# Geography Year 12 fieldwork – Ecosystems and global biodiversity – Avoca Lagoon

**Note:** a comprehensive health and safety risk assessment is required for all school/work excursions and travel. Please visit [Excursions and travel](https://education.nsw.gov.au/inside-the-department/health-and-safety/risk-management/excursions-and-travel-health) for further guidance.

Controversial issues may be questions, subjects, topics or problems which create a difference of opinion, causing contention and debate within the school or the community. Controversial issues will differ across schools and communities.

In many of the topics covered within the HSIE syllabuses teachers are required to address controversial issues. Stage 6 geography has content that can be deemed controversial. As per the [Controversial issues in schools policy](https://education.nsw.gov.au/policy-library/policies/pd-2002-0045), teachers in HSIE must deliver lessons ensuring content is for ‘educational purposes consistent with the delivery of curriculum and provision of school programs and activities’.

The manner in which teachers approach the delivery of controversial issues in NSW public schools is guided by the Department of Education’s [Controversial issues in schools policy](https://education.nsw.gov.au/policy-library/policies/pd-2002-0045) and the [Code of Conduct policy](https://education.nsw.gov.au/rights-and-accountability/department-of-education-code-of-conduct). These documents call for a sensitive, objective and balanced approach to coverage of controversial issues. [Values in NSW public schools](https://education.nsw.gov.au/policy-library/policies/pd-2005-0131) is also a useful reference document which sets out the values to be promoted in classrooms.

## Syllabus focus area

This fieldwork resource is on the following syllabus focus area – **Ecosystems and global biodiversity**

### Outcomes

A student:

* **GE-12-01** analyses rural and urban places, ecosystems, global biodiversity and economic activity, for their characteristics, spatial patterns, interactions, and nature and extent of change over time
* **GE-12-02** analyses geographical processes and influences, at a range of scales, that form and transform places and environments
* **GE-12-07** selects and applies geographical inquiry skills and tools, including spatial technologies, fieldwork, and ethical practices, to investigate places and environments

[Geography 11–12 Syllabus](https://curriculum.nsw.edu.au/learning-areas/hsie/geography-11-12-2022/overview) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2022.

### **Syllabus content**

* The nature and complexity of ecosystem functioning and global biodiversity

**Including:**

* energy flows and nutrient cycles
* dynamic equilibrium and feedback loops
* relationships between natural systems
* The relationship between ecological and human stresses, and the vulnerability and resilience of ecosystems, including ecological integrity and biocapacity
* Strategies for the sustainable management of ecosystems at a range of scales, including at least one successful conservation program

## Background to the location

This fieldwork case study provides an opportunity for students to gain an in-depth understanding of the nature and complexity of ecosystem functioning and global biodiversity.

The chosen ecosystem provides an effective case study as it:

* clearly demonstrates energy flows and nutrient cycle processes, which are easily observed in the field
* offers accessible and safe areas for fieldwork that can be completed within one teaching day
* represents a diverse and complex system that contrasts with many students’ own understanding of natural environments
* has a detailed ecological history, highlighting human stresses, such as urban expansion, agriculture, industrial activities and their impact on ecosystem resilience
* links directly to the syllabus content, offering a robust platform for discussing ecological integrity and the strategies used to maintain biocapacity at local, regional and global scales
* is supported by a range of educational materials, such as case studies of successful conservation programs, articles and multimedia content for both pre- and post-fieldwork activities.

**Background to wetlands and Avoca Lagoon**

**Note:** access [About wetlands](https://www.environment.nsw.gov.au/topics/water/wetlands/about-wetlands), [DCCEEW: What are wetlands?](https://www.dcceew.gov.au/water/wetlands/about) and [WWF – What is a wetland?](https://www.worldwildlife.org/stories/what-is-a-wetland-and-8-other-wetland-facts) for more information.

Wetlands are areas of land that are covered or saturated with fresh, brackish or salt water, which is generally still or slow-moving. The water can also sit just below the surface. There are more than 20,000 wetlands across New South Wales.

* In 2003, mapped wetlands covered about 4.5 million hectares of New South Wales – roughly 6% of the state. The following points provide high-level facts about wetlands in NSW
* some of the largest wetlands are in the Murray−Darling Basin, such as the Macquarie Marshes near Dubbo
* most of the other wetlands are located along the coast, including estuaries, coastal lakes and lagoons
* a few freshwater wetlands can be found on the tablelands and in the highest alpine regions, such as the lakes in Kosciuszko National Park.

The Central Coast (NSW) has 4 coastal lagoon systems: Wamberal, Terrigal, Avoca and Cockrone. These lagoons are a significant geographic feature of the region, highly valued as a natural resource that supports a network of important ecological communities, as well as a diverse range of recreational activities. These lagoons belong to a special class of estuary known as Intermittently Closing and Opening Lakes and Lagoons (ICOLLs). An ICOLL is a shallow coastal water body with an entrance barrier that connects intermittently to the ocean through one or more restricted inlets.

* ICOLLs have a lower tolerance for external pressures compared to other estuary types, making careful management and conservation essential to prevent significant environmental degradation. However, past land-use changes, human activities and a growing population are placing increasing pressure on the natural values and ecological health of the lagoons. Improved planning seeks to balance environmental protection with human activities.
* There are 4 lagoons on the Central Coast that discharge directly into the Pacific Ocean: Avoca, Cockrone, Terrigal and Wamberal. These lagoons are characterised by sand berms (a raised, elongated mound of sand, often created by natural wave action or human intervention) that naturally control their entrance conditions. The council intervenes to open these lagoons when water levels reach a trigger point (as listed in Table 1), particularly when the lagoons are closed, to reduce the risk of flooding. This approach is similar to that taken in other coastal local government areas.
* The Flood Planning Level is the minimum floor level for any new residential developments. To protect properties and prevent flooding the local council monitor water levels above mean sea levels (Australian Height Datum, AHD) and set trigger levels. Once reached the entrance barrier will mechanically open. For the Avoca Lagoon this water monitoring can be viewed at [Live water level, Avoca Lagoon](https://mhl.nsw.gov.au/Station-212452). Examples of trigger levels for mechanical opening on the central coast can be found at [Coastal lagoon](https://www.centralcoast.nsw.gov.au/environment/coastlines/estuaries-lagoons-and-wetlands/coastal-lagoons)s.

Table 1 – catchment over and trigger level

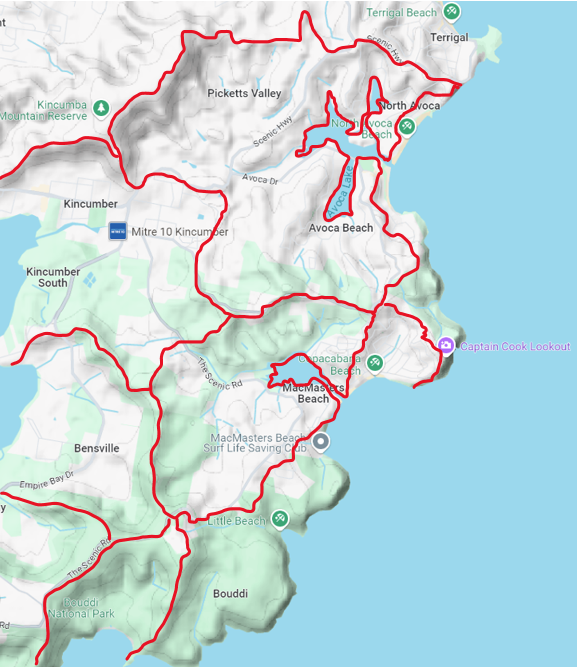
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Lagoon | Catchment size | Major tributaries | Avg Ann. Inflow (ML)/Vol (ML) | Catchment/Lagoon area |
| Avoca | 10 km2 | Saltwater creek | 5.3 | 17.5 |

Avoca Lagoon is an ICOLL and the functioning of an ICOLL is driven by 2 key factors:

* catchment processes
* entrance condition.

Catchment processes influence the amount of water and nutrients flowing into the lagoon, while the entrance condition determines how the lagoon connects to the ocean, which affects water levels, salinity and overall ecosystem health. Both factors are crucial for maintaining the lagoon’s ecological balance and must be carefully managed to ensure the lagoon’s long-term sustainability.

Figure 1 – relief map of Avoca Lagoon and surrounding catchment boundaries



Map data by Google Maps.

**Cultural and historical context** – overview of the history of the area and land use

Over the last 50 years, there has been a noticeable shift from rural land uses to increasing residential development in the study area. Agricultural activities during the 1950s and 1960s likely had negative impacts on lagoon water quality, primarily due to increased sediment and nutrient loads resulting from the clearing of formerly forested areas. The use of fertilisers and pesticides during this period may also have contributed to soil and water quality degradation.

* In the 1970s and 1980s, the area saw further intensification of residential development. This led to additional clearing of vegetation clearing resulting in an increase of impervious surfaces, which has altered stormwater run-off patterns, particularly affecting the timing and volume of flows. Water quality issues persisted, especially during construction phases, when erosion and sedimentation controls were not yet commonly implemented.
* The sealing of informal roads during this period helped reduce sediment loads from road runoff. However, water quality issues continued due to the prevalent use of septic systems, as widespread adoption of reticulated sewage systems did not occur until the 1990s (Fletcher et al. 2014:39). Improved catchment management practices have likely enhanced the quality of stormwater runoff entering the lagoons, though the flow rate remains faster than what occurred in less developed or natural conditions.
* Historical land-use decisions have significantly shaped current management practices. Development on low-lying lands required substantial intervention from the Council, including the establishment of an Entrance Management Policy for flood mitigation. Over the past 50 years, each lagoon has undergone mechanical breaching of its beach berm to prevent flooding of nearby foreshores and infrastructure. This ongoing management has profoundly affected the lagoons’ natural processes. For additional details, refer to [Appendix 1](#_Appendix_1_–.).

## Geographical investigation and/or questions

**Note**: the state-wide Monitoring, Evaluation and Reporting (MER) program indicates persistent very poor turbidity grades and poor–very poor chlorophyll-a grades from the reporting years 2018 to 2023. Similarly, Beachwatch grades have been consistently poor from 2018 to 2022 (page 11 [Avoca Lagoon Floodplain Management Study](https://flooddata.ses.nsw.gov.au/dataset/avoca-lagoon-floodplain-management-study-report)).

**Water quality**

* Assess the current water quality of Avoca Lagoon. How does it compare with historical trends?
* What factors can explain the similarities or differences in water quality over time and what is contributing to the current water quality results?
* How should catchment management strategies change to improve Avoca water quality?

**Threatened species management**

* What is the current status of the Green and Golden Bell Frog at Avoca Lagoon? How has this population managed to survive in such a dynamic environment?
* What are the key management issues that need to be addressed to ensure the future survival of this population?

## Pre-fieldwork tasks

Students complete activities and questions prior to fieldwork.

### Pre-fieldwork task 1 – water quality

Activities:

* Access [Avoca Lagoon: Changes Over Time (2:10)](https://www.youtube.com/watch?v=VT5AYaOBVXs&t=130s) and answer the following questions.

1. What kind of lagoon is Avoca Lagoon? What does that mean?

|  |
| --- |
|  |

1. Describe some of the changes over time that have affected the health and water quality of Avoca Lagoon.

|  |
| --- |
|  |

* View the data recorded for [Avoca Lagoon](https://mhl.nsw.gov.au/Station-212452) by Manly Hydraulics Laboratory and answer the following questions.

1. Describe the station that records water level and rainfall.
2. Identify the specific station number that monitors water levels and rainfall.
3. Find the station’s location on [Google Maps Avoca Beach](https://www.google.com/maps/@-33.4705025,151.4179935,15z/data=!5m1!1e4?entry=ttu&g_ep=EgoyMDI0MTAwOS4wIKXMDSoASAFQAw%3D%3D) and describe its geographical setting (for example, nearby landmarks, region).
4. Explain why this station is in place. Consider monitoring water levels for flood prevention or tracking rainfall to support ecological studies.

**Look at the latest values for rainfall (precipitation).**

1. Describe the recorded rainfall in the last 24 hours.
2. Provide details on the rainfall over the past 96 hours (4 days).

**Look at the latest values for water level.**

1. What is the latest recorded value of the water level?
2. When exactly was this measurement taken?

Note: Avoca Lagoon also has a water quality monitoring buoy named ‘Beatrice’. Beatrice is a multi-depth water quality monitoring device that samples water from the surface to the depths of Avoca Lake. Learn more about [Beatrice.](https://www.environment.nsw.gov.au/topics/water/estuaries/estuaries-research/avoca-lake-process-study) Students can list the water quality parameters it measures.

Communities and schools can contribute to monitoring water quality in local waterways through the [Waterwatch](https://www.nswwaterwatch.org.au/) program. This program provides training and support for those involved.

Students to work in small groups of 3 to 5 and complete a [jigsaw activity](https://app.pre.education.nsw.gov.au/learning-tools-selector/LearningActivity/Card/546?clearCache=3c131ef-6553-34b4-702f-1e4bc4585e18). Each group will be assigned one water quality parameter to study: Water Temperature, Turbidity, Salinity, pH, Dissolved Oxygen, Available Phosphate. Each group will be provided with a video that demonstrates how to measure their specific water quality indicator. The length of the videos and the indicator each group will focus on are as follows – [temperature (water)](https://www.youtube.com/watch?v=LKfWV45953I) (0:52), [turbidity](https://www.youtube.com/watch?v=p7QtBRhK5kE) (1:35), [salinity](https://www.youtube.com/watch?v=ZNNGWArk7BQ) (1:50), [pH test](https://www.youtube.com/watch?v=vdOEgCQf-LE) (1:07), [dissolved oxygen](https://www.youtube.com/watch?v=NrPEInbCHv0) (10:58), [available phosphate](https://www.youtube.com/watch?v=08x1eSWznPA) (7:20). Each group accesses their assigned video and takes notes on the key points, such as:

* equipment required to measure the parameter
* step-by-step instructions on how to conduct the test
* why this parameter is important for water quality
* any potential challenges in measuring the parameter
* interpretation of the results (for example, what high or low levels indicate).

After watching the videos, students will gather in their groups to discuss the content and ensure that everyone understands how to measure their assigned water quality indicator. They will prepare a brief explanation of the procedure and significance of their water quality test. Students will then reorganise into new groups. Each group will have one ‘expert’ from each of the original water quality parameter groups. The experts will teach the others in their new group about the procedure for their assigned indicator. This way, every student learns how to measure all 6 water quality indicators.

* After the jigsaw activity, reconvene as a whole class to discuss the significance of the different water quality indicators in understanding overall water health. Discuss how these tests are used in fieldwork and environmental monitoring. For further information, see [Appendix 1](#_Appendix_1_–.).

Table 2 – water quality indicators

|  |  |  |
| --- | --- | --- |
| Water quality tests | What is this? | Comments (for example, why does it matter? What affects this parameter?) |
| Temperature (water) | Affects how much O2 in water |  |
| Turbidity | Measures cloudiness |  |
| Salinity | Measures concentration of salt in water |  |
| pH | Measures acids/base or alkaline chemicals |  |
| Dissolved oxygen | Concentration of oxygen in water |  |
| Available phosphate | Concentration of phosphate in water |  |

### Pre-fieldwork task 2 – threatened species

**Activities**

* Research the Green and Golden Bell Frog (Litoria aurea). The following are useful resources for your research: [Green and Golden Bell Frog](https://australian.museum/learn/animals/frogs/green-and-golden-bell-frog/), [Native animal facts – bell frogs](https://www.environment.nsw.gov.au/topics/animals-and-plants/native-animals/native-animal-facts/frogs/bell-frogs), [Threatened species – Green and Golden Bell Frog - profile](https://threatenedspecies.bionet.nsw.gov.au/profile?id=10483) and [Avoca Lagoon Green and Golden Bell Frog Investigations](https://loveourwaterways.centralcoast.nsw.gov.au/projects/avoca-lagoon-green-and-golden-bell-frog-investigations). Complete the following.

1. Describe the optimal conditions for the Green and Golden Bell Frog in terms of habitat and water quality. Begin by identifying and explaining the specific habitat preferences of the Green and Golden Bell Frog. Consider elements, such as:

* type of environment (for example, wetlands, marshes, lagoons)
* vegetation cover and structure
* availability of breeding sites, such as water bodies that retain water year-round.

1. Explain the water quality factors that influence the survival and breeding success of the species. Consider elements such as:

* pH levels
* temperature ranges
* oxygen content and absence of pollutants.

Use the resources identified at the start of the activity to provide detailed examples and scientific explanations regarding the preferred habitat and water conditions.

1. What are the main threats to the Green and Golden Bell Frog? List and explain the major threats facing the Green and Golden Bell Frog today. Consider factors, such as:

* habitat loss due to urban development and agricultural expansion
* pollution of water bodies (for example, chemical run-off from agriculture or industrial activities)
* the introduction of invasive species like the mosquito fish
* disease, especially chytrid fungus, which has been a significant factor in frog population declines
* climate change and its impact on breeding and habitat conditions
* specific examples and real-life case studies where these threats have been observed.

1. Describe the current distribution of the Green and Golden Bell Frog in NSW.

* Use the provided resources to map the current distribution of the species. Be specific in your descriptions, identifying key regions where they are found.
* Discuss any changes in their distribution over time, and what might have contributed to these changes (for example, habitat fragmentation, conservation efforts).
* Highlight conservation areas or projects aimed at supporting the recovery of this species, such as the Avoca Lagoon project.

**Note**: scaffold the task by breaking it down into manageable sections (habitat, threats and distribution). Guiding questions for each section are provided. For example: ‘What type of water do they prefer to breed in?’, ‘How does urban development affect their habitat?’, ‘Where in NSW have these frogs been found?’ and ‘Why do they live in those areas?’.

Encourage students to practise using both the online and provided resources effectively, teaching them to critically evaluate the credibility and relevance of information sources. Ask students to compare findings from different sources and note any inconsistencies or additional details they discover. If possible, incorporate the use of maps or GIS tools to track and visualise the distribution of the Green and Golden Bell Frog. This can help students make spatial connections and understand the environmental geography of the species. After students complete their research, lead a class discussion to share findings, encouraging students to reflect on why conserving species like the Green and Golden Bell Frog is important in terms of biodiversity and ecosystem health.

## Fieldwork tasks

Fieldwork may be conducted with the teachers or independently.

### Avoca Lagoon water quality monitoring

Figure 2 – map of Avoca Lagoon and possible sites for water quality testing



Map data by Six Maps.

**Note**: for equipment for water monitoring, contact your local Department of Education Environmental Education Centre for resources, consult the Science department at your school for potential equipment or contact [*Waterwatch NSW*](https://www.nswwaterwatch.org.au/) to access monitoring equipment.

Students to complete the site and condition description using the table below. At each site, sketch or photograph the area and describe the physical conditions (for example, size, shape, vegetation, depth, human activities). Hypothesise what you expect the water quality results to show based on your observations.

Table 3 – site condition description

|  |  |
| --- | --- |
| Site | Condition |
| Date |  |
| Weather today (for example, sunny, cloudy, windy) |  |
| Recent rainfall (amount and duration) |  |
| Lagoon level (refer to MHL website) |  |
| Lagoon last opened (if relevant) |  |

Complete the site location and attribute information using the table below. Mark each site on the provided map, detailing the specific attributes for each location. Take photographs of each site, capturing any factors that may influence water quality, such as pollution sources, human activities, vegetation, and other relevant features.

Table 4 – site location and attributes

|  |  |  |
| --- | --- | --- |
| Site | Location | Description of site attributes |
| 1. Lagoon edge |  | (Size, shape, depth, width, vegetation, erosion signs, and so on) |
| 1. Stormwater drain |  | (Size, shape, depth, signs of pollution or erosion, and so on) |
| 1. Creek inflow |  | (Vegetation, signs of erosion, sediment deposition, and so on) |
| 1. Green and Golden Bell Frog population |  | (Presence of frogs, vegetation, breeding areas, and so on) |

Compare your map and descriptions, discussing how the different site characteristics might affect water quality.

* Conduct water quality testing at each site and record the results in the following table.

Table 5 – water quality testing site record

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Water quality tests | Site 1 – Lagoon edge | Site 2 – stormwater drain | Site 3 – creek inflow | Site 4 – G&G Bell Frog population |
| Time of sampling |  |  |  |  |
| Water temperature |  |  |  |  |
| Air temperature |  |  |  |  |
| Turbidity |  |  |  |  |
| Salinity |  |  |  |  |
| pH |  |  |  |  |
| Dissolved oxygen |  |  |  |  |

Based on the water quality test results, students analyse how various environmental factors (for example, stormwater run-off, human activity, wildlife presence) may influence water quality in the region. Discussion questions:

1. Which site had the highest and lowest water quality results? Why might this be the case?
2. How does rainfall affect the turbidity and salinity levels? Discuss run-off from urban areas.
3. What is the relationship between dissolved oxygen levels and the presence of aquatic life?

## Post-fieldwork tasks

Review collected water quality data (temperature, turbidity, pH, dissolved oxygen, salinity, phosphate levels) for Avoca Lagoon. Summarise the key findings using the questions below.

1. What are the significant readings?
2. Did any parameters exceed expected levels (for example, high turbidity, low oxygen)?
3. Are there any patterns that stand out?

* Plot results alongside annual trends to observe how current water quality compares. Use line graphs or bar charts to visually represent the differences. For example, how does turbidity change seasonally? Is your data consistent with previous findings? Use tools like Excel or [ArcGIS](https://www.arcgis.com/index.html) (will need a login) to create graphs showing the data comparison.
* Access the [ANZECC](https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000) Guidelines ([Appendix 2](#_Appendix_2_–)) that are national standards for water quality. Compare results with these guidelines to assess if Avoca Lagoon meets the minimum water quality criteria. Guidelines for comparisons:
* pH range: the acceptable range for most aquatic ecosystems is 6.5 to 8.5
* dissolved oxygen: should generally be above 5 mg/L for aquatic life
* phosphate levels: high phosphate can indicate nutrient pollution and eutrophication.
* Create a comparison table showing your results versus [ANZECC](https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000) guidelines for each parameter. Factors to consider:
* recent rainfall: heavy rainfall may cause higher turbidity due to sediment run-off, dilution of pollutants or nutrient inputs
* weather: cooler weather can affect water temperature and dissolved oxygen levels
* lagoon opening: if the lagoon was recently opened to the sea, salinity levels and water exchange may influence water quality.
* Write a brief interpretation of how rainfall, weather conditions and lagoon opening times influenced your water quality findings.
* Using previous research, such as the habitat needs of the Green and Golden Bell Frog and fieldwork study, consider the following:
* water quality: frogs require clean, low-pollution environments with suitable pH and dissolved oxygen levels
* vegetation: a mix of aquatic plants for cover, breeding and shelter from predators
* temperature: warm conditions that promote frog breeding, but without extreme fluctuations
* predation control: control of non-native species, such as feral cats or invasive fish that prey on frog eggs.
* List and discuss the key factors necessary for frog habitat maintenance, using Avoca Lagoon as a case study.

## Resources

Equipment may vary depending on methodology and access. Check with the Science department at your school and/or local Environmental and Zoo Education Centre about equipment that is available. Materials list for fieldwork sites:

* buckets
* tarpaulin.

A typical set of equipment for a group would include:

* turbidity tube
* beaker
* thermometer
* pH strips
* salinity meter – (various meters available)
* test for dissolved oxygen
* test for available phosphate.

If using chemicals for any tests, then safety equipment should include:

* safety glasses
* gloves.

Safety equipment for outdoor fieldwork – hats, sunscreen, water bottles, sturdy footwear and first aid kits.

## Appendix 1 – history of the area

**1954:** The predominant land use was rural, with what appear to be orchards and other rural properties scattered throughout the study area. Some residential properties existed along the coastal strip, though it is unclear whether these were permanent residences or holiday homes. Interpretation of the aerial photography is difficult, but it appears that many roads through the study area were unsealed at this time. There were several pockets of vegetation, commonly associated with ridgelines, creek lines and dune areas. The lagoon entrances were closed on the day the aerial photographs were captured.

The western and southwestern portions of the Avoca Lagoon catchment were largely forested, with some isolated cleared lands, not unlike how they appear in more recent years. Orchards were also present in this catchment, while other rural lands were being used for various agricultural activities. Expanses of exposed substrate were visible in the lagoon due to lower water levels at the time the photograph was taken. As with the other lagoons, residential lands were concentrated closer to the coastline. Scenic Drive, Avoca Drive and Cape Three Points Road were all visible.

**1964:** The lagoon entrances were all closed on the day the aerial photographs were captured. Much of the northern, western and southern portions of the Avoca Lagoon catchment are forested, with scattered rural lands. Bradleys Road, Lake Shore Drive and Easter Parade are present, but there are very few residences in this location at this time. Residential development has intensified since 1954 along the coastal strip and around the Hillside Road and The Round Drive areas with minimal impacting of the forested areas.

**1983:** By 1983, extensive residential development had occurred in the study area, resulting in a sharp increase in land use since 1964. This includes not only an expansion of development but also an increase in development density. Some formerly rural lands have now been converted to residential use, particularly closer to the coast. Development around Avoca Lagoon is concentrated along the northern, eastern and southern shorelines. In some locations, this has resulted in the displacement of vegetation near the lagoon shoreline, particularly in the south.

**2007:** Land use patterns in the study area do not appear to have changed significantly since 1983. The minimal development that has occurred involves an increase in the extent of residential areas to the southwest of Terrigal Lagoon, towards Picketts Valley, at the expense of pre-existing rural lands.

Ref: Avoca Lagoon Processes Study, 2022 – Technical Report – May 2024

## Appendix 2 – ANZECC Guidelines for the protection and health of aquatic ecosystems

In November 1992 the Australian and New Zealand Environment and Conservation Council (ANZECC) published a document entitled: *Australian Water Quality Guidelines for Fresh and Marine Waters*.

These are some of the guidelines from that document.

Table 6 – summary of the Australian Water Quality Guidelines for Fresh and Marine Waters

|  |  |  |
| --- | --- | --- |
| Indicator | Fresh water minimum standard | Comments |
| Dissolved oxygen | > 6 mg/L | < 2 mg/L will not support fish life |
| Phosphorus (total) | 0.005–0.050 mg/L | > 0.03 may contribute to algae growth |
| Nitrogen (total) | 0.100–0.500 mg/L | High levels of nitrogen increase oxygen consumption in the water |
| pH | 6.5–9.0 | 6.6–8.5 for drinking water  4.5–9.0 for agricultural use  Sea water has a natural pH of 8.2  Rainwater is usually between 5.5–6.0  Water drained through forest leaf litter, basalt and sandstone has increased acidity  Water drained through limestone has reduced acidity |
| Temperature | < 20°C increase in water temperature in 24 hour period | Changes over 20°C will cause thermal stress for aquatic animals  The higher the water temp the lower the amount of oxygen in the water |
| Salinity | < 1000 mg/L | Rainwater < 10 mg/L  Desirable tap water level < 500 mg/L  Brackish water 1000–3000 mg/L  Sea water 35,000 mg/L |
| Suspended solids/turbidity (NTU)  (Nephelometric Turbidity Units) | < 10% change in seasonal mean NTU | EPA recommends < 5 NTU for recreational waters |

## References

This resource contains NSW Curriculum and syllabus content. The NSW Curriculum is developed by the NSW Education Standards Authority. This content is prepared by NESA for and on behalf of the Crown in right of the State of New South Wales. The material is protected by Crown copyright.

Please refer to the NESA Copyright Disclaimer for more information <https://educationstandards.nsw.edu.au/wps/portal/nesa/mini-footer/copyright>.

NESA holds the only official and up-to-date versions of the NSW Curriculum and syllabus documents. Please visit the NSW Education Standards Authority (NESA) website <https://educationstandards.nsw.edu.au> and the NSW Curriculum website <https://curriculum.nsw.edu.au>.

[Geography 11–12 Syllabus](https://curriculum.nsw.edu.au/learning-areas/hsie/geography-11-12-2022/overview) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2022.

ArcGIS Online (2024) [ArcGis Online](https://www.arcgis.com/index.html) [website], accessed 16 October 2024.

Australian Government Initiative: Australian & New Zealand GUIDELINES FOR FRESH & MARINE WATER QUALITY (2000) [*ANZECC & ARMCANZ (2000) water quality guidelines*](https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000), Water Quality Australia website, accessed 16 October 2024.

Australian Museum (2021) [*Green and Golden Bell Frog*](https://australian.museum/learn/animals/frogs/green-and-golden-bell-frog/), Australian Museum website, accessed 10 September 2024.

Backyard Buddies (n.d.) Green and Gold Frog, [*Backyard Buddies website*](https://backyardbuddies.org.au/backyard-buddies/green-and-gold-frog/), accessed 10 September 2024.

Central Coast Council (n.d.) [*Online Mapping*](https://maps.centralcoast.nsw.gov.au/public/), Central Coast Council website, accessed 10 September 2024.

Central Coast Council (19 June 2020) [‘Avoca Lagoon: Changes Over Time’](https://www.youtube.com/watch?v=VT5AYaOBVXs&t=130s) [video), *Central Coast Council*, YouTube, accessed 10 September 2024].

Central Coast Council (2024) [*Coastal lagoons*](https://www.centralcoast.nsw.gov.au/environment/coastlines/estuaries-lagoons-and-wetlands/coastal-lagoons), Central Coast Council website, accessed 10 September 2024.

Central Coast Waterways (n.d.) [*Avoca Lagoon Green and Golden Bell Frog Investigations*](https://loveourwaterways.centralcoast.nsw.gov.au/projects/avoca-lagoon-green-and-golden-bell-frog-investigations), Central Coast Waterways website, accessed 10 September 2024.

Central Coast Waterways (n.d.) [*Discover our waterways*](https://loveourwaterways.centralcoast.nsw.gov.au/), Central Coast Waterways website, accessed 10 September 2024.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2023) [*About Wetlands*](https://www.dcceew.gov.au/water/wetlands/about), DCCEEW website, accessed 10 September 2024.

Estuaries and catchment team, science and insight division (unpublished) *Avoca lagoon processes study 2022 technical report May 2024,* Estuaries and catchment team, science and insight division, Department of Climate Change, Energy, the Environment and Water (DCCEEW), accessed 5 November 2024.

Fletcher M, Rollason V, Haines P and Gale E (2014) [*Coastal Zone Management Study for Gosford Lagoons*](https://cdn.centralcoast.nsw.gov.au/sites/default/files/coastal-zone-management-study-for-gosford-lagoons2014.pdf) [PDF 2.5 MB], BMT WBM, accessed10 September 2024.

Google Maps (2024) [*Avoca Beach*](https://www.google.com/maps/@-33.4705025,151.4179935,6640m/data=!3m1!1e3!5m1!1e4?entry=ttu&g_ep=EgoyMDI0MTAyMi4wIKXMDSoASAFQAw%3D%3D), Google Maps website, accessed 16 October 2024.

Manly Hydraulics Laboratory (2024) [*Avoca Lagoon (212452)*](https://mhl.nsw.gov.au/Station-212452), Manly Hydraulics Laboratory website, accessed 10 September 2024.

NSW Government (Environment and Heritage) (2018) [*About wetlands*](https://www2.environment.nsw.gov.au/topics/water/wetlands/about-wetlands), Environment and Heritage website, accessed 10 September 2024.

NSW Government (Office of Environment & heritage) (2022) [*Avoca Lake study*](https://www2.environment.nsw.gov.au/topics/water/estuaries/estuaries-research/avoca-lake-process-study), Office of Environment & Heritage website, accessed 16 October 2024.

NSW Government (Office of Environment & Heritage) (2022) [‘Green and Golden Bell Frog – profile’](https://threatenedspecies.bionet.nsw.gov.au/profile?id=10483), *Threatened species*, Office of Environment & Heritage website, accessed 16 October 2024.

NSW Government (Office of Environment & Heritage) (2023) [*Bell frogs*](https://www2.environment.nsw.gov.au/topics/animals-and-plants/native-animals/native-animal-facts/amphibians/frogs/bell-frogs), Office of Environment & Heritage website, accessed 16 October 2024.

NSW State Emergency Services (NSW SES) (2017) [*Avoca Lagoon Floodplain Management Study*](https://flooddata.ses.nsw.gov.au/dataset/avoca-lagoon-floodplain-management-study-report), NSW SES website, accessed 16 October 2024.

NSW Waterwatch (22 October 2013) [‘3. Measuring Water Temperature’](https://www.youtube.com/watch?v=LKfWV45953I) [video), *NSW Waterwatch*, YouTube, accessed 16 October 2024.

NSW Waterwatch (2016) [*Waterwatch NSW*](https://www.nswwaterwatch.org.au/) [website], accessed 10 September 2024.

NSW Waterwatch (22 October 2023) [‘4. Measuring pH’](https://www.youtube.com/watch?v=vdOEgCQf-LE) [video], *NSW Waterwatch*, YouTube, accessed 16 October 2024.

NSW Waterwatch (22 October 2023) [‘5. Measuring Electrical Conductivity salinity’](https://www.youtube.com/watch?v=ZNNGWArk7BQ) [video), *NSW Waterwatch*, YouTube, accessed 16 October 2024.

NSW Waterwatch (22 October 2023) [‘6. Measuring Turbidity’](https://www.youtube.com/watch?v=p7QtBRhK5kE) [video), *NSW Waterwatch*, YouTube, accessed 16 October 2024.

NSW Waterwatch (23 October 2023) [‘7. Measuring Available Phosphate’](https://www.youtube.com/watch?v=08x1eSWznPA) [video), *NSW Waterwatch*, YouTube, accessed 16 October 2024.

NSW Waterwatch (23 October 2013) [‘8. Measuring Dissolved Oxygen’](https://www.youtube.com/watch?v=NrPEInbCHv0) [video], *NSW Waterwatch*, YouTube, accessed 16 October 2024.

State of New South Wales (Department of Education) (n.d.) [*Controversial issues in schools*](https://education.nsw.gov.au/policy-library/policies/pd-2002-0045), NSW Department of Education website, accessed 16 October 2024.

State of New South Wales (Department of Education) (n.d.) [*Digital Learning Selector*](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=4cf93), NSW Department of Education website, accessed 16 October 2024.

State of New South Wales (Department of Education) (2020) [*Values in NSW public schools*](https://education.nsw.gov.au/policy-library/policies/pd-2005-0131), NSW Department of Education website, accessed 16 October 2024.

State of New South Wales (Department of Education) (2023) [NSW Department of Education Code of Conduct](https://education.nsw.gov.au/rights-and-accountability/department-of-education-code-of-conduct), NSW Department of Education website, accessed 16 October 2024.

State of New South Wales (Department of Education) (2024) [*Excursions and travel*](https://education.nsw.gov.au/inside-the-department/health-and-safety/risk-management/excursions-and-travel-health), NSW Department of Education website, accessed 16 October 2024.

World Wildlife Fund (WWF) (2024) [*What is a wetland? And 8 other wetland facts*](https://www.worldwildlife.org/stories/what-is-a-wetland-and-8-other-wetland-facts), WWF website, accessed 10 September 2024.

**© State of New South Wales (Department of Education), 2024**

The copyright material published in this resource is subject to the *Copyright Act 1968* (Cth) and is owned by the NSW Department of Education or, where indicated, by a party other than the NSW Department of Education (third-party material).

Copyright material available in this resource and owned by the NSW Department of Education is licensed under a [Creative Commons Attribution 4.0 International (CC BY 4.0) license](https://creativecommons.org/licenses/by/4.0/).

[](https://creativecommons.org/licenses/by/4.0/)

This license allows you to share and adapt the material for any purpose, even commercially.

Attribution should be given to © State of New South Wales (Department of Education), 2024.

Material in this resource not available under a Creative Commons license:

* the NSW Department of Education logo, other logos and trademark-protected material
* material owned by a third party that has been reproduced with permission. You will need to obtain permission from the third party to reuse its material.

**Links to third-party material and websites**

Please note that the provided (reading/viewing material/list/links/texts) are a suggestion only and implies no endorsement, by the New South Wales Department of Education, of any author, publisher, or book title. School principals and teachers are best placed to assess the suitability of resources that would complement the curriculum and reflect the needs and interests of their students.

If you use the links provided in this document to access a third-party's website, you acknowledge that the terms of use, including licence terms set out on the third-party's website apply to the use which may be made of the materials on that third-party website or where permitted by the *Copyright Act 1968* (Cth). The department accepts no responsibility for content on third-party websites.