



Terrigal and Coastal Lagoon Audit: Terrigal Catchment Audit

Water quality investigation report 2



January 2020

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Executive Summary

The Terrigal and Coastal Lagoons Audit is a comprehensive water quality monitoring project being undertaken in partnership between Central Coast Council and the NSW Government's Department of Planning, Industry and Environment (NSW Government). The Terrigal Catchment Audit is a subset of this broader project, which aims to investigate the cause and extent of microbial contamination at Terrigal Beach and Terrigal Haven, and address pollution risks to swim safety through a range of strategies. This report provides an update on the Terrigal Catchment Audit project.

The process

The audit is comprised of three phases:

- Phase 1: Initial investigation,
- Phase 2: Major catchment investigation, and
- Phase 3: Works and monitoring.

This is being rolled out across Terrigal Beach, Terrigal Lagoon, Avoca Lagoon, Wamberal Lagoon and Cockrone Lagoon. The Terrigal Catchment Audit has seen considerable progress with Phase 1 completed, and Phases 2 and 3 underway.

The investment

From January 2019 to December 2019, Central Coast Council contributed \$440,000 toward investigations and improvement works, and the NSW Government is managing \$500,000 for investigations in the 2019-2020 financial year. This funding is collectively delivering high quality information on catchment water quality, sediment characteristics and hydrodynamic processes. This improved knowledge of the system is assisting with prioritising on-ground actions, investigating public and private infrastructure through comprehensive inspections, ongoing repairs and upgrades as well as community engagement activities.

Catchment investigations and works

Through the Terrigal CBD, 2.3 km of stormwater pipe has been inspected via CCTV as of 18 November 2019. Access is constrained at times, but contractors are working systematically through the catchment network as guided by the audit.

Across the Terrigal CBD and Terrigal Lagoon catchments, more than 15.7 km of CCTV sewer pipe inspections had been undertaken as of 1 November 2019. Through these inspections, 3.61 km of sewer pipes were identified as needing upgrade, and of this length, 1.15 km had been relined.

These figures will increase as works continue and will be included in future reports.

Communication and engagement

A number of changes have been made to reporting, including a new web-based platform to share information with the community. The website, which is part of Council's Your Voice Our Coast engagement platform, contains information about the project, fact sheets, frequently asked question responses, videos and tips on what people can do to help improve water quality in their local area. In addition, an interactive map has been built which identifies monitoring locations, sewer and stormwater upgrades (proposed and completed) and other investigations that are underway as part of the audit. The map also allows community members to provide relevant local information directly to the project team. Individuals can drop a pin on the map to identify water quality or pollution issues. This information will be visible to the project team and followed up as part of the audit.

The website is available at yourvoiceourcoast.com/tcla

The community engagement program for the Terrigal Catchment Audit has been rolled out through December 2019 and January 2020, where Council and the NSW Government hosted six informal 'pop-up' information stalls at Terrigal Beach and Terrigal Haven. These allowed the project team to speak directly with the local community, address any concerns, provide updated information about water quality results, answer specific questions and let people know where to find out more. The 'pop-up' events were well attended and have been an overall positive forum for engaging with the local community on this important project. These will be followed by a series of formally advertised 'drop-in' sessions in February 2020, will provide more detailed information to the community of the audit's progress.

Water quality update

Since this initial project report, Council and NSW Government has undertaken additional water quality surveys. An updated summary of water quality results is provided in this report, which has been derived from 56 sampling surveys from January to November 2019. Some key findings so far are summarised below. Refer to Table 1 for category definitions.

During dry weather, Terrigal Beach is considered good for swimming 96% of the time. Directly in front of the Surf Life Saving Club, the water quality was 'Good' 100% of the time. Terrigal Haven was considered 'Good' for swim safety 89% of the time during dry weather.

Council does not recommend that people swim at Terrigal Beach within three days of rainfall. During wet weather Terrigal Beach, excluding the Lagoon and Haven, was considered 'Good' 53%. The SLSC was 'Good' for swimming 73% of the time. Terrigal Haven had 'Good' water quality 50% of the time.

Moving forward

The outcomes documented in this report give a snapshot of swim safety and the works undertaken to date throughout the catchment to reduce contamination and improve water quality.

The audit is an important project for Council and investigations are ongoing. The direction of this audit will adapt as the project progresses and more information becomes available.

Introduction

Recreational water quality is monitored by Central Coast Council (Council) across the Central Coast's swimming sites as part of the Beachwatch Partnership Program (Beachwatch). The results are used to inform the annual NSW State of the Beaches Report which is published by the NSW Government. Since 2011-12 reporting period, Terrigal Beach has received a "Poor" rating.

Beachwatch uses long-term data to derive an annual Beach Suitability Grade for each sampling site. The grades can be "Very Good", "Good", "Fair", "Poor" or "Very Poor" and are based on the National Health and Medical Research Council's *Guidelines for Managing Risks in Recreational Waters 2008* (Table 1). These categories are used throughout this report to describe water quality trends at each sampling site.

Table 1: Beach suitability grading in the Australian Government's National Health and Medical Research Council's *Guidelines for Managing Risks in Recreational Waters 2008*.

Rating	Enterococci category (colony forming units per 100ml)	Category	Description
****	<41	Good	Good: microbial levels are safe for bathing according to NHMRC guidelines.
***	41–200	Fair	Fair: microbial levels indicate an increased risk of illness to bathers, particularly those with lower immune function such as the elderly and young children.
**	201–500	Poor	Poor and Bad: microbial levels indicate a substantially increased risk of illness to bathers.
*	>500	Bad	

Beachwatch uses long-term environmental trends to highlight areas of concern, which may trigger further investigation. Beachwatch is not comprehensive enough to determine the source or scale of the factors affecting water quality which is why the Terrigal Catchment Audit was initiated.

In January 2019, Council commenced the Terrigal Catchment Audit. The aim of the audit is to assess microbial contamination as a risk to swim safety at Terrigal Beach and Terrigal Haven. Whilst the audit primarily addresses recreational water quality, it also includes other water quality, sediment chemistry and hydrodynamic processes to build a clearer picture of the conditions at Terrigal.

The audit extends the Beachwatch sampling program, quantifying ocean water quality along Terrigal Beach from the Lagoon to the Haven, and moving systematically up through the catchment to investigate sources of contamination. Catchment sampling involves testing and investigating both the sewer and stormwater networks to understand pollution sources and identify solutions. This rigorous sampling process helps to narrow down priority locations for further investigation and upgrade. It also establishes a baseline which will be compared to future water quality results.

The Terrigal Catchment Audit is a subset of the Terrigal and Coastal Lagoon Audit, which is a comprehensive water quality monitoring project being undertaken in partnership between Council and the NSW Government's Department of Planning, Industry and Environment (NSW Government). The Terrigal Catchment Audit covers Terrigal Beach, Terrigal Haven and Terrigal Lagoon, whilst the broader audit expands to include Avoca Lagoon, Wamberal Lagoon and Cockrone Lagoon.

Investigation and works program

Geographical extent of the Terrigal catchment audit

The Terrigal Catchment Audit spans the catchments which may impact on recreational water quality at Terrigal Beach. These areas include Terrigal Haven, Terrigal Beach and Terrigal Lagoon catchments (Figure 1).

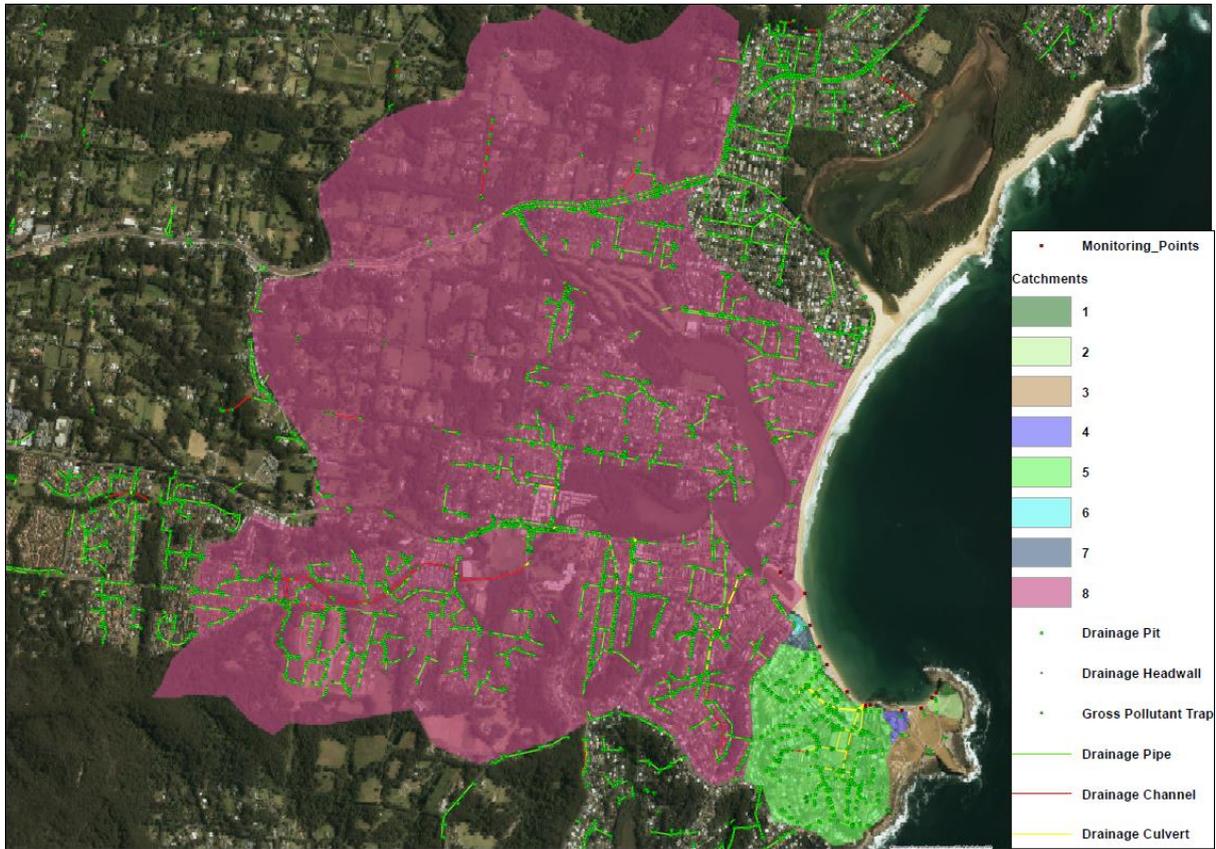


Figure 1: Geographical area covered by the Terrigal Catchment Audit.

Project phases

There are three (3) main phases in the Terrigal Catchment Audit, with several activities undertaken per phase (Figure 2):

- Phase 1 – Initial investigation aims to develop an understanding of the water quality at each site.
- Phase 2 – Major investigation aims to undertake detailed catchment investigations to track down microbial contamination sources.
- Phase 3 – Works and monitoring aims to undertake a works program to improve water quality and monitor water quality after works are completed.

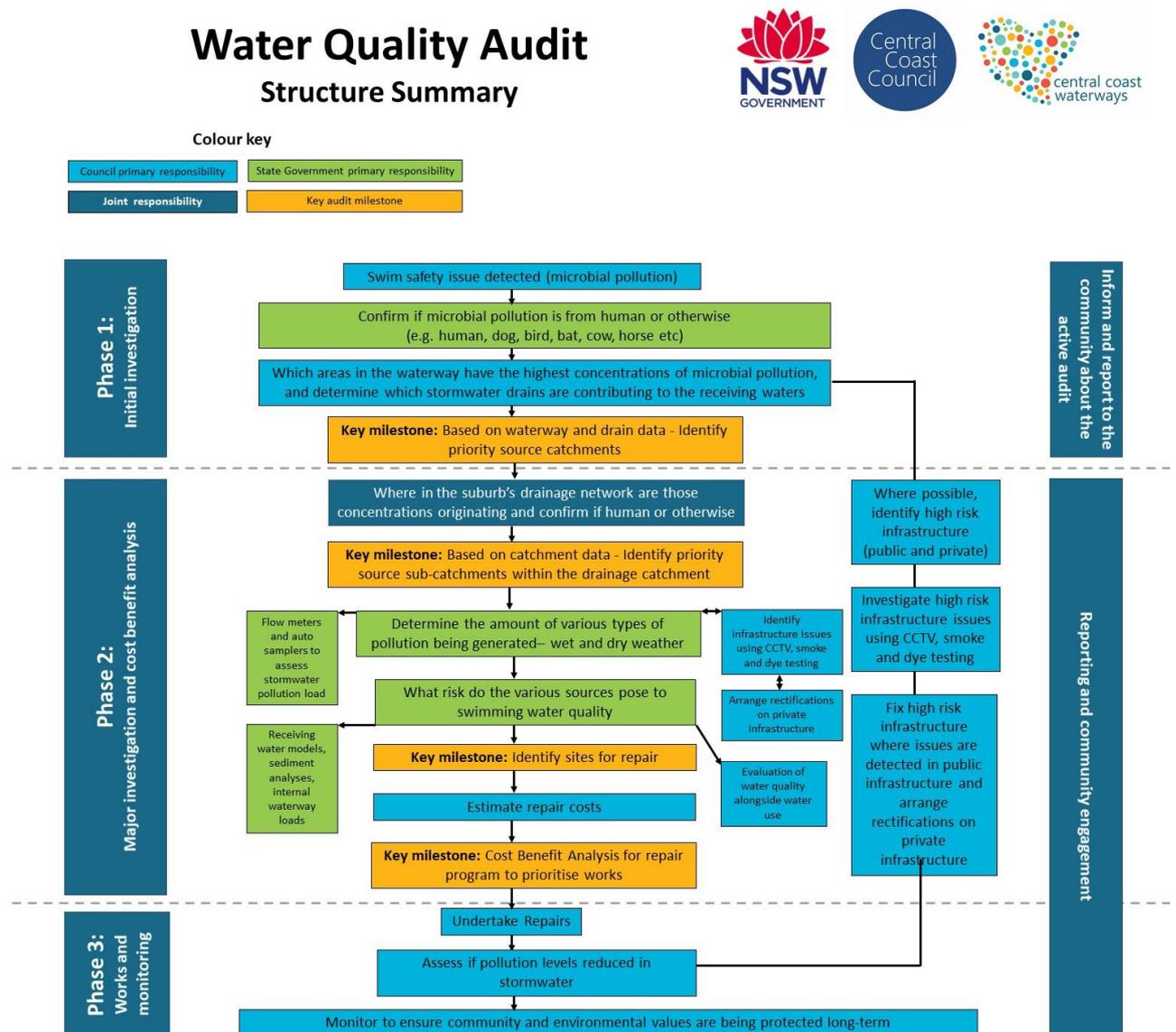


Figure 2: The structure of water quality investigation and improvement program for the Terrigal and Coastal Lagoons Audit, including 3 phases, engagement and reporting.

Phase 1

The following activities form part of the initial phase of audit process:

- **Confirm if source from human or other animals** – To determine the cause of poor water quality at Terrigal Beach (human or otherwise), an analysis of stormwater drains and seawater is undertaken using a suite of assays targeting microbial indicators of human, bird and dog faecal material as well as microbial markers for urban waste-water.
- **Beach based water sampling in Terrigal** – To assess the impact of stormwater on the surf zone in Terrigal Beach, the initial audit establishes a monitoring program at 12 locations – one in Terrigal Lagoon, six along Terrigal Beach stretching from the lagoon to the “7 drains”, one in the rockpool and four along Terrigal Haven. In addition to sampling at Terrigal Beach, Council samples scientific controls (reference sites). These controls enable us to compare the variability in water quality in Terrigal to prevailing conditions experienced along the coastline, such as tide, rainfall and wave conditions.
- **Coastal lagoon water sampling** – To identify pollution hotspots and establish priority sub-catchments for investigation within each lagoon catchment, water sampling is being undertaken in four coastal lagoons, Terrigal, Avoca, Wamberal and Cockrone lagoons. Sampling is being undertaken in different areas of each lagoon to establish patterns throughout each waterbody.
- **Stormwater outlet water sampling** - To assess the impact of stormwater on water quality, samples taken from the stormwater pipes that discharge to the beach or lagoon are paired with adjacent ocean/lagoon sample sites.
- **Ocean sampling in Terrigal** - Recreational use of Terrigal bay is wide ranging throughout the bay thus knowledge of water movement patterns and residence times within the bay is required for managing the bay and ensuring the safety of the bay’s users. The main objective of this sub-program is to provide data for hydrodynamic model calibration and verification for the Terrigal bay area to allow accurate assessment of dominant circulation patterns, major drivers and residence times for any contaminants entering the bay area.
- **Sediment sampling** – To assess if sediment acts as a reservoir for bacteria and whether broader environmental impacts from other possible pollution sources require further investigation, sediment sampling includes tests for nutrients, TOC (total organic carbon), Enterococci counts, microplastics, pesticides and herbicides and metals.
- **Identify high risk infrastructure** – To identify priority areas for investigation, pump station performance data and overflow points are assessed and high risk infrastructure is identified such as vitreous clay pipe and asbestos cement pipe which are more vulnerable to breaks.

Phase 2

The second phase of the audit comprises the following detailed investigations:

- **Catchment water sampling** - Catchment water sampling involves sampling in stormwater pipes to capture rainwater and dry weather water flow, lifting pit lids to access the underground network. Catchment sampling is undertaken systematically, sampling in a logical pattern, moving throughout an investigation area over time to establish a clear understanding of the patterns observed in the variables being measured. To prioritise areas in the catchment which pose the largest risk for water quality, flow gauges and water samplers are installed at key locations in the catchment and the volume of rainwater measured alongside concentrations of microbial contamination to determine microbial load. This helps to guide a priority sub-catchment works program.
- **CCTV camera down sewer network** - a camera mounted on a wheeled buggy that fits down pipes takes video and photos of pipe condition, to see cracks/breaks, groundwater infiltration. Detected breaks and displacements are assessed on a risk basis, and fixed where required. CCTV can be done in the stormwater to assess the condition of the stormwater network, however, this is done in dry weather only.
- **Dye testing** – Dye testing tells Council if cracks and displacements in pipes are exfiltrating to stormwater, beach or lagoon. Dye testing involves placing dye into the sewer network where a break is suspected. If the sewer network is intact, the dye travels to the Kincumber Treatment Plant via the sewer network. If there is a break in the sewer pipes, dye may leave the sewer network and leach into the stormwater network. After the dye is placed in the sewer network, staff monitor the nearby stormwater to detect if dye ends up in the stormwater, this indicates leaching of sewage into stormwater.
- **Manhole reveal and seal program** – The reveal and seal program inspects the condition of sewer network manholes looking for cracks or tree root intrusion. Infiltration of rainwater into broken manholes and groundwater infiltration into cracked or displaced pipes, increases the volume of water in the sewer network. In rainfall events, this can cause sewage overflows. The manhole may also be raised and repaired where required to prevent infiltration to the sewer network.
- **Smoke testing for illegal connections** – Smoke testing tells Council if houses or businesses have their stormwater (gutters and drainage) connected illegally to the sewer network. Smoke testing involves pumping artificial smoke into the sewer network. Smoke testing methods are only used when sewer pump station sensors indicate that rainwater or groundwater is infiltrating into the sewer network. Infiltration of water into the sewer network can cause manhole overflows in wet weather, discharging untreated sewage.

Phase 3

Phase 3 of the audit is focussed on addressing identified sources of pollution, in addition to ongoing monitoring. The following activities form part of the final phase:

- **Relining pipes** - Old or damaged sewer pipes can be relined to renew them and increase the life of the asset (~50 years).
- **Resealing and raising manholes** - Manholes are resealed or replaced to fix holes and gaps. The level of manholes may also be raised to reduce the exposure of the lid to pooling water in wet weather.
- **Dig and replace** - Where the pipe has collapsed or cannot be relined, the pipe is dug up and replaced with a new pipe.
- **Monitoring** - Monitor to ensure community and environmental values are being protected long-term; methods are yet to be determined.

Priority sub-catchments

Terrigal Beach and Haven

The direction of the Terrigal Catchment Audit is being driven by scientifically accurate water quality information. Water quality results have shown that the Terrigal catchment has dispersed sources of microbial contamination, which affect the beach in wet weather. Using the concentrations of dispersed contamination, the catchment priority list in Figure 3 has been developed to direct CCTV investigations for both stormwater and sewer networks in the Terrigal and Haven catchments. Later stages of the audit with the NSW Government will reassess the priority sub-catchment map based on microbial load.

Terrigal Lagoon priority sub-catchments

The Terrigal Lagoon catchment is currently being investigated and microbial concentration data is being collected to develop a priority sub-catchment map. It is expected that the sub-catchment maps will be reported in subsequent reports.



Figure 3: Priority sub-catchment zones scheduled for works in the 2018-2019 and 2019-2020 financial years based on stormwater quality. Phase 2 of the audit will reassess the priority sub-catchment map based on microbial load.

Expected project timeframe

There is no absolute timeframe for the completion of the audits, as there is no way to predict how many pipes might be broken in Council or private infrastructure, or how many illegal connections there may be. Having said that, the program does have a series of 'deadlines' Council and the NSW Government are striving to meet (Table 2).

Table 2: Expected timeframe for the Terrigal and Coastal Lagoons Audits by Central Coast Council and the NSW Government. The audit is an adaptively managed project, and results may change timeframes, outcomes and future project direction.

Location	2018-19 FY	2019-20 FY	2020-21 FY	2021-22 FY	2022-23 FY	2023-24 FY	2024-25 FY
Terrigal Beach and Haven	P1	P1, 2 and 3	P2 and 3	Monitoring ***			
Terrigal Lagoon*	**	P1, 2 and 3	P2 and 3	P2 and 3**	P3**	Monitoring ***	

* Lagoon catchments are considerably larger than the Terrigal Beach and Haven catchment and will take longer to complete.

** Initial sampling only

*** Monitoring periods may provide recommendations to revisit phases 2 and 3 depending on water quality results.

Broad outcomes: Investigation and works progress

Field investigation and maintenance works associated with the Terrigal Catchment Audit are ongoing as shown in Table 2.

The below provides an update of the works to date, with a focus on the key outcomes.

Works

2.3 km of stormwater pipe had been inspected via CCTV throughout the Terrigal CBD catchment as of 18 November 2019. Access is constrained at times, but contractors are working systematically through the catchment network as guided by the audit.

Across the Terrigal and Terrigal Lagoon catchments, more than 15.7 km of CCTV sewer pipe inspections have been undertaken, as of 1 November 2019. Throughout these inspections, 3.61 km of sewer pipes were identified as needing upgrade, of which 1.15 km had been relined. These figures will increase as works continue and will be included in future updates.

During extreme rainfall events in Terrigal, the Pine Tree Lane pump station sensors indicate no significant impact from infiltration (no stress on pump performance). Therefore there is no indication of overflows from the pump station. However, high

bacteria results indicate a source of pollution is located further up in the catchment and further investigation is required (method discussed later). This indicates that illegal connections in the Terrigal basin/CBD are unlikely.

During extreme rainfall events in Terrigal Lagoon, a number of pump stations show stress on pump performance, which indicates impact from infiltration. Rainwater infiltration into the sewer network, either via groundwater, rainwater or illegal connections from stormwater to sewer are possible causes for this. Water infiltration into the sewer network may cause sewage overflows in wet weather.

Currently, two sub-catchment investigations are complete with smoke testing showing ten (10) properties with illegal connections from stormwater to sewer, which contributes to overflows within the Terrigal Lagoon catchment. Four (4) properties have been rectified and six (6) properties are pending final inspection to confirm that the required rectification work has been completed. Investigations and works are continuing.

A further sewer sub-catchment adjoining Terrigal Lagoon has been identified for wet weather inflows investigation and planning is underway to initiate a detailed assessment (Table 3). Pending the available resources, the expected completion date for the additional sewer sub-catchment is the end of the 2019-2020 financial year.

Table 3: Terrigal Catchment Audit investigation and works action plan as of 30 December 2019 Dark blue: Joint responsibility, Light blue: Council responsibility, Green: NSW Government responsibility (Figure 2). Works as zoned in Priority catchment map (Figure 3), and in reference to expected timeframes (Table 2). Locations of works available at: yourvoiceourcoast.com/tcla

Zone	Location	Task	Activity completed - Council stormwater network (2019)	Activity completed - Council sewer network (2019)	Status	Further works to be done	Approximate timeframe (month) (See Table 2)
1	Terrigal Haven	Investigation	Ocean, stormwater outlet and catchment monitoring		Ongoing	Further catchment sampling in rainfall	July-August 2020
1-4	Terrigal	Investigation	Investigate genomics sampling to assess microbial sources		Completed	Not applicable	Completed October 2019
1	Terrigal Haven	Investigation	CCTV assessment of Council stormwater in Terrigal Haven Catchment 100% complete	CCTV assessment* of Council sewer mains in Terrigal Haven Catchment 100% complete	Completed in Council infrastructure	Investigations ongoing	Investigations ongoing and expected to be completed by the end of the 2019-2020 financial year
1	Terrigal Haven	Works	Stormwater relined where required (H2)	Sewer pipes relined across Terrigal Haven	Completed in Council infrastructure	Not applicable	Not applicable
2-4	Terrigal Haven	Investigation	Ocean, stormwater outlet and catchment monitoring		Ongoing	Further catchment sampling in rainfall	July-August 2020
2-4	Terrigal Beach	Investigation	CCTV assessment of Council stormwater in Terrigal Beach Catchment 75% complete	CCTV assessment* of Council high risk sewer network in Terrigal Catchment 60% complete	Underway	Remaining CCTV investigations to be completed in the stormwater and sewer* network	Approximate timeframe for the sewer network* is the end of 2019-20 financial year. Where CCTV and water quality results implicate broken private infrastructure** Council will include a new component of the audit to investigate.
2-4	Terrigal Beach	Works	Stormwater pipe cleaning and repairs scheduled for second and third quarter of 2019-2020 financial year	Relined pipes in the first and second quarters of 2019-2020 financial year	Underway and ongoing in response to investigations	Reline stormwater pipes/easements/pits	Improvement works underway, completion of audit and works expected at the end of the 2020-21 financial year

Zone	Location	Task	Activity completed - Council stormwater network (2019)	Activity completed - Council sewer network (2019)	Status	Further works to be done	Approximate timeframe (month) (See Table 2)
Ocean	Terrigal Bay	Investigate offshore water quality	Not applicable	Not applicable	Sampling completed	Genomics analysis to be completed and final report to be submitted	September 2020
Ocean	Terrigal Bay	Investigate other forms of pollution	Not applicable	Not applicable	Sampling completed	Sediment sampling reporting	September 2020
Ocean	Terrigal Bay	Hydrodynamic modelling of offshore water quality	Not applicable	Not applicable	Sampling completed	Ocean modelling to be completed and final report to be submitted	September 2020
TL	Terrigal Lagoon	Investigation	Ocean, stormwater outlet and catchment monitoring		Ongoing	Further catchment sampling in rainfall	September 2020
TL	Terrigal Lagoon	Investigation	Water sampling in stormwater underway	CCTV assessment* of Council high risk sewer network and manhole reveal and seal program underway in 3 sub-catchments***. Smoke testing complete in 1 sub-catchment	Underway	Investigations ongoing	Approximate timeframe for the Terrigal Lagoon sewer network investigations* is the end of 2021-22 financial year. Smoke testing is assessing illegal connections. Where CCTV and water quality results implicate private infrastructure is damaged** Council will include a new component of the audit to investigate private infrastructure
TL	Terrigal Lagoon	Works	Not applicable. Sewer network is currently the priority within the lagoon catchments	Underway in 2 sub-catchments***	Underway	Investigations ongoing	Improvement works underway, completion of audit and works expected at the end of the 2022-2023 financial year
TL	Terrigal Lagoon	Investigate genomics sampling to assess microbial sources	Not applicable	Not applicable	Underway. Sampling is reliant on wet weather. Sampling 40% completed	Genomics analysis to be completed and final report to be submitted	September 2020

Zone	Location	Task	Activity completed - Council stormwater network (2019)	Activity completed - Council sewer network (2019)	Status	Further works to be done	Approximate timeframe (month) (See Table 2)
TL	Terrigal lagoon	Investigate benthic metabolism – assess if sediment is a contributing factor to poor water quality	Not applicable	Not applicable		Benthic metabolism analysis to be completed and final report to be submitted	September 2020

* Investigations are focusing on vitreous clay pipe and asbestos cement pipe. These pipe types are known for deterioration with displaced joints and cracking type failures. Lower risk infrastructure may also need assessment as a part of the audit, as well as private infrastructure.

** Within Terrigal catchment CCTV and water quality investigations are operating together to detect possible deterioration. Where CCTV indicates that Council infrastructure is in good condition, but water quality remains poor in wet weather sampling, investigations on private infrastructure is needed to detect deterioration or damage.

*** Terrigal lagoon is seen as a key component of the Terrigal Catchment Audit, however due to the size of the catchment and the different conditions expected within a coastal lagoon, investigation methods are different, and investigations will progress at a different rate compared to Terrigal Beach catchment. Care needs to be taken to prioritise Terrigal Beach catchment.

Community engagement

As this project has been progressing, Council and the NSW Government have been engaging with the community to provide a meaningful exchange of information.

Council have developed a **new website**, that provides a platform for information sharing and progress updates on the audit - yourvoiceourcoast.com/tcla (Figure 4).

At present, the website contains:

- A range of project information, including progress reports, frequently asked questions, fact sheets, committee presentations and ocean water quality data.
- Information on what Council does to maintain water quality and how the community can help to improve water quality across the Central Coast.
- An interactive pinpoint map showing stormwater and sewer issues and upgrades, and information about catchment-based smoke testing and other investigations Where Council infrastructure is identified as a source of pollution, these locations are immediately scheduled for refurbishment, with outcomes reported on the website (Figure 5).
- Reporting options for community to notify Council of issues in the catchment that may influence water quality. This option will be available during the engagement program and will be investigated by the project team.

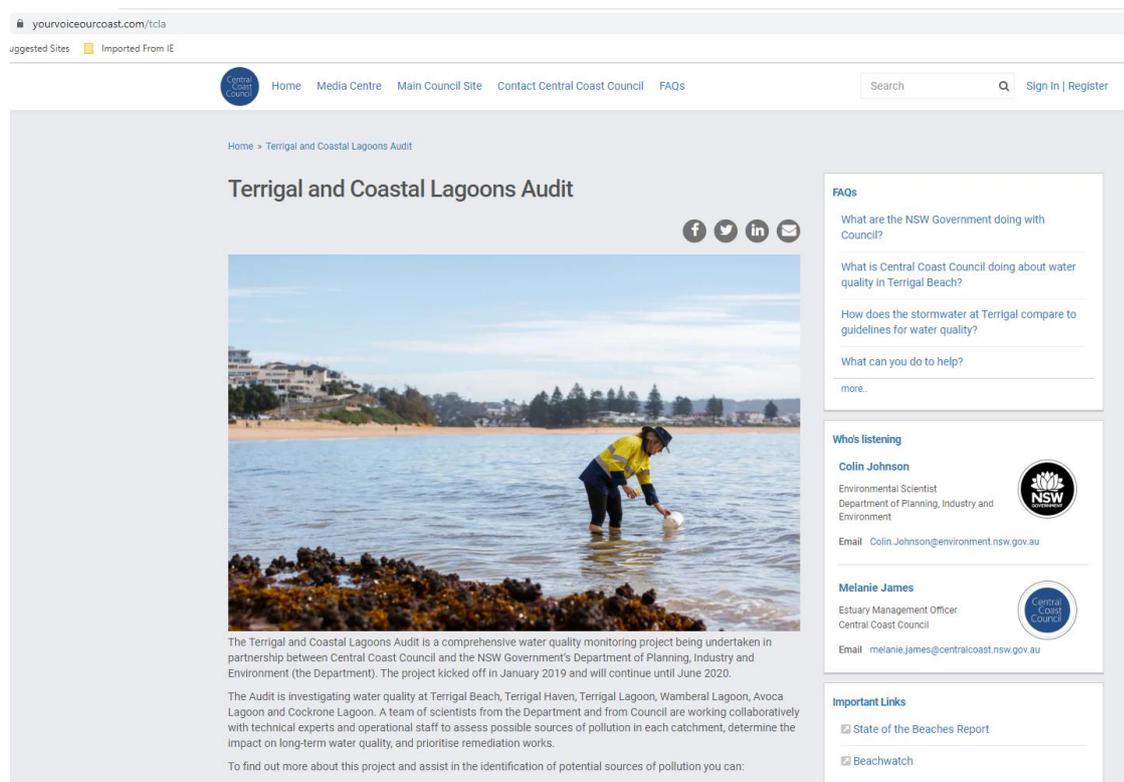


Figure 4: Screenshot of new website – yourvoiceourcoast.com/tcla

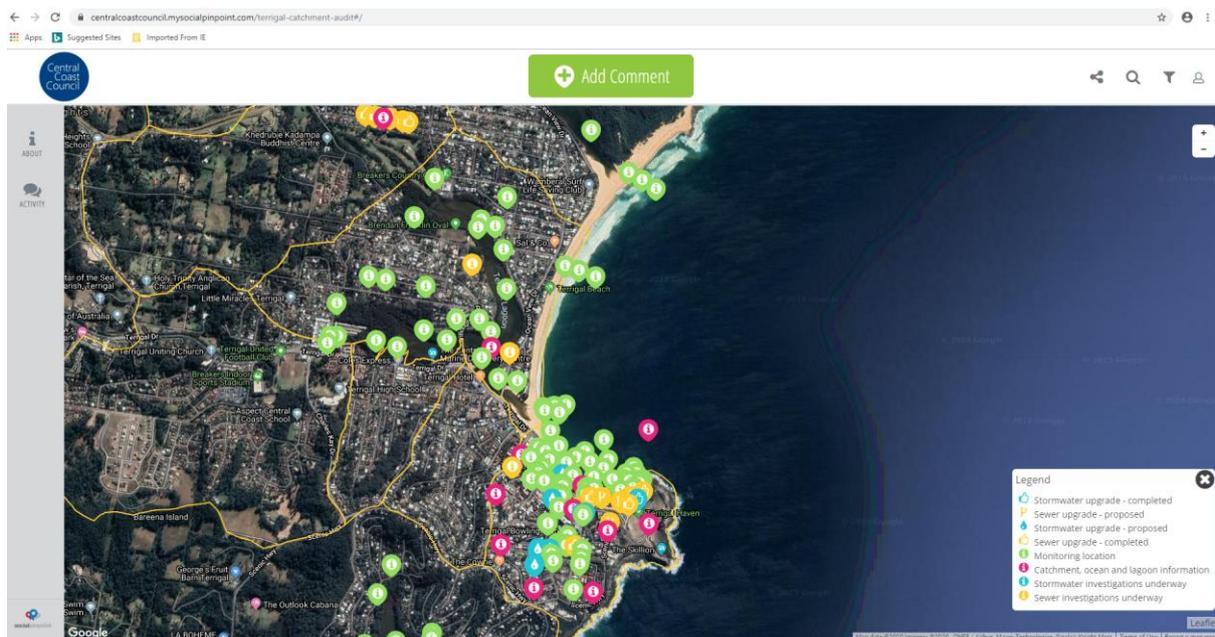


Figure 5: Screenshot of interactive pinpoint map – click through from yourvoiceourcoast.com/tcla

The **community engagement program** for the Terrigal Catchment Audit commenced in December 2019. As part of this program, Council and the NSW Government hosted several informal ‘pop-up’ information stalls for the community through December 2019 to January 2020. The stalls aimed to increase community awareness of the audit program and allow member of the public to speak directly with the Council and NSW Government scientists taking part in the audit. Fact sheets were handed out, the new website and interactive map were advertised, and community concerns were listened to and addressed where possible. Overall, the ‘pop-up’ events were a success, with many community members engaged in the project.

In February 2020, the project team will formally advertise four (4) ‘drop-in’ sessions, that will provide a further engagement opportunity for community, with technical staff available to answer specific community enquiries.

Project costs

The audit is a joint program funded by both Council and the NSW Government.

Central Coast Council

From January to December 2019, Council has invested \$390,000 toward investigations and improvement works including; water sampling, CCTV, smoke testing, dye testing, and relining or replacement of broken pipes in the Terrigal Beach, Haven and Lagoon catchments. Works are ongoing. Council has also provided \$50,000 to the NSW Government to assess the microbial contamination in Terrigal Bay and the hydrodynamics of the bay and ocean.

In addition to this funding, Council has two full time staff dedicated directly to the audit, whilst indirectly drawing on the skills of 48 staff who provide specialist input where required. This team range in expertise from environmental scientists, stormwater and sewer engineers, maintenance staff, compliance officers, administrative and managerial support. This diverse team provide the wide variety of expertise required to assess the water quality issue, to find solutions and to fix the problem.

NSW Government

The NSW Government has invested \$500,000 to assist with the project. This funding is administered by the Department of Planning, Industry and Environment's Estuary Catchment Science Division who have a long-standing partnership with Council. The expert scientists from the Department are familiar with the challenges of reducing environmental risk in Central Coast waterways through their work on Council's existing estuary ecological health program.

Long-term costs

Currently, no final dollar figure has been assigned to the audit, as there is no way to predict how many pipes might be broken, or how many illegal connections there may be. Improvements to the infrastructure at these sites are considered important and will be funded and reported in subsequent project updates.

Beach water quality update

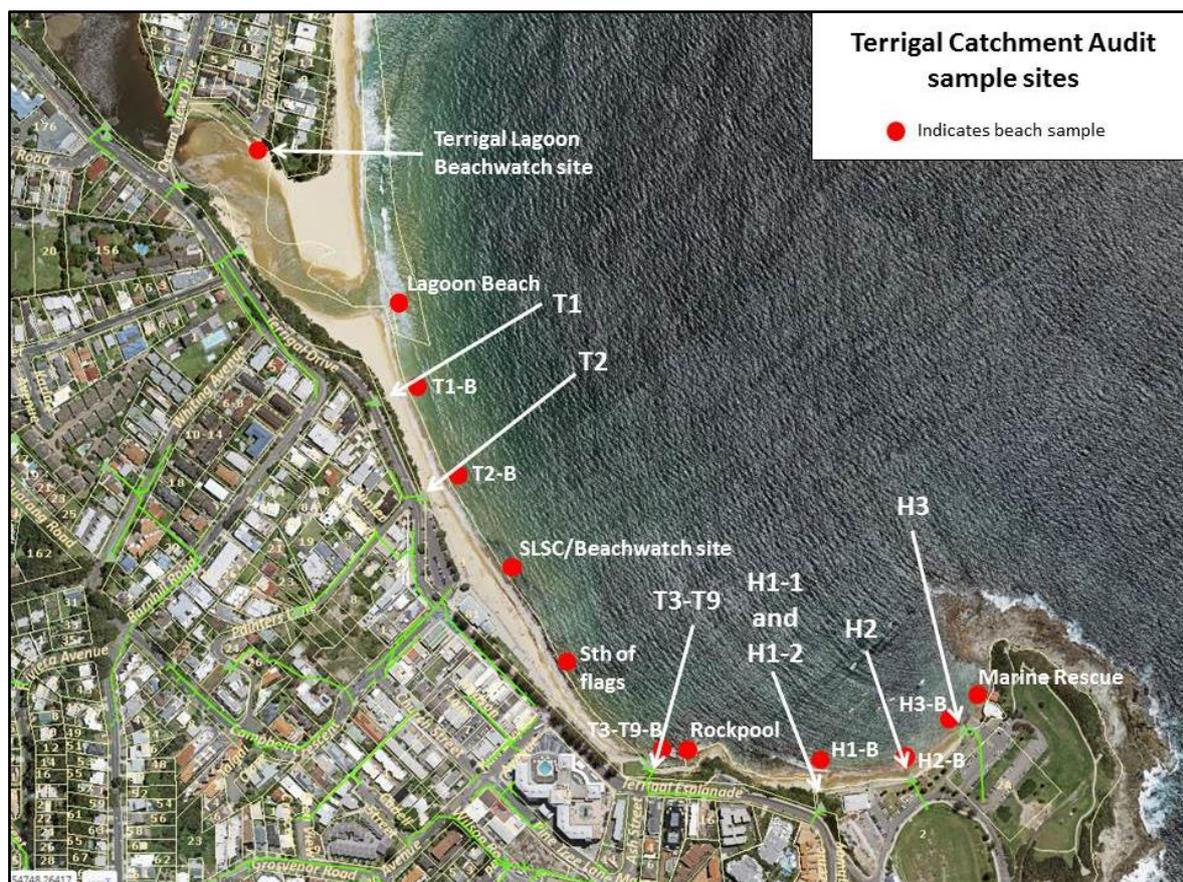


Figure 6: Sample sites for the Terrigal Catchment Audit.

Dry Weather

Throughout the first 56 sampling surveys, 30 days were considered dry weather. Terrigal as a whole (including Beach and Haven) was considered "Good" for swimming 94% of the time during dry weather* (Table 1 shows definitions for "Good", "Fair", "Poor" and "Bad"; rounded to nearest whole number).

Terrigal Beach was considered "Good" for swimming 96% of the time, when assessed separately from the Haven (calculated by combining all seven (7) ocean sample sites; outliers included)*. During dry weather, Terrigal Haven was considered "Good" for swimming 89% of the time (calculated by combining all four (4) ocean sample sites outliers included)*.

Terrigal Lagoon was considered good to swim 74% of the time in dry weather*.

During dry weather, the water quality was considered "Good" 100% of the time directly in front of the Surf Lifesaving Club (SLSC) and at the rockpool at the southern end of Terrigal Beach.

At the sample location on Terrigal Beach directly outside the T3-T9 drains (also known as the "7 drains"), the drains were often flowing in dry weather. Here, 90% of the ocean samples were considered "Good" for swimming. Despite this, the location is not a suitable place to swim due to the presence of exposed rocks.

The low average levels of Enterococci bacteria at all locations indicate that during dry weather, any contamination is quickly diluted and does not affect the swim safety of the beach. Further testing has been undertaken in the offshore zone where swimmers cross to Terrigal Haven. These tests are investigating if the embayment is being affected by minor levels seen at T3-9B and will be included in subsequent reports.

A single outlier from Sth of Flags on 20 May 2019 and Marine Rescue on 9 May 2019 were excluded from the map below. These anomalies were not consistent with results from surrounding locations collected on the same days and were not explained by the existing conditions. The outliers were included in swim safety percentage calculations above.



*These values are derived from 56 samples 17 January to 31 October 2019. The audit is an ongoing investigation and values will change as the audit progresses.

Figure 7: Average water quality 55 sampling days 17 January – 31 October 2019 (average excludes a single outlier at Sth of Flags and Marine Rescue which is discussed in the text).

Wet Weather

Council and the NSW Government do not recommend that people swim at Terrigal Beach within three days of rainfall. Wet weather is defined as $\geq 5\text{mm}$ of rainfall within the preceding three days.

Throughout the first 56 sampling surveys, 26 surveys were considered wet weather. Terrigal as a whole was considered "Good" for swimming 52% of the time* during wet weather (Table 1 shows definitions for "Good", "Fair", "Poor" and "Bad").

Assessing Terrigal Beach separately from Terrigal Haven, Terrigal Beach was considered "Good" for swimming 53% of the time in wet weather, and Terrigal Haven was considered "Good" for swimming 50% of the time*.

Terrigal Lagoon was considered good to swim 12% of the time in wet weather*.

During rainfall, elevated levels of Enterococci bacteria occurred at multiple locations between Terrigal Lagoon and Terrigal Haven. On Terrigal Beach directly outside the T3-T9 drains, 20% of the ocean samples were considered "Good" in wet weather, Sth of Flags was considered "Good" to swim 55% of the time and the Rockpool was considered "Good" to swim 54% of the time*.

*These values are derived from 56 samples from January to end of October 2019. The audit is an ongoing investigation and values will change as the audit progresses.



Figure 8: Average water quality of wet weather sampling days from 17 January – 31 October 2019, excluding the pollution event from 24 June- 28 June 2019.

Lagoon opening

The entrance to Terrigal Lagoon opens to the ocean on occasions through natural and manual (mechanical) processes. During the lagoon opening on 2 April 2019, the Terrigal Catchment Audit took samples before (1 April 2019) and after (3 April 2019) the lagoon was manually opened. A rainfall total of 44.5mm was recorded over three days period prior to lagoon opening. Ocean conditions resulted in the lagoon water moving south, in front of the SLSC and evidence of turbid water was seen at the sample site known as Sth of Flags. Enterococci sampling indicated that beach sites were not suitable for swimming.

In the week or so following the lagoon opening and rainfall event, water samples from 9 April 2019 showed the beach was "Good" for swimming at 100% of Terrigal Beach and 75% of Terrigal Haven (Table 1 shows definitions for "Good", "Fair", "Poor" and "Bad").



Figure 9: Water quality (single day sample 3/4/2019).

Pollution event – June 2019

Between 24 and 27 June 2019, a large storm event resulted in significant stormwater runoff from the catchment and the opening of Terrigal Lagoon. As a result of this storm event, high bacterial counts were recorded at multiple sampling points at Terrigal Lagoon, Terrigal Beach and Terrigal Haven. The control sites at Forresters, North Avoca and Avoca beaches did not see a significant rise in bacteria levels, indicating this pollution event was associated with Terrigal only. As a result, Council closed Terrigal Beach, Haven and Lagoon on 25 June until bacterial levels returned to a safe level on 1 July 2019.

Analysis of results show the lagoon opening caused minimal impact on the beach water quality initially, indicated by the low levels of bacteria at the Lagoon Beach, T1-B and T2-B sites on the first sample day (24 June 2019). This indicates that the lagoon water plume had not yet reached the SLSC or the south of the beach.

At the same time the bacterial counts at the stormwater pipes known as the "7 drains" (T3-T9) were extremely high. The initial pulse of rain affected nearby sites as well indicating that microbial contamination of the stormwater was the major source of pollution at the southern end of the beach on the first day. Samples from Terrigal Haven also showed high concentrations at the beach and stormwater pipes.

Results after the initial rainfall event from 25 to 28 June show a decrease in Enterococci over time for all ocean sites and stormwater pipes, with a return to safe swimming conditions at all ocean locations by the 28 June 2019. Terrigal Beach, Terrigal Haven were not opened until 1 July as the testing takes 24-48 hours to complete.

Investigation of the impacts of large wet weather events is ongoing. With more information, it may become clearer that the triggers for elevated bacterial loads under high rainfall conditions are different from those experienced under dry weather and light-moderate rain events. Council, in partnership with the NSW Government, will continue to investigate the impacts of large events and lagoon openings and report back in future project updates.



Figure 10: Water quality after large rainfall event and lagoon opening (Enterococci sampling from 24 June - 28 June 2019).

Project risks and limitations

Rainfall

A major limiting factor to stormwater sampling is the current lack of rainfall. The best time to identify contaminant pollution sources is during wet weather events which have been limited in recent months. Regardless of the lack of rainfall, the audit is progressing using various methods which can be done in dry weather, such as CCTV, smoke testing and dye testing.

Low risk vs high risk infrastructure

Council has an ongoing sewer network inspection and repair program across the Local Government Area to manage the 2490 km of sewer pipe, 324 pumping stations and eight treatment plants. The Terrigal Catchment Audit has brought greater focus to the Terrigal area with works to date including pump station monitoring, an expansion of the CCTV inspection program to assess cracked or displaced infrastructure, the 'Reveal and Seal' program which inspects manholes for tree root intrusion or other issues as well as smoke and dye testing throughout the catchments.

General sewer CCTV inspections throughout the Terrigal catchment have detected structural issues in a number of sewer pipes. Sewer network structural issues can vary in severity from minor fractures and displacements which may not cause exfiltration, to cracks, displacements and collapses which likely or directly show evidence of exfiltration. Third party damage to Council's sewer infrastructure that is not reported to Council, may also cause exfiltration of sewage to the stormwater network.

Accessing and evaluating infrastructure below the ground is challenging. Due to access constraints, it is not always possible to directly pinpoint a damaged pipe for water quality analysis, and as such there is not always direct evidence that a structural issue is influencing water quality. With this in mind, Council adopts a risk-based approach, whereby each pipe is assessed on the likelihood it could be affecting water quality.

Factors that contribute to a higher risk rating can include:

- Interaction between the sewer network and the stormwater network, e.g. sewer mains located above or crossing stormwater drains or culverts
- Age and pipe material of the adjacent sewerage network when located in close proximity to stormwater network or natural waterway
- Failure history of the sewerage network in proximity to the stormwater network or a natural waterway
- Consideration of historical surcharges from sewerage assets to the environment for particular locations and the proximity of the surcharge to the stormwater network or natural waterway. Any related weather events were also included
- Location of any designed overflow points from the sewerage network to the stormwater network or natural waterway.

Current investigations are focussed on vitreous clay pipe and asbestos cement pipe. These pipe types are known for deterioration with displaced joints and cracking type failures. Lower risk infrastructure may also need assessment as a part of the audit, as well as private infrastructure and this work will be scheduled after high risk infrastructure has been thoroughly assessed and as required.

Private property vs Council network

Where structural or other issues are identified, they will be scheduled for remediation based on the risk category. This applies to both public and private assets. Council will work with landholders to rectify any issues identified on private land through existing compliance processes. In the interest of privacy, these will not be reported by location however a total number of private repairs will be included. If water quality remains a concern beyond these initial repairs, future investigations may expand into private land and lower risk infrastructure.

Summary

- Since January 2019, the NSW Government and Central Coast Council have been working in partnership to deliver an integrated and holistic water quality monitoring program which covers Terrigal Beach, Terrigal Lagoon, Avoca Lagoon, Wamberal Lagoon and Cockrone Lagoon. The program is funded by both organisations, and is one of the most comprehensive recreational water quality investigations in NSW. Outcomes of the audit will be reported via the interactive pinpoint map and in future written reports.
- The Audit has three clear phases – Phase 1 is complete for Terrigal Beach and the audit has moved into phases 2 and 3 here. Phase 1, 2 and 3 are underway in the Terrigal Lagoon catchment which is a larger and more complex system.
- As the data set has increased, the impacts of extreme rainfall have become evident, both from the main catchment and the lagoon outflow. Pending significant rainfall, the Audit will continue to have a major future focus on extreme wet weather events with a view to understanding the drivers of water quality decline during these events. A team of staff from both organisations have been trained to sample and inspect the catchment safely during these conditions.
- Whilst Council has an ongoing sewer network inspection and repair program across the Local Government Area, the Terrigal Catchment Audit has brought more focus to the Terrigal area, including pump station monitoring, an expansion of the CCTV inspection program to assess cracked or displaced infrastructure, the 'Reveal and Seal' program which inspects manholes for tree root intrusion or other issues as well as smoke and dye testing throughout the catchments.
- As at 1 November 2019, Council had invested \$440,000 on investigations and repairs, with more expected as the audit continues. This investment is considered important to improve asset condition, increase asset life and address the water quality issues identified through routine monitoring programs.
- The NSW Government has invested an additional \$500,000 to the project.
- As problems are identified, infrastructure is immediately scheduled for repair with timing based on the scale of the problem and the risk of water quality impacts.

- More than 2.3 km of stormwater pipe had been inspected via CCTV as at November 2019. This will increase as the audit continues.
- More than 15.7 km of CCTV sewer pipe inspections had been undertaken as at November 2019. Through these inspections, 3.61 km of sewer pipes were identified as needing upgrades, of which 1.15 km has been relined.
- CCC 48 staff providing specialist expertise such as scientists and engineers 2 full time staff.
- The audit is progressing as planned, with significant focus from both organisations on resourcing the investigation.
- Reporting on progress will be via the Council website on a regular basis, and a report on the major findings will be prepared in October 2020 for the next Council meeting.
- Council has ongoing recreational and ecological water quality programs across the Central Coast. These allow Council to benchmark water quality, identify areas requiring further investigation and target investment in improvement works. For further information on water quality across the Central Coast, please visit centralcoast.nsw.gov.au/waterwayhealth.

APPENDIX

Photographs of investigation methods



Photo line: 1 Water sampling in ocean and catchment, 2 CCTV camera and camera going down a pipe, 3 flow sampler and filtering for sediment sampling, 4 smoke testing showing smoke from driveway drainage and gutters, line 5 dye testing in a pipe.

Photographs of audit activity



Photo line: 1 broken man hole and repaired and raised manhole from the reveal and seal program, 2 cracked and collapsed sewer pipes which have been fixed, 3 root intrusion, 4 pipe relining.