for Temperate Perennial Pastures in NSW*	Guidelines for sustainable management of grazing lands. For example, in order to ensure clean runoff into waterways: establish fenced vegetation buffer zones, avoid fertilising buffer areas, rotate graze pastures to prevent stock camps and tracks forming.
Croke, J. 2002 *Managing Phosphorus in Catchments*, Fact Sheet 11, Land and Water Australia, Canberra	Provides information about how and why phosphorus gets into waterways and what can be done to reduce this.
Land, Water and Wool 2006 *Rivers and Water Quality: Managing Rivers, Creeks and Streams – A Woolgrowers Guide*	These guidelines are tailored to different industry groups so that appropriate management of rivers and riparian areas can be integrated into on-farm management systems.
Lovett, S. and Price, P. 2001 *Managing Riparian Lands in the Sugar Industry. A Guide to Principles and Practices.* Sugar Research & Development Corporation / Land & Water Australia, Brisbane	The purpose of this Guide is to be a resource for people who work with the sugar industry to improve riparian land management on cane farms.
NSW Local Land Services. 2018 Gully Erosion Assessment and Control Guidelines.	Gully erosion is a leading contributor of sedimentation and poor water quality in the southeast of NSW. This guideline assists users identify if a gully is actively eroding, the severity of the erosion and outlines common management options.
Blue Carbon Project. 2021 A coastal wetland restoration first pass prioritisation for blue carbon and co-benefits in NSW.	Report focused on the ability of vegetated coastal ecosystems to act as a carbon sequestration and cycling service.
Sunshine Sugar. 2020 *The NSW sugar industry best practice guidelines for acid sulfate soils*	The intended purpose of this document is to provide guidelines, based on the best available information, for cane farmers with acid sulfate soils, to minimise any downstream impacts caused by acidity and monosulfidic black ooze.

Coastal Drains and Acid Discharges

Over the past 100 years, most of our coastal wetlands have been drained and floodgated for agricultural purposes. These low-lying areas are particularly susceptible to over-drainage and have led to the exposure of underlying acid sulfate soils. Subsequent oxidation of the iron pyrite within those soils has produced and exported vast quantities of sulfuric acid, with significant consequences for estuarine health, oyster aquaculture, commercial and recreational fishing and land-based agriculture. Peat fires are also far more likely when the land is drained and dries out.

An alternate approach is to return natural water flows to former wetlands and restore a wetland ecosystem. This approach has been used to rehabilitate the Darawakh/Frogalla wetlands on the Wallamba River and the Yarrahappini Wetlands on the Macleay River.

Studies funded by the Marine Estate Management Strategy have developed models and identified areas of NSW catchments that have been impacted by barriers to tidal exchange and land-use change in tidal wetlands which increase acid-sulfate soils and blackwater events. The models have identified coastal floodplains that would benefit most from efforts to reintroduce tidal inundation that could improve water quality associated with the reinstatement of a higher water tables and tidal exchange, inhibiting the activation of potential acid sulfate soils and reducing the frequency and intensity of black water events. These areas are mapped in the NSW DPI Fisheries Spatial Data Portal. Effort includes measures such as blocking drains to raise ground water levels and sustain fresh groundwater. Also, the implementation of 'smart' flood gates to manage tidal regimes may be required, as has occurred in wetland restoration projects across the Hunter River.

Resource	*Content*
Johnston, S., Kroon, F., Slavich, P., Cibilic, A. and Bruce, A. 2003 *Restoring the Balance: Guidelines for Managing Floodgates and Drainage Systems on Coastal Floodplains.* NSW Agriculture, Wollongbar	Guidelines for local government authorities, landholders, industry and community groups to improve environmental performance (reduce drainage of acidity) of coastal floodplain drainage systems.
Rogers, K., Lal, K., Asbridge, E., Dwyer, P. 2022 *Coastal wetland rehabilitation first-pass prioritisation for blue carbon and associated co-benefits.* Marine and Freshwater Research.	Discusses the ecosystem services provided by mangroves and saltmarshes, including the social and cultural co-benefits of using these ecosystems as a carbon storage tool.
Wetland Care Australia 2003 *Darawakh Creek and Frogalla Swamp Wetland Management Plan*	Discusses the issues of acid sulphate soils impacting on this catchment, and the success of the Darawakh Creek & Frogalla Swamp Wetland Management Plan.

ESTUARY PROTECTION IN ACTION

BELLINGER AND TILLIGERRY BACK IN BUSINESS

December 20, 2007 saw the lifting of oyster harvest closures from the Bellinger River and parts of Tilligerry Creek following the successful work of two interagency taskforces set-up by the NSW Department of Premiers and Cabinet. These taskforces investigated the source of the problem and facilitated the implementation of remedial actions. This model is now formalised in the Incident Response Protocol: Aquaculture Estuaries in NSW. The actions in these guidelines are directed towards preventing closures like this from occurring in the future.

Strategic Planning

> Oyster farmers are like any farmers, but what sets them apart is the area in which they farm, the estuary. Their paddocks are water, their livestock are hidden beneath and it is sometimes difficult to appreciate what they are producing until it appears on your plate (English, 2007, p12).

Local Environmental Plans and State Environmental Planning Policy (Primary Production 2021)

The impacts of past development of estuarine catchments (e.g. stormwater, septic seepage, sewerage outfalls) has, in many cases, resulted in a deterioration in the environmental conditions required for oyster cultivation.

To address this issue, the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) introduced provisions to ensure that oyster aquaculture is considered in the preparation of Local Environmental Plans (LEPs).

These provisions are designed to implement the Healthy River Commission recommendation (HRC, 2003) that regional and local planning processes for land and other resource uses should be specifically directed to achieve the protection of Priority Oyster Aquaculture Areas (POAA).

In accordance with the Standard Instrument – Principal Local Environmental Plan 2006, oyster aquaculture is permitted without consent in POAA in all Local Government Areas. POAA maps are published on the NSW DPI Fisheries Spatial Data Portal.

Under SEPP PP 2021, a consent authority may refuse to grant consent to development, if it is satisfied that the development will have an adverse effect on, or impede, or be incompatible with oyster aquaculture.

Where possible an environmental protection zone adjacent to estuarine foreshores should be established in the LEP.

Coastal Management Programs

Coastal management programs (CMPs) set the long-term strategy for the coordinated management of the coast, with a focus on achieving the objects and objectives of the *Coastal Management Act 2016* (CM Act).

CMPs identify coastal management issues and the actions required to address these issues in a strategic and integrated way. CMPs also detail how and when those actions are to be implemented, their costs and proposed cost-sharing arrangements and other viable funding mechanisms.

The CM Act (and other relevant legislation) establishes specific roles and responsibilities for relevant Ministers, the NSW Coastal Council, public authorities and local councils, as well as

providing opportunities for communities to participate when preparing and implementing a CMP.

Oyster farmers are a major stakeholder in the management of many estuaries (Figure 5). It is therefore important to include industry representatives when establishing CMP committees for an oyster producing estuary to ensure that the requirements and concerns of the industry are addressed. Oyster farmers may also be able to contribute important local knowledge regarding the estuary.

CMPs for oyster producing estuaries should include the aim of achieving OISAS water quality objectives as a major goal. Current and historic water quality data collected under the local NSW Shellfish Program may also be useful base data, available from the NSW Food Authority in consultation with local farmers. The CMP should also ensure that other management actions are compatible with the operation of the industry.

Figure 4: Oyster farmers are a major stakeholder in the management of many estuaries (Source: NSW DPI, 2008).

Marine Estate Management Strategy

The NSW Marine Estate Management Strategy 2018 - 2028 (MEMS) is the overarching framework for the NSW Government to coordinate the management of the marine estate, to protect and enhance our waterways, coastline and estuaries over the next ten years. Developed by the Marine Estate Management Authority, the Strategy underpins holistic and integrated management of the marine estate. The Strategy outlines how to protect and enhance our waterways, coastline and estuaries over the next ten years.

Informed by a state-wide Threat and Risk Assessment (TARA), the Strategy has nine management initiatives which correspond to the cumulative threat categories identified in the TARA process: environmental, social, cultural and economic threats. The initiatives include hundreds of programs that address issues such as water quality, estuary health and sustainable aquaculture.

The TARA process identified water pollution and litter from diffuse sources and stormwater discharge as the number one threat to the marine estate. In order to combat the impacts of urban and agricultural diffuse-source water, MEMS initiative 1 'Improving water quality and reducing litter' has several projects addressing water quality, including projects such as those in the Clean Coastal Catchments program (see 4.7), Fish Friendly Council workshop (see 3.9) oyster reef restoration projects (see next page), and the 'Riskbased Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions'. The water quality and litter programs aim to take action to stop water pollution and litter before it gets into waterways, including diffuse and point source pollution. Updates on MEMS programs are published on the MEMS website.

OYSTER REEF RESTORATION PROJECTS

The NSW Oyster Reef Restoration project is a key action under the NSW Marine Estate Management Strategy's (MEMS) Initiative 1 'Improving water quality and reducing litter'. The MEMS team has collaborated with project partners to deliver oyster reef restoration projects in Port Stephens, Botany Bay and Narooma, NSW. Oyster reefs are good for our waterways. They not only contribute to improved water quality but provide food and shelter for fish and other animals and protect shorelines from wave erosion. The project involves partnerships with NGOs and local Councils, and engagement with local oyster farmers, community and volunteers to co-develop, implement and monitor these projects.

The other eight MEMS initiatives include: delivering healthy coastal habitats with sustainable use and development, planning for climate change, protecting Aboriginal cultural values, reducing impacts on threatened and protected species, ensuring sustainable fishing and aquaculture, enabling and sustainable boating, enhancing social, cultural and economic benefits and delivering effective governance.

The program will provide annual progress reporting and a comprehensive review every five years.

Environmental Management Systems

The future of the oyster industry relies not only on a healthy environment, but also on the ability to demonstrate that farmers are utilising the environment in a responsible and sustainable manner. One way of doing this is to develop an Environmental Management System (EMS).

An EMS is a simple yet powerful approach where farmers identify environmental issues that pose a risk to their business and the wider catchment. The process systematically identifies, assesses and prioritises risks, and then constructs a plan to mitigate these risks. Such an approach increases industry resilience.

Risks can result from internal oyster farming practices (e.g. the continued use of tar and running inefficient 2-stroke outboards) but may also arise from external catchment based activities (e.g. livestock effluent in creeks and faulty sewerage pumping stations). Addressing these risks require farmers to work closely with other stakeholders, including Local Land Services (LLS), NSW DPI, local councils, other landholders and NPWS.

For an insight into how EMS has been effectively used by south coast growers, watch the South Coast Oyster Growers short documentary video.

OceanWatch Australia and the coastal LLS are actively involved with the industry and of 37 oyster producing estuaries in NSW, there are now 18 estuary-wide EMS documents in varying stages of development that outline local industry priorities for the future.

Once prepared, attention needs to be given to EMS implementation. South Coast oyster grower groups with the assistance of OceanWatch, Sapphire Coast Wilderness Oysters and the South East LLS employed Oyster EMS Implementation officers. These officers have enabled the smooth implementation of the estuary-wide EMS and assist the oyster industry make full use of their EMS in building the partnerships necessary to ensure the long-term sustainability of the local oyster industry.

Prioritising Actions

There are various management plans that include actions to improve estuarine water quality. They include estuary management plans, coastal management plans, Local Land Services strategic plans and stormwater management plans.

Inevitably, these plans propose actions that exceed the available budget for implementation and therefore actions need to be prioritised.

NSW DPI and the NSW Food Authority have prepared a risk assessment of all oyster harvest zones in NSW (NSW Food Authority, 2009 & 2017). This assessment includes recommendations for prioritising works based on this hierarchy.

ESTUARY PROTECTION IN ACTION

SHOALHAVEN OYSTER-DAIRY CO-OPERATION

The Shoalhaven Dairy – Oyster Partnership project was just one of the many on-ground projects undertaken as part of Southern Rivers CMA and South East Local Land Services Oyster Partnerships Program. In the Shoalhaven estuary alone, over 30 km of stock exclusion fencing along the lower Crook haven River adjacent to local oyster leases has been erected. This has resulted in improvements in local water quality, oyster harvest conditions and the protection of valuable mangrove and saltmarsh communities.
As well as the on-ground works associated with the project, constructive dialogue between the two primary producer groups has been initiated and is on-going. This has come as a result of field days, on-site meetings and working bees where oyster farmers have assisted the property owners in erecting the stock proof fences. Each industry now has a greater awareness and appreciation of the impacts of certain practices on the livelihoods of others.

Resource	*Content*
Marine Estate Management Strategy 2018 – 2028	The Marine Estate Management Strategy outlines how to protect and enhance our waterways, coastline and estuaries over the next ten years.
NSW Catchment Management Authority South Coast Oyster Growers video	A video presented by oyster farmers, discussing the importance of water quality on their product, and the direct benefits of Environmental Management Systems on their estuaries.
NSW Oysters Environmental Management Systems, OceanWatch Australia.	Information about the benefits of EMS, and how oyster farmers can use an EMS, and keep it up to date.

References

ARMCANZ and ANZECC., 1999. Effluent Management Guidelines for Intensive Piggeries in Australia and New Zealand.

Barclay, K., McIlgorm, A., Mazur, N., Voyer, M., Schnierer, S., Payne, A.M., 2016. Social and Economic Evaluation of NSW Coastal Aquaculture, Fisheries Research and Development Corporation (FRDC 2015/302) and University of Technology Sydney.

BDO EconSearch., 2023. Economic Contribution of Aquaculture to New South Wales. A Report for NSW Department of Primary Industries.

Bennett, J., Saunders, N., Moulton, D. and Phillips, N., 2002. Guidelines for Protecting Australian Waterways. Land and Water Australia, Canberra.

Blue Carbon Project., 2021. Blue Carbon Prioritisation Report.

Blunden, B. and Naylor, S., 1995. Assessing and Managing Acid Sulfate Soils: Guidelines for Land Management in NSW Coastal Areas. NSW Environmental Protection Authority

BMT WBM Pty Ltd., 2017. New South Wales Marine Estate. Threat and Risk Assessment Report. Produced for the NSW Marine Estate Management Authority.

Clarence Landcare., 2011. A Community Resource – Clarence Coast and Estuary Resource Kit. Clarence Landcare.

Croke, J., 2002. Managing Phosphorus in Catchments. Fact Sheet 11, Land and Water Australia, Canberra

Davidson, L. and Schwizer, B., 2001. Waterless Composting Toilets. Septic Safe Publication 01/11. NSW Department of Local Government.

Davies, H., Keating, J., Perry, M., Fraser, M., McPhee, D. and Presland, C., 2007. SPAT: Southern Producers Achieving Together. Southern Rivers Catchment Management Authority, NSW

Dela-Cruz J, Pik A and Wearne P., 2017. Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions. Office of Environment and Heritage and Environment Protection Authority, Sydney.

Department of Environment and Conservation, Department of Health, Department of Water and the Water Corporation., 2002. Western Australian Guidelines for Direct Land Application of Biosolids and Biosolids Products.

Department of Environment and Conservation., 2004. Environmental Guidelines: Use of Effluent by Irrigation.

Department of Land and Water Conservation (DLWC)., 1994. Guidelines for the Construction and Maintenance of Tracks (Brochure)

Department of Planning and Environment –Water., 2022. Guidelines for controlled activities on waterfront Land- Riparian Corridors.

Dove, M.C. and Sammut, J., 2007a. Impacts of estuarine acidification on survival and growth of Sydney rock oysters Saccostrea glomerate (Gould, 1850). Journal of Shellfish Research, 26.

Dove, M.C. and Sammut, J., 2007b. Histologic and feeding response of Sydney rock oysters, Saccostrea glomerata, to acid sulfate soil outflows. Journal of Shellfish Research, 26.

Dywer, P and Dengate, C., 2021. Breakwater maintenance and upgrades: multi-use and eco-features: guidance for asset owners, designers and project managers. NSW Department of Primary Industries.

English, N., 2007. A Community Resource Kit. Northern Rivers Catchment Management Authority. Grafton, NSW.

Environment Protection Authority (now DECC)., 2003. Licensing Guidelines for Sewage Treatment Systems.

FSA Environmental., 2003. Development of Indicators of Sustainability for Effluent Reuse in the Intensive Livestock Industries: Piggeries and Cattle Feedlots. Prepared for Australian Pork Limited, Meat and Livestock Australia and NSW Environment Protection Authority.

Geary, P., 2007. Oyster Industry Harvest Protection On-site Wastewater System Specifications. For NSW DPI, Port Stephens NSW.

Great Lakes Council., 2007. Healthy Lakes Program: Structural Solutions for Urban Water Quality. Constructed wetland factsheet

Havilah, E., Warren, H., Lawrie, R., Senn, A. and Milham, P., 2005. Fertilisers for Pastures. NSW NSW Department of Primary Industries.

Healthy Rivers Commission., 2003. Final report – HRC Review into the relationship between healthy oysters and healthy rivers. HRC, Sydney.

Johnston, S., Kroon, F., Slavich, P., Cibilic, A. and Bruce, A., 2003. Restoring the Balance: Guidelines for Managing Floodgates and Drainage Systems on Coastal Floodplains, NSW Agriculture, Wollongbar.

Land and Water Australia (Croke, J.)., 2002. Managing Phosphorus in Catchments, Fact Sheet 11.

Land and Water Australia., 2001. Guidelines: Wool Industry River Management Guide; Managing Riparian Lands in the Cotton Industry; Managing Riparian Lands in the Sugar Industry.

Land and Water Australia., 2002. Fact Sheets: Managing Riparian Land; Improving Water Quality; Managing Stock; Planning for River Restoration; Riparian Ecosystem Services; and Managing Riparian Widths.

Land, Water and Wool., 2006. Rivers and Water Quality: Managing Rivers, Creeks and Streams – A Woolgrowers Guide.

Landcom., 2004. Managing Urban Stormwater: Soils and Construction. Volume 1 (Fourth Edition) (Blue Book).

Lovett, S. and Price, P., 2001. Managing Riparian Lands in the Sugar Industry. A Guide to Principles and Practices. Sugar Research & Development Corporation / Land & Water Australia, Brisbane

Lovett, S. and Price, P., 2007. Principles for Riparian Lands Management. Land and Water Australia, Canberra

Marine Estate Management Strategy 2018 – 2028. Clean Coastal Catchments website

Meat and Livestock Australia., 2012. National Guidelines for Beef Cattle Feedlots in Australia (3rd Edition).

Murray Darling Basin Commission., 2001. Australian Code of Practice for On-farm Irrigation. Irrigation Association of Australia and NSW Agriculture

National Working Party on Acid Sulfate Soils., 2000. National Strategy for the Management of Coastal Acid Sulfate Soils.

Natural Resource Management Ministerial Council, Environment Protection and Heritage Council and Australian Health Ministers Conference., 2006. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1). National Water Quality Management Strategy.

Northern Rivers Catchment Management Authority 2005/2006. Soil Erosion Solutions – Helping North Coast landholders reduce soil erosion (fact sheet).

NRMMC, EPHC and AHMC., 2006. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1

NSW Acid Sulfate Soil Management Advisory Committee., 1998. Acid Sulfate Soils Manual.

NSW Agriculture (now NSW DPI)., 1996. Turf Farming – Guidelines for Consent Authorities in NSW.

NSW Agriculture (now NSW DPI)., 1997. Successful Plant Nursery Production – A Guide for New and Established Operators.

NSW Agriculture (now NSW DPI)., 1998. Policy for Sustainable Agriculture in New South Wales.

NSW Agriculture (now NSW DPI)., 2001. Environmental Management Guidelines for Growing Cut Flowers.

NSW Agriculture (now NSW DPI)., 2004. NSW Meat Chicken Farming Guidelines.

NSW Agriculture (now NSW DPI)., no date. Best Practice Guidelines for Growing Vegetables: Best Irrigation Practices.

NSW Agriculture (now NSW DPI)., no date. Best Practice Guidelines for Growing Vegetables: Best Crop Fertilisation Practices.

NSW Agriculture (now NSW DPI)., no date. Best Practice Guidelines for Growing Vegetables: Best Soil Management Practices.

NSW Catchment Management Authority., no date. South Coast Oyster Growers video.

NSW Department of Environment and Conservation (now NSW Department of Planning and Environment)., 2004. Environmental Guidelines: Use of Effluent by Irrigation.

NSW Department of Environment and Conservation (now NSW Department of Planning and Environment)., 2006. Considering Environmental Values of Water when Issuing Prevention Notices.

NSW Department of Environment and Conservation (now NSW Department of Planning and Environment)., 2009. NSW Diffuse Source Water Pollution Strategy. DECC, Sydney.

NSW Department of Local Government., 2000. The Easy Septic Guide (Septic Safe). Developed by Social Change Media for the NSW Department of Local Government.

NSW Department of Local Government.,1998. Environment and Health Protection Guidelines: On-Site Sewage Management for Single Households.

NSW Department of Planning and Environment., 2023. Acid Sulfide Soils Planning Maps.

NSW Department of Primary Industries and Northern Rivers Catchment Management Authority., 2007. Current Best Management Practices for Blueberry Growers in Northern NSW.

NSW Department of Primary Industries and the Department of Natural Resources., 2006. Best Management Practices for Temperate Perennial Pastures in NSW.

NSW Department of Primary Industries., 2001. Water Quality (Pesticides). Fishnote DF 93.

NSW Department of Primary Industries., 2002. Rabbit Farming: Planning and Development Control Guidelines.

NSW Department of Primary Industries., 2004. Landform and Soil Requirements for Biosolids and Effluent Reuse. AgNote ISSN 1034-6848.

NSW Department of Primary Industries., 2004. Managing Soil Amendments and Fertilisers for a Cleaner Environment. Agfact AC.29

NSW Department of Primary Industries., 2004. Soil management for commercial vegetables and small crops.

NSW Department of Primary Industries., 2004a. Landform and Soil Requirements for Biosolids and Effluent Reuse. AgNote ISSN 1034-6848

NSW Department of Primary Industries., 2004b. Managing Soil Amendments and Fertilisers for a Cleaner Environment. Agfact AC.29.

NSW Department of Primary Industries., 2005. Degradation of native riparian vegetation along NSW watercourses. Primefact 12

NSW Department of Primary Industries., 2005. Fertilisers for Pastures.

NSW Department of Primary Industries., 2005a. Degradation of native riparian vegetation along NSW watercourses. Primefact 12.

NSW Department of Primary Industries., 2005b. Maintaining Groundcover to Reduce Erosion and Sustain Production. AgFact P2.1.14

NSW Department of Primary Industries., 2006a. Preparing a development application for intensive agriculture in NSW. NSW DPI, Orange

NSW Department of Primary Industries., 2006b. Deep-litter Housing for Pigs. Primefact 68.

NSW Department of Primary Industries., 2007. Best Practice Guidelines for Using Poultry Litter on Pastures. Primefact 534.

NSW Department of Primary Industries., 2007. Oysters and Acid Sulfate Soil Pollution. PrimeFact 591

NSW Department of Primary Industries., 2008. Environmental management guidelines for the dairy industry.

NSW Department of Primary Industries., 2010. Organic vegetable production - soil management and crop establishment – Prime Facts 803. NSW DPI

NSW Department of Primary Industries., 2012. Best Practice Management for Meat Chicken Production in NSW – Manual 1 – Site Selection and Development & Manual 2 – Meat Chicken Growing Management.

NSW Department of Primary Industries., 2013. Policy and guidelines for fish habitat conservation and management. NSW DPI, Wollongbar.

NSW Department of Primary Industries., 2019. Planning Guidelines – Intensive Livestock Agriculture Development.

NSW Department of Primary Industries., 2019. Sustaining the basin irrigated farm modernisation. Case studies in irrigation infrastructure improvement.

NSW Department of Primary Industries., 2020. Living and working on a riverbank.

NSW Department of Primary Industries., 2021. Domestic waterfront structures strategies.

NSW Department of Primary Industries., 2021. NSW Oyster Industry Sustainable Aquaculture Strategy. NSW DPI.

NSW Department of Primary Industries., 2021. Primefact Responsible Pig Ownership. Primefact 712, Fourth edition.

NSW Department of Primary Industries., 2022. Domestic Waterfront Structures Land Owner's Consent Strategy (series).

NSW Department of Primary Industries., 2023. NSW Oyster Industry Sustainable Aquaculture Strategy. NSW DPI, Orange NSW.

NSW Environment Protection Authority., 2000. Environmental Guidelines: Use and Disposal of Biosolids Products.

NSW Environmental Protection Authority., 1997. Managing Urban Stormwater: Council Handbook, NSW EPA, Sydney.

NSW Environmental Protection Authority., 2003. Licensing Guidelines for Sewage Treatment Systems. EPA, Sydney.

NSW Food Authority., 2008. Final Report- HRC Review of the Relationship between Healthy Oysters and Healthy Rivers.

NSW Food Authority., 2009. Food safety risk assessment of New South Wales food safety schemes. NSW Food Authority.

NSW Food Authority., 2017. Risk Assessment of the Seafood Safety Scheme. NSW Food Authority.

NSW Government., 1998. Policy for Sustainable Agriculture in New South Wales. Published by NSW Agriculture (now NSW DPI).

NSW Health., 2010. Waterless Composting Toilets (WCT) Accreditation Guidelines.

NSW Local Land Services., 2018. Gully Erosion Assessment and Control Guidelines.

NSW Local Land Services., 2020. Erosion and sediment control for blueberry growers. A best management practice guide.

NSW Marine Estate Management Authority., 2018. Marine Estate Management Strategy 2018 – 2028.

NSW Office of Environment and Heritage, Environmental Protection Authority., 2017. Risk based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions.

NSW Oysters., no date. Environmental Management Systems. OceanWatch Australia.

NSW Roads and Maritime Services., 2015. Leave only water in your wake. NSW RMS.

NSW Roads and Maritime Services., 2020. Boating Handbook. NSW RMS.

Rogers, K., Lal, K., Asbridge, E., Dwyer, P., 2022. Coastal wetland rehabilitation first-pass prioritisation for blue carbon and associated co-benefits. Marine and Freshwater Research.

Shumway, S.E., 1996. The Eastern Oyster, Crassostrea virginica. Maryland Sea Grant College, University of Maryland System, College Park, Maryland, USA.

Standards Australia and Standards New Zealand., 2008. AS/NZS 1546.2-2008 Onsite Domestic Wastewater Treatment Units Part 2: Waterless Composting Toilets

Standards Australia., 2012. AS/NZS 1547:201200 On-site Domestic Wastewater Management.

Staton, J. and O'Sullivan, J., 2006. Stock and Waterways: A Managers Guide. Land and Water Australia, Canberra.

Sunshine Sugar., 2020. The NSW sugar industry best practice guidelines for acid sulfate soils.

Swan River Trust., 2014. Environmental Guidelines for the Establishment and Maintenance of Turf and Grassed Areas. Swan River Trust.

University of Wollongong Australia., 2021. A Coastal Wetland Restoration First Pass Prioritisation for Blue Carbon and Co-benefits in NSW. A NSW Marine Estate Management Authority program.

URS Australia Pty Ltd., 2004. Guidelines for Better Practice in Foreshore Works. Prepared for Department of Planning.

WA Department of Environmental Protection and Water & Rivers Commission Swan River Trust., 2014. Environmental Guidelines for the Establishment and Maintenance of Turf and Grassed Areas.

Water NSW., 2022. Neutral or Beneficial Effect on Water Quality Assessment Guideline. Water NSW, Sydney.

Wetland Care Australia., 2003. Darawakh Creek and Frogalla Swamp Wetland Management Plan.

White, I., 2001. Safeguarding Environmental Conditions for Oyster Cultivation in NSW. Report to Healthy Rivers Commission of New South Wales.