NSW GOVERNMENT | Public Works Advisory

Bowral Sewage Treatment Plant Incoming Main Replacement

Review of Environmental Factors Addendum

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Prepared for:

WINGECARRIBEE SHIRE COUNCIL

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Cover image: Bowral STP site aerial. SIX Maps, July 2021

Declaration

This Review of Environmental Factors (REF) has been prepared as an addendum to the *Bowral Sewage Treatment Plant Upgrade Review of Environmental Factors* Report No ISR18138 (Public Works Advisory, 2021) (referred to hereafter as the original REF) on behalf of Wingecarribee Shire Council. The purpose of the report is to assess the potential impacts that may result from activities associated with proposed Bowral Sewage Treatment Plant (STP) incoming sewer main replacement works, which was not assessed as part of the original REF, and is to be read in conjunction with the original REF. Much of the background information including the statutory considerations, project justifications, option evaluation, the description of the environment and the identification of environmental impacts and safeguards are presented within the original REF. Any such background information which remains relevant to the Bowral STP replacement incoming sewer main works is not replicated in this report.

Wingecarribee Shire Council is a public authority and a determining authority as defined in the *Environmental Planning & Assessment Act 1979* (EP&A Act). The proposal satisfies the definition of an activity under the Act, and as such Wingecarribee Shire Council must assess and consider the environmental impacts of the proposal before determining whether to proceed.

This REF addendum has been prepared in accordance with Sections 5.5 and 5.7 of the EP&A Act and Clause 228 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Reg). It provides a true and fair assessment of the proposed activity in relation to its likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposed activity.

On the basis of the information presented in this REF addendum it is concluded that:

(1) the proposed activity is not likely to have a significant impact on the environment. An Environmental Impact Statement is not required.

(2) the proposed activity is not likely to significantly affect threatened species, populations, ecological communities, or critical habitat. A Species Impact Statement (SIS) is not required.

(3) the proposed activity is not likely to affect or being carried out on any Commonwealth land, or significantly affect any Matters of National Environmental Significance.

Subject to implementation of the measures to avoid, minimise or manage environmental impacts listed in this REF addendum, the proposed activity is recommended to proceed.

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Verification and Determination

Verifier

I have examined this REF addendum and the Declaration by Kristen Parmeter (the author) and accept the report on behalf of Wingecarribee Shire Council.

Name	
Designation	
Organisation	
Signature	

Determination

I determine that the activity is approved and may proceed.

Name	
Designation	
Organisation	
Signature	

Executive Summary

Wingecarribee Shire Council (WSC) has engaged Public Works Advisory (PWA) to prepare a Review of Environmental Factors (REF) addendum for the proposed replacement of the incoming gravity sewer main for the Bowral Sewage Treatment Plant (STP) located at 217 Burradoo Road, between Bowral and Burradoo. The REF addendum is being prepared to assess the potential environmental impacts associated with the incoming sewer main replacement, which forms a package of works associated with the Bowral STP upgrade works (the Proposal), in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979*.

The existing incoming main transfers sewage from the Bowral sewerage scheme to the Bowral STP inlet works for treatment. Sewer flow containment modelling undertaken on the Bowral sewage conveyance system identified a number of improvement opportunities including the upsizing of the incoming main directly upstream of the STP in order to resolve the predicted overflows from upstream access chambers (manholes). As the Bowral STP is currently being upgraded, and the inlet works are being relocated within the STP site, it is proposed to realign and replace the existing incoming main with a larger capacity to reduce the risk of future sewage overflows.

Scope of Works

The proposed replacement of the incoming sewer main comprises the following new components:

- New incoming gravity main (675 mm diameter, Mild Steel Cement Lined (MSCL) pipe, approximately 160 m in total length) from the new upstream manhole to the STP site. The new main will be aligned to the west of the existing main so as to provide a direct route to the proposed new inlet works on the STP site.
- Approximately fifteen reinforced concrete piers to support the above ground section of the pipeline.
- Four new access chambers (man holes) at sewer main intersection points. One on the northern side of three on the southern side of Mittagong Creek (also known as Mittagong Rivulet).

Planning Framework

The proposed Bowral STP incoming main replacement works are permissible without consent pursuant to clauses 106(1) and 106(3B) of *State Environmental Planning Policy (Infrastructure) 2007* (SEPP Infrastructure). Clauses 106(1) and 106(3B) of SEPP (Infrastructure) 2007 allow development for the purpose of sewage reticulation systems to be carried out by or on behalf of a public authority without consent on any land in the prescribed circumstances, whereby 'prescribed circumstances' are works are carried out by or on behalf of a public authority.

This Review of Environmental Factors (REF) addendum has been prepared in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) which requires the proponent to fully assess the potential environmental impacts associated with the proposal in accordance with sections 5.5 and 5.7 of the EP&A Act and clause 228 of the *Environmental Planning and Assessment Regulation 2000*. WSC would be the proponent and determining authority for the works.

Summary of Potential Environmental Impacts

A number of short-term construction impacts associated with noise, dust, traffic, and waste management are predicted. It has been assessed that these impacts can be managed to avoid or minimise impacts to the environment through the implementation of appropriate mitigation measures.

The Proposal would not significantly affect any historic heritage, Aboriginal heritage sites, listed threatened species, fauna populations or communities provided appropriate mitigation measures are implemented.

The replacement of the incoming main works would improve the operational reliability of the STP and reduce the risk of sewage overflows upstream of the STP.

Conclusion and Recommendations

On the basis of the information presented in this REF addendum it is concluded that by adopting the safeguards identified in this assessment and in the original REF it is unlikely that there would be significant adverse environmental impacts associated with the proposed Bowral STP incoming man replacement works. Therefore, an Environmental Impact Statement would not be required.

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Abbreviations

AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
BC Act	*Biodiversity Conservation Act 2016*
CEMP	Construction Environmental Management Plan
DPI	Department of Primary Industries
DPIE - <agency>	Department of Planning, Industry and Environment
EEC	Endangered Ecological Community
EES	Environment, Energy and Science (Formerly OEH)
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FM Act	*Fisheries Management Act 1994*
LEP	Local Environmental Plan
LGA	Local Government Area
MSCL	Mild Steel Cement Lined
NPW Act	*National Parks and Wildlife Act 1974*
OEH	Office of Environment and Heritage (now Environment, Energy and Science)
OEMP	Operation Environmental Management Plan
POEO Act	*Protection of The Environment Operations Act 1997*
PWA	Public Works Advisory
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy
SWMP	Soil and Water Management Plan
TMP	Traffic Management Plan
WM Act	*Water Management Act 2000*
WMP	Waste Management Plan
WSC	Wingecarribee Shire Council

1 Introduction

This section provides the background and a brief description of the Proposal.

1.1 Background

Wingecarribee Shire Council (WSC) has engaged Public Works Advisory (PWA) to prepare a Review of Environmental Factors (REF) addendum for the proposed replacement of the incoming gravity sewer main to the Bowral Sewage Treatment Plant (STP) located at 217 Burradoo Road, between Bowral and Burradoo. The REF addendum is being prepared to assess the potential environmental impacts associated with the replacement of the incoming sewer main, which forms a package of works associated with the Bowral STP upgrade (the Proposal), in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979*.

WSC is currently augmenting the Bowral STP capacity and treatment system to meet current and future population demand in the region and to improve treated effluent quality.

The existing incoming main transfers sewage from the Bowral sewerage scheme to the Bowral STP inlet works for treatment. Sewer flow containment modelling undertaken on the Bowral sewage conveyance system identified a number of improvement opportunities including the upsizing of the incoming main directly upstream of the STP in order to resolve the predicted overflows from upstream access chambers (manholes). As the Bowral STP is currently being upgraded and the inlet works are being relocated within the STP site, it is proposed to realign and replace the existing incoming main with a larger capacity to reduce the risk of future sewage overflows.

This REF has been prepared as an addendum to the *Bowral Sewage Treatment Plant Upgrade Review of Environmental Factors Report No ISR18138* (Public Works Advisory (PWA), 2021) (referred to henceforth as the original REF). It is limited to the Bowral STP incoming sewer main replacement works. Strategic considerations and justification of the project have previously been included in the original REF and are not addressed in this document.

1.2 Proposal Objectives

The principal objective of the Proposal is to:

- reduce the risk of sewerage system overflows upstream of the STP, and
- realign the incoming main to integrate with the relocated new STP inlet works.

1.3 Overview of the Proposed Works

The proposed replacement of the incoming sewer main comprises the following new components:

- New incoming gravity main (approx. 160 m in length, 675 mm diameter, Mild Steel Cement Lined (MSCL) pipe) from the new upstream manhole to the STP site to be aligned to the west of the existing main so as to provide a direct route to the proposed new inlet works on the STP site.

- Approximately fifteen reinforced concrete piers to support the above ground section of the pipeline.
- Four new access chambers (man holes) at sewer main intersection points. One on the northern side of three on the southern side of Mittagong Creek.

The location of the Proposal works is shown in Figure 1-1 to Figure 1-3.

1.4 Land Ownership

The Proposal would predominantly be located within the existing Bowral STP site (Lot 2 DP 1119953), which is owned by WSC. However, a small section of the replacement sewer main and one access chamber on the northern side of Mittagong Creek within Lot 2 DP 604662 would be located within freehold land (see Figure 1-2).

It is noted that the beds of most tidal waters and non-tidal waters are Crown land. Accordingly, the creek bed of Mittagong Creek is considered Crown land.

Figure 1-1 Location of the Bowral STP

Source: SIX Maps, 2021

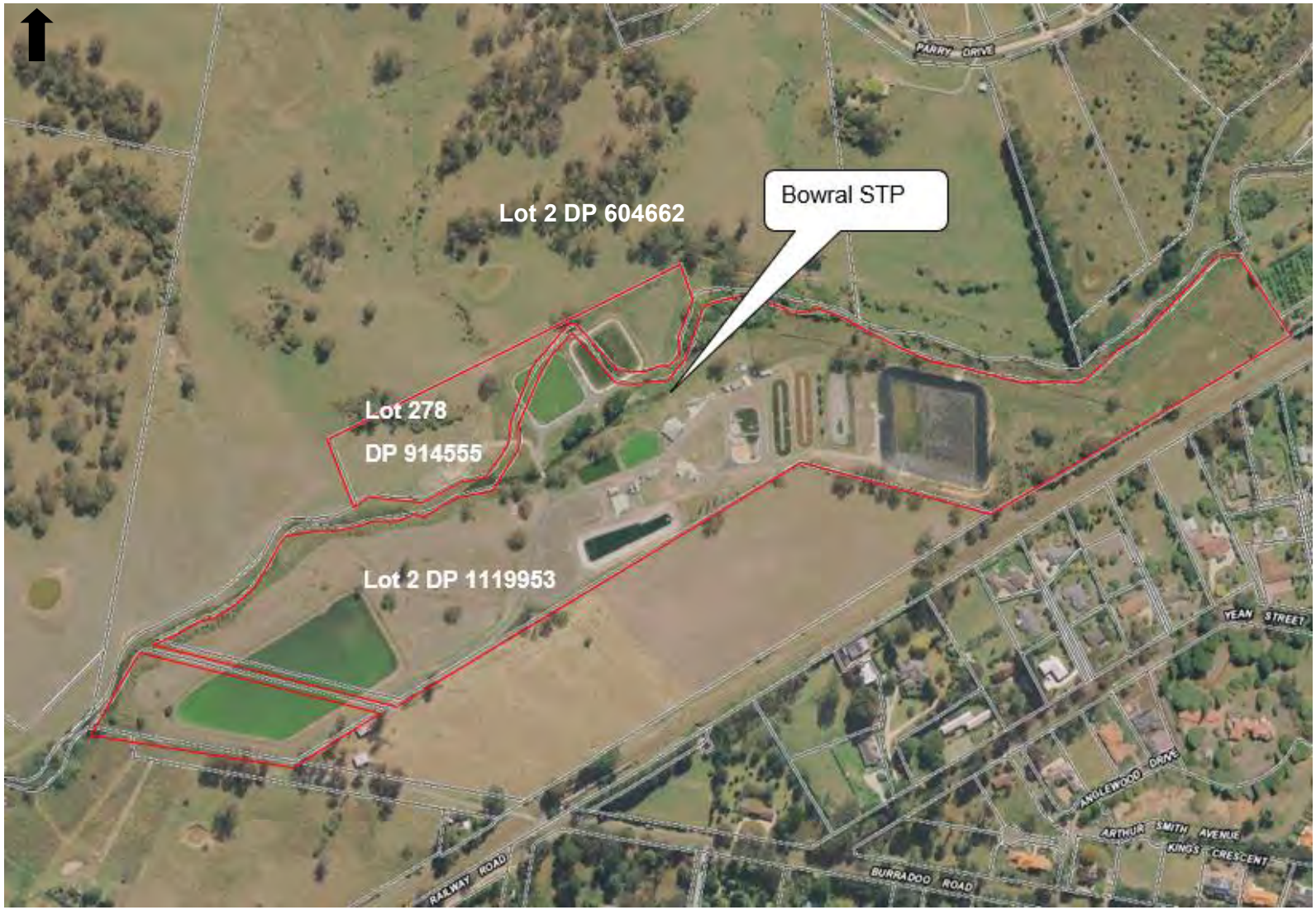


Figure 1-2 Aerial view of the existing Bowral STP site (outlined in red)

Source: SIX Maps, 2021

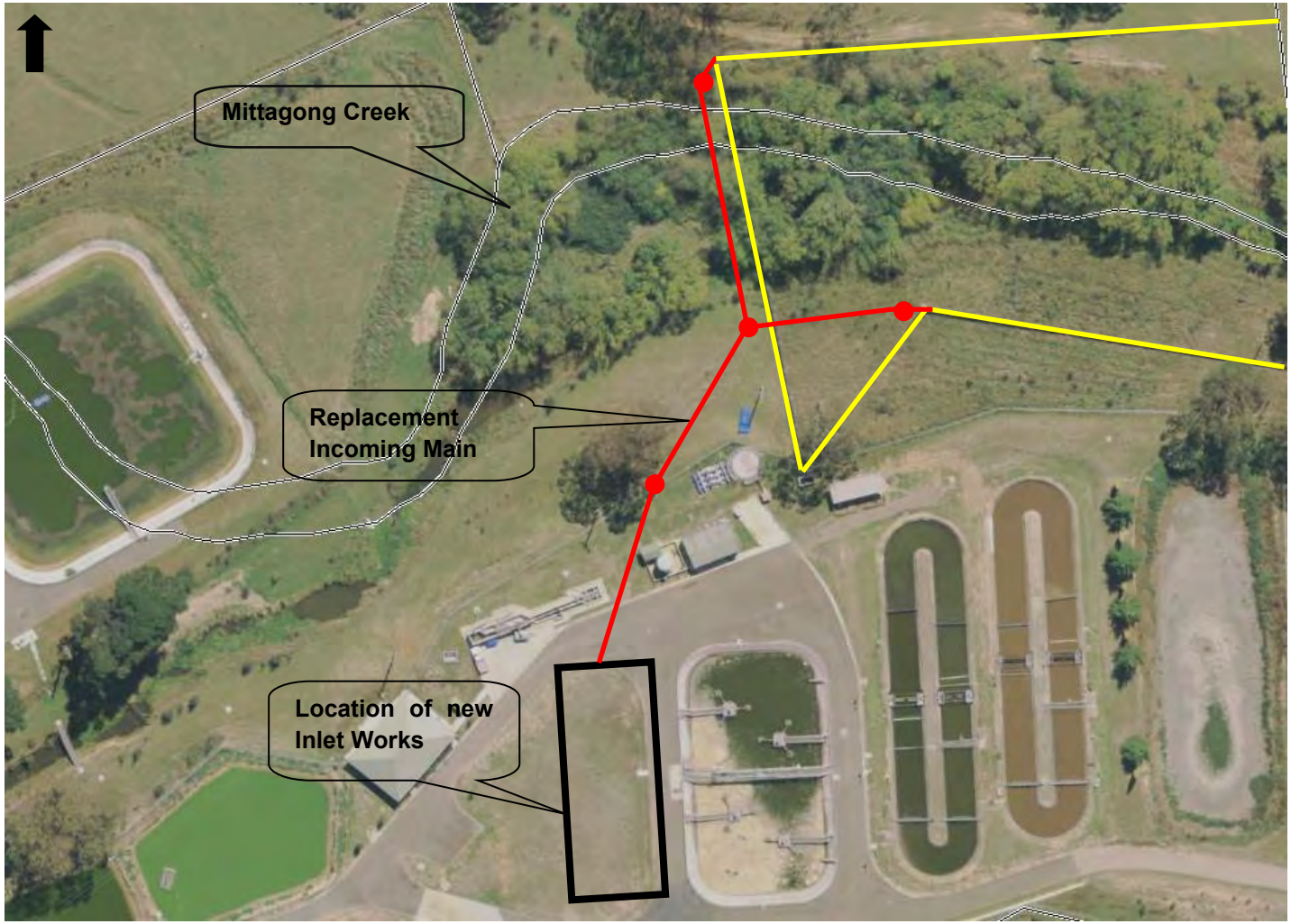


Figure 1-3 Aerial view of the existing incoming sewer main alignment (in yellow) and replacement section of the incoming sewer main and new access chambers (in red)

Source: SIX Maps, 2021

2 Statutory Planning Framework

This section presents the statutory planning and strategic policy context for the proposal.

2.1 Environmental Planning Instruments

2.1.1 Wingecarribee Local Environmental Plan 2010

The proposed replacement incoming sewer main is located within the Wingecarribee LGA. It would traverse two land use zones under the *Wingecarribee Local Environment Plan 2010* (Wingecarribee LEP 2010*),* including land zoned SP2 Infrastructure (Sewerage System) and E3 Environmental Management. Sewerage Systems and development that is ancillary to development for that purpose is permitted with consent in the SP2 zone; Sewerage systems are prohibited within the E3 zone.

However as discussed in Section 2.1.2 below, *State Environmental Planning Policy (Infrastructure) 2007* (SEPP (Infrastructure) 2007) is the relevant environmental planning instrument for the Proposal which would allow the sewer main works to proceed without development consent.

The Proposal is consistent with the objectives of the land zoned SP2; however, they are not explicitly consistent with all of the aims of the E3 land use zone under the Wingecarribee LEP 2010 through which the Proposal would traverse. However, Clause 5.12 (1) of the Wingecarribee LEP 2010 states that the LEP *does not restrict or prohibit, or enable the restriction or prohibition of, the carrying out of any development, by or on behalf of a public authority, that is permitted to be carried out with or without development consent, or that is exempt development, under State Environmental Planning Policy (Infrastructure) 2007.* Therefore, the development controls contained within the Wingecarribee LEP 2010 would not be applicable to the Proposal.

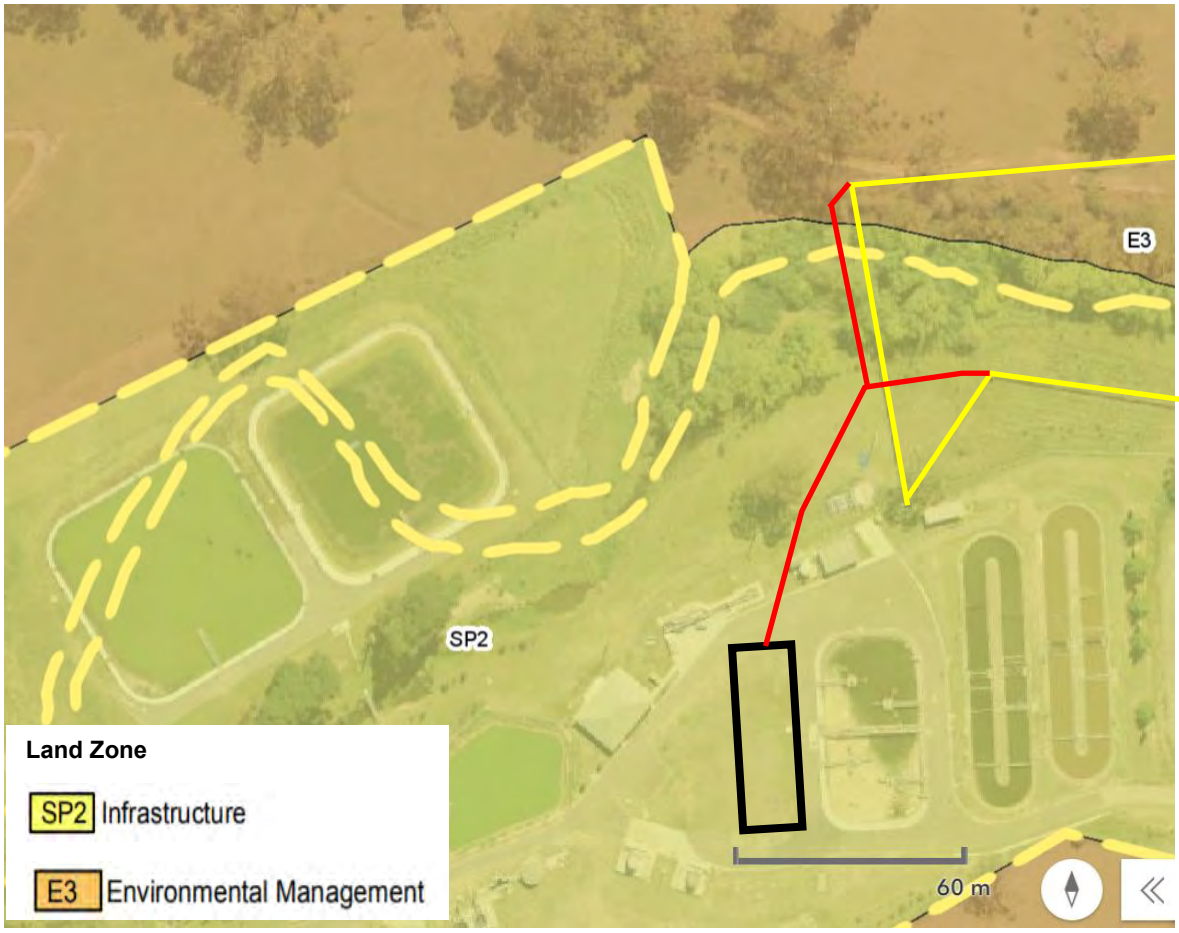


Figure 2-1 Extract from the Wingecarribee LEP 2010 Zoning Map, showing new incoming sewer main (red) and existing sewer main (yellow) locations

Source: NSW Planning Portal ePlanning Spatial Viewer - Land Zoning layer, accessed July 2021

Natural Resources and Sensitivities

Where Mittagong Creek bisects the STP site, this land is identified as Riparian Land Category 2 - Aquatic and Terrestrial Habitat on the Wingecarribee LEP 2010 Natural Resources and Sensitivity Map (see Figure 2-2 below). Clause 7.5 of the LEP requires a consent authority to consider impacts to riparian lands before determining a development application. It is noted that the Proposal does not require development consent and therefore these provisions do not apply. Nevertheless, a biodiversity assessment has been carried out to assess the potential impact on riparian land adjacent to Mittagong Creek associated with the Proposal (refer to Section 5.5).

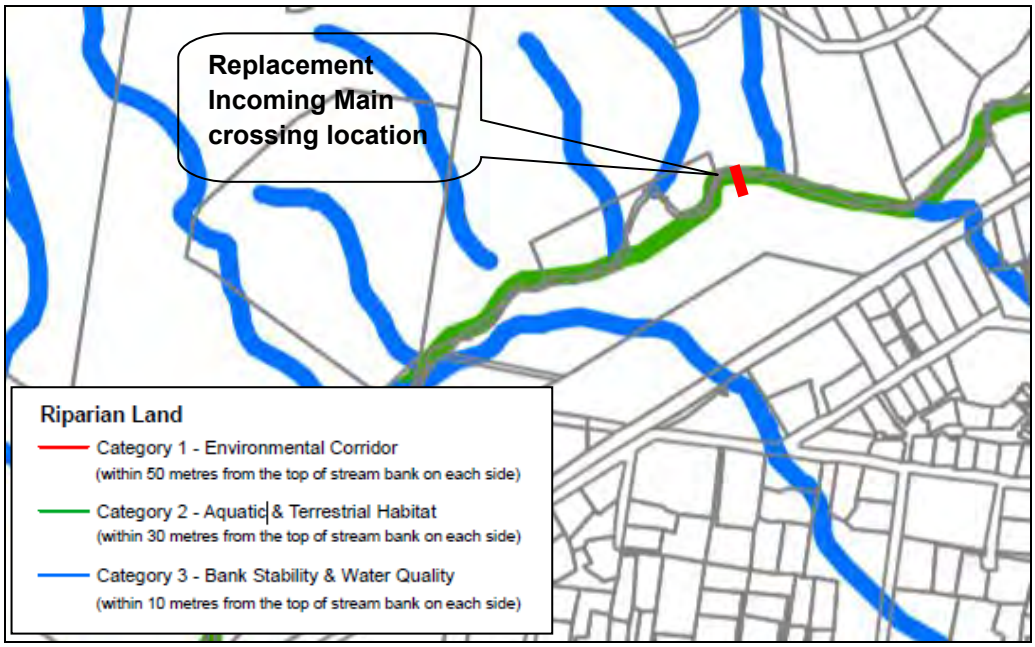


Figure 2-2 Bowral STP Natural Resources Sensitivity Map

Source: Wingecarribee LEP (2010) Natural Resources Sensitivity Map (Tile 007D)

Flood Planning

The Flood Planning Map made under the Wingecarribee LEP 2010 identifies the Proposal works site as being located in a flood prone area (see Figure 2-3). Assessment of the impact on flood planning, as well as proposed mitigation measures, are provided in Section 5.3.

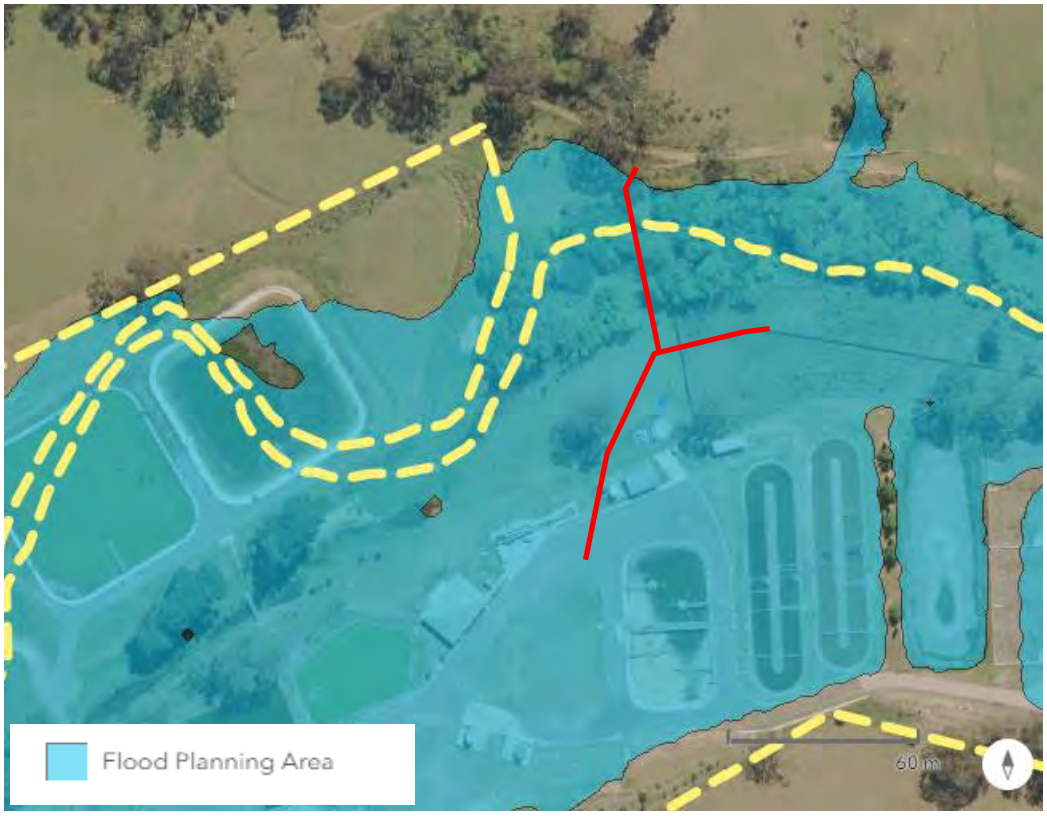


Figure 2-3 Wingecarribee LEP 2010 Flood Planning Map (new pipeline in red)

Source: NSW Planning Portal ePlanning Spatial Viewer – Flood Planning layer, accessed July 2021

2.1.2 State Environmental Planning Policy (Infrastructure) 2007

SEPP (Infrastructure) 2007 aims to assist in the effective delivery of public infrastructure throughout the State by improving certainty and regulatory efficiency through a consistent planning assessment and approvals regime for public infrastructure and services across NSW. The SEPP provides clear definition of environmental assessment and approval process for public infrastructure and services facilities.

Clauses 106(1) and 106(3B) of SEPP (Infrastructure) 2007 allow development for the purpose of sewage reticulation systems to be carried out by or on behalf of a public authority without consent on any land in the prescribed circumstances, whereby 'prescribed circumstances' are works are carried out by or on behalf of a public authority.

The SEPP removes the need for development consent for the proposed sewage reticulation works and therefore the Proposal would be assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

2.1.3 State Environmental Planning Policy (Koala Habitat Protection) 2021

State Environmental Planning Policy (Koala Habitat Protection) 2021 (SEPP (Koala Habitat Protection)) seeks to encourage the proper conservation and management of areas that provide habitat for Koalas. Schedule 1 of SEPP (Koala Habitat Protection) identifies Wingecarribee as a LGA to which this planning instrument applies. It is noted that SEPP does not apply to proposals assessed under Part 5 of the EP&A Act, nevertheless the provisions of this SEPP are considered as part of this REF.

A biodiversity assessment undertaken for the Proposal found that two Schedule 2 tree species occur at the Proposal site (Ribbon Gum and Cabbage Gum). However, no mature trees require removal for the works (See Appendix D).

2.1.4 State Environmental Planning Policy (Sydney Drinking Water Catchments) 2011

The Bowral STP site is located within the Warragamba sub-catchment, the largest of Sydney's five drinking water catchments. The *State Environmental Planning Policy (Sydney Drinking Water Catchments)* 2011 requires public authorities to consider the effect on water quality of any activity it proposes to carry out in the Sydney drinking water catchment to which Part 5 of the EP&A Act applies. Specifically, the public authority must consider whether the activity is likely to have a neutral or beneficial effect (NorBE) on water quality. It is considered that the works would meet the NorBE requirements as the new section of pipeline is being constructed to mitigate the potential for sewage overflows upstream of the STP. Appropriate erosion and sediment controls would also be implemented during construction works to ensure the NorBE requirements are met.

The SEPP also requires any development or activity proposed to be undertaken in the Sydney drinking water catchment to incorporate WaterNSW's current recommended practices and standards. The current recommended practice is are considered most relevant for this Proposal is the application of *Managing Urban Stormwater: Soils and Construction – Vol 1 (Landcom, 2004) and Vol.2A* (Department of Environment and Climate Change, 2008) ("Blue Book" Vol 1 and Vol.2A)).

2.2 NSW Statutes

2.2.1 Environmental Planning and Assessment Act 1979

The relevant environmental planning instrument for the proposal is SEPP (Infrastructure) 2007 which removes the requirement to obtain development consent. Therefore, the Proposal has been assessed under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). WSC is the proponent and the determining authority for the development.

This REF has been prepared in accordance with Section 5.5 of the EP&A Act, which requires that the proponent take into account, to the fullest extent possible, all matters affecting or likely to affect the environment due to the proposed activity. Consideration of the factors listed under Clause 228 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) has been used to assist in assessing the significance of the Proposal, and is provided in Appendix A.

2.2.2 Local Government Act 1993

Section 60 of the *Local Government Act 1993* (LG Act) states that a Council must seek approval from the Minister for Water, Property and Housing to provide for sewage from its area to be discharged, treated or supplied to any person. However, this is not applicable to the proposed STP incoming sewer main works.

2.2.3 Crown Land Management Act 2016

The Crown Land Management Act 2016 (CLM Act) has consolidated eight pieces of legislation, including the (former) *Crown Lands Act 1989*. The aim of the Act is to reduce complexity and duplication with regards to the management of Crown lands.

Section 9.2 of the CLM Act relates to the unauthorised use of Crown land, and states that it is an offence to erect a structure, clear or dig up Crown land without a lawful authority.

As noted in Section 1.4, the bed of waterways are considered Crown land. Accordingly, any works located within the bed of Mittagong Creek would require authorisation by a lease, licence or other permit from the Department of Planning, Industry and Environment (DPIE) – Crown Land. It is noted that the new sewer main would cross over Mittagong Creek via an aerial crossing, avoiding the creek bed as the piers would be located on top of adjacent banks. As such, it is considered that a licence would not be required for the Proposal.

2.2.4 Pipelines Act 1967

The *Pipelines Act 1967* aims to:

- implement a timely and efficient approvals system to facilitate the construction of cross-country transmission pipelines in New South Wales;
- ensure the effect of a pipeline project commenced under the Act on the environment, landowners and native titleholders is properly considered and managed;
- ensure pipeline licensees protect the environment, pipeline employees and the public from dangers arising from both pipeline construction and the transmission of potentially hazardous substances.

Under the *Pipelines Act 1967*, any person who wishes to construct and operate a pipeline for the purposes of any substance, can do so under an authorisation or Licence.

However, Section 5 of the *Pipelines Act 1967* has a number of exemptions to a licence under that Act, including a pipeline constructed by a public authority. Therefore, this Act does not apply to the Proposal.

2.2.5 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) provides for the statutory protection of Aboriginal cultural heritage places, objects and features. One of the objects of the NPW Act is the conservation of places, objects and features of significance to Aboriginal people (Section 2A). The NPW Act provides for the management of both Aboriginal Objects and Aboriginal Places.

Aboriginal Objects and Aboriginal Places are protected under Part 6 of the NPW Act and there are legislative penalties if a person harms or desecrates an Aboriginal Place or Object (s. 86). Harm to an Aboriginal Place or Object includes any act or omission that destroys, defaces or damages the object or place, or, in relation to an Aboriginal object, moves the object from the land on which it had been situated.

However, harm to an Aboriginal Object that is 'trivial or negligible' does not constitute an offence. Also, it is a defence against prosecution for unintentionally harming Aboriginal Objects if due diligence had been exercised to determine that no Aboriginal object would be harmed, or the harm or desecration was authorised by an Aboriginal heritage impact permit (AHIP).

An Aboriginal Objects Due Diligence Assessment report (provided in Appendix C) carried out for the Proposal determined that the proposed works can proceed with caution as no Aboriginal sites are located within the Proposal site. Accordingly, no impact to Aboriginal heritage is expected as a result of this proposal and therefore no approval under the NPW Act would be required. No further archaeological investigations and/or an AHIP are required and the works can proceed with caution in accordance with the mitigation measures in this REF addendum and the original REF (see Section 5.6).

2.2.6 Heritage Act 1977

The *Heritage Act* 1977 protects the State's natural and cultural heritage and contains measures to protect archaeological remains. More specifically, it provides protection for European/historic relics and sites.

A search of the State Heritage Inventory did not identify any items located along or in proximity to the replacement sewer main alignment. Accordingly, it is considered that the works can be carried out to avoid impacting all identified heritage items, as discussed in Section 5.7. No approval under the *Heritage Act* 1977 is required.

2.2.7 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) regulates air, noise, land and water pollution. The Environment Protection Authority (EPA) is generally responsible for implementing the POEO Act and would be the appropriate regulatory authority for the proposal.

Schedule 1 of the POEO Act lists scheduled activities which are required to be licensed by the EPA. The replacement sewer main does not constitute a scheduled activity listed under Schedule 1 of the POEO Act and therefore an EPL is not anticipated to be required.

Section 120 of the POEO Act makes it an offence to pollute waters. It is considered that the construction and operation of the Proposal can be carried out without causing water pollution; as appropriate mitigation measures would be implemented to prevent water pollution during the works. Therefore, a licence is unlikely to be required under Section 120 of the POEO Act for the pollution of waters.

Other relevant provisions of the POEO Act include:

- Section 115 – It is an offence to dispose of waste in a manner that harms or is likely to harm the environment.
- Section 116 – It is an offence to cause any substance to leak, spill or otherwise escape (whether or not from a container) in a manner that harms or is likely to harm the environment.

2.2.8 Protection of the Environment Operations (Waste) Regulation 2014

The *Protection of the Environment Operations (Waste) Regulation 2014* sets out the provisions with regards to non-licensed waste activities and non-licensed waste transporting, in relation to the way in which waste must be stored, transported, and the reporting and record-keeping requirements.

The proposed works including disposal of construction waste and spoil and operational water by-products would be undertaken to be consistent with the requirements of this regulation.

2.2.9 Water Management Act 2000

The objects of the *Water Management Act* 2000 (WM Act) are to provide for the sustainable and integrated management of the water sources of the state for the benefit of both present and future generations.

The proposed works involves the carrying out of a controlled activity (that is, carrying out of work or excavation) as defined under the WM Act. Section 91(E) of the WM Act states that a controlled activity cannot be carried out in, on or under waterfront land otherwise than in accordance with a controlled activity approval. However, Clause 41 of the *Water Management (General) Regulation 2018* (WM (General) Reg) states that public authorities are exempt from the requirement to obtain a controlled activity approval. Therefore, this approval would not be applicable to the works.

Section 91(F) of the WM Act states that an aquifer interference activity cannot be carried out without, or otherwise than as authorised by, an aquifer interference approval if more than 3 ML of groundwater is taken per year. However, if less than 3 ML of groundwater is encountered during the proposal works, the quantity of extracted water should be recorded and an aquifer interference activity exemption should be recorded with the DPIE – Water, Natural Resources Access Regulator (NRAR).

2.2.10 Biodiversity Conservation Act 2016

The Biodiversity Conservation Act 2016 (BC Act) protects species of threatened flora and fauna, endangered populations and endangered ecological communities and their habitats in NSW. It also lists each Key Threatening Process that adversely affects threatened species, populations or ecological communities or that may cause species, populations or ecological communities that are not threatened to become threatened.

A biodiversity assessment undertaken for the proposal identified one threatened flora species (Camden Woollybutt) during the field survey listed under the BC Act. A copy of the report is provided in Appendix D. However, no significant impact on the identified species is expected and no areas of outstanding biodiversity value are affected by the Proposal. Therefore, an SIS is not required, provided that the mitigation measures proposed are implemented (see Section 5.5).

2.2.11 Biosecurity Act 2015

The *Biosecurity Act 2015* guides the management of weeds at the regional level throughout NSW. Under the Act, all plants are regulated with a general biosecurity duty to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant who knows or ought to know of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable. Individual land holders and managers are required under the Act to control priority weeds for their area according to the relevant biosecurity toolset.

Four weed species (Blackberry, Fireweed, White Willow, Black Willow) listed under Schedule 3 of the *Biosecurity Regulation 2017* were identified within the proposal works area. Weed species within the Proposal site would be managed in accordance with the *Biosecurity Act 2015 and the Biosecurity Regulation 2017*.

2.2.12 Fisheries Management Act 1994

The objects of *the Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. In particular, the objects of this Act include:

- to conserve fish stocks and key fish habitats, and
- to conserve threatened species, populations and ecological communities of fish and marine vegetation, and
- to promote ecologically sustainable development, including the conservation of biological diversity.

The Act includes schedules of threatened aquatic species, populations and ecological communities, which must be considered in accordance with Section 5A of the EP&A Act. The installation of instream structures, the degradation of native riparian vegetation along New South Wales water courses and the removal of large woody debris from New South Wales rivers and streams are listed as a key threatening process under the Schedule 6 of the FM Act.

A biodiversity assessment has been prepared to assess impacts to threatened species and is attached in Appendix D. The assessment concluded that no key threatening processes are

associated with the proposal and no species or communities listed under the FM Act are considered likely to be impacted by the proposal (see Section 5.5).

Section 200 of the FM Act requires a local government authority to obtain a permit for dredging or reclamation works in waterland. For the purposes of Section 200 of the FM Act, dredging works includes any work that involves excavating water land, and reclamation work includes:

(a) using any material (such as sand, soil, silt, gravel, concrete, oyster shells, tyres, timber or rocks) to fill in or reclaim water land, or

(b) depositing any such material on water land for the purpose of constructing anything over water land (such as a bridge), or

(c) Draining water from water land for the purpose of its reclamation.

Waterland includes land submerged by water whether permanently or intermittently, or whether forming an artificial or natural body of water. The pipeline crossing of Mittagong Creek would be constructed as an aerial crossing with the support piers located on the top of the creek banks . As such, the works would not require dredging or reclamation works within waterland. Therefore a permit under section 200 of the FM Act would not be required for the Proposal.

Mittagong Creek is also identified as Key Fish Habitat (refer to Figure 5-2). The replacement incoming main would cross Mittagong Creek. However, as an aerial crossing is proposed, the works would not impact fish habitat or passage.

A biodiversity assessment was undertaken for the Proposal to assess the vegetation surrounding creek line. The assessment concluded that the Proposal would be located within an existing disturbed area with no unique habitat value. The works would result in the disturbance and temporary removal of a very small area of riparian vegetation surrounding the creek. However, the area is expected to return to pre-works condition following completion of the works. Refer to Section 5.5 and Appendix D.

2.2.13 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) provides for Commonwealth involvement in development assessment and approval in circumstances where there exist 'matters of national environmental significance'. Matters of national environmental significance include:

- World heritage properties
- National heritage places
- Wetlands of international importance
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mining)

- A water resource, in relation to coal seam gas development and large coal mining development

A biodiversity assessment has been prepared for the Proposal to assess impacts to threatened species and ecological communities listed under the EPBC Act(Appendix D). Two Camden Woollybutt trees (listed as an endangered under the EPBC Act) are located in the Proposal works area, however these would not be impacted. The biodiversity assessment concluded that it is unlikely that the Proposal would significantly impact any Matters of National Environmental Significance as listed under the EPBC Act, therefore referral to the Commonwealth under the EPBC Act is not required for the Proposal (See Section 5.5).

2.3 Summary of Approvals

The following table provides a summary of the approvals required for the Proposal. Council would be responsible for ensuring that all permits and approvals are obtained, either by Council or by others on behalf of Council, prior to commencement of the relevant works.

Table 2-1 Summary of Approvals and Requirements

Agency	Requirements	Reference
Wingecarribee Shire Council	Determination of the proposal	Pt 5 of EP&A Act
Private Landowners	Landowner notification for construction of sewerage works within private property	N/A

2.4 Consultation

Relevant government agencies were consulted during the preparation of the original REF and additional consultation was carried out for the REF addendum. The responses received are provided in Table 2-2 below and copies of the letters are in Appendix F.

Table 2-2 Agency Consultation

Agency	Summary of Comments	Where Addressed in REF
Department of Primary Industries – Fisheries (DPI-Fisheries)	DPI - Fisheries request that the advice issued in our initial response to this project (Bowral STP Upgrade) be applied to the new scope of works. Comments from previous DPI Fisheries consultation for the original REF are provided below.	Noted.
	The REF should include:	
	• Location of works (including topographic map and photos).	Section 1
	• Name of adjacent waterway(s).	Mittagong Creek
	• Description of works to be undertaken.	Section 4
	• Description and condition of aquatic habitats (watercourses, wetlands) located on the site and downstream of the site in Mittagong Creek. In particular, description of the aquatic and riparian habitat conditions at and adjacent to proposed STP site and waterway discharge site – particularly extent and condition of riparian vegetation, water depth, and permanence of water flow and snags (large woody debris).	Refer to original REF and Section 5.4 and 5.5
	• Analysis of any interactions of the proposed works with aquatic and riparian environments. In particular details of any impacts on aquatic habitats and riparian areas associated with pipeline crossings of waterways and proposed construction methods	Section 5.4 and 5.5
	• Safeguards to mitigate any impacts upon aquatic environments and riparian habitats.	Refer to original REF and Section 5.3, 5.4 and 5.5
	• Potential impacts on any aquatic threatened species, populations and ecological communities listed under the Fisheries Management Act 1994 and safeguards to mitigate any potential impacts.	Refer to original REF and Section 5.3, 5.4 and 5.5
	• Details of proposed revegetation of adjacent riparian buffer areas.	Section 5.5

Agency	Summary of Comments	Where Addressed in REF
WaterNSW	Regarding the sewer main replacement works, Water NSW requests that the risks of an above ground crossing of Mittagong Creek be assessed in the Addendum REF including:	
	• spillage of any raw sewage into Mittagong Creek from leaks in the pipe	Section 5.4
	• any potential damage to the pipe during flooding events from debris in Mittagong Creek	Section 5.4
	• potential for flooding of the effluent management ponds in the STP from flooding caused by debris being trapped on the pipe creating unpredictable streamflow pathways during flood events.	Section 5.4
	• consideration of alternative design options including under-boring or trenching of the sewer main across Mittagong Creek.	Sections 3 and 4
Environment Protection Authority (EPA)	The EPA has reviewed the proposal and requests that the REF include consideration of the following:	
	• A description of the function and integration of the new sewage main in the sewerage system.	Section 4
	• The locations and expected reductions in frequency and volume of sewage overflows.	Sections 3 and 4
	• Whether upstream overflows are likely to occur before STP bypasses in wet weather events.	Sections 3 and 4. Section 5.4
	• Whether the new manhole will function as an overflow point or be secured to prevent overflow.	Section 5.4
	• Measures to minimise construction impacts from noise emissions and stormwater pollution. For reference, the EPA's relevant guidelines are as follows: o Interim Construction Noise Guideline, July 2009. o Managing Urban Stormwater Soils, Construction, Volume 2A, Installation of Services, January 2008.	Original REF. Section 5.3.2

Agency	Summary of Comments	Where Addressed in REF
Department of Planning, Industry and Environment (DPIE) - Water (DPIE- Water)	No response received to the consultation letter issued on 10 March 2021 requesting a response within 21 days.	N/A
DPIE – Biodiversity, Conservation and Science Directorate (DPIE-BCS)	No response received to the consultation letter issued on 10 March 2021 requesting a response within 21 days.	N/A
DPIE- Crown Land	No response received to the consultation letter issued on 10 March 2021 requesting a response within 21 days.	N/A
NSW Health - South Western Sydney Local Health District	No response received to the consultation letter issued on 10 March 2021 requesting a response within 21 days.	N/A
Heritage NSW	No response received to the consultation letter issued on 10 March 2021 requesting a response within 21 days.	N/A

3 Proposal Justification

This section provides the justification for the proposal and a summary of the options considered.

3.1 Justification and Options Evaluation

The project context and justification for the Bowral STP upgrade works is provided in the original REF and therefore has not be duplicated in this report.

Sewer flow containment modelling undertaken on the Bowral sewage conveyance system in 2014 identified a number of improvement opportunities, including the upsizing of the incoming main directly upstream of the STP, in order to resolve the predicted overflows from upstream access chambers (manholes). As such, WSC intends to replace a section of the existing 450 mm incoming sewer main pipeline with a new 675 mm pipeline. The new section of the incoming main also needs to be slightly realigned to facilitate it's integration with the new STP inlet works, which will be located in a different area of the upgraded STP site.

The need replace the existing incoming main to the STP site with a larger 675 mm diameter pipeline was identified as part of sewer flow containment modelling carried out in the *Bowral Sewerage Catchment Flow Containment Report (Urban Water Solutions, 2014*). The upsizing of the incoming main is required to resolve predicted upstream overflows during high flow periods; therefore, retaining the existing incoming main is not considered an option. Furthermore, the incoming main requires realignment to provide a direct route to interface with the proposed new inlet works; undertaking the construction works and commissioning the replacement incoming main concurrently with the STP upgrade works is considered to be the most practical method of replacing the pipeline in order to minimise impacts and interruptions to existing the pipeline and STP's operation. Furthermore, during operation, the proposed upsized incoming main would reduce the risk of sewage overflows and uncontrolled discharges into Mittagong Creek.

An aerial pipeline crossing of Mittagong Creek is considered the only viable option for the replacement incoming main as the pipeline is a gravity main. As a result, the pipeline invert levels are governed by the invert of the upstream manhole on the northern bank and the existing surface levels at the STP site. Accordingly, underboring and open trench creek crossing methods for the replacement incoming main are not considered feasible options. However, once the incoming main reaches the STP site on the southern side of the creek, ground surface levels allow for the replacement main to be installed below ground to the STP inlet works.

4 Description of the Proposal

This section provides a description of the Proposal which is assessed in this REF addendum.

4.1 Incoming Main Description and Design

The proposed replacement of the incoming sewer main comprises the following new components:

- New incoming gravity main (675 mm diameter) from the new upstream manhole to the STP site to be aligned to the west of the existing main so as to provide a direct route to the proposed new inlet works on the STP site.
- Approximately fifteen piers to support the aerial section of the pipeline.
- Four new access chambers (man holes) at sewer main intersection points. One on the northern side and three on the southern side of Mittagong Creek.

The replacement section of the Bowral STP incoming gravity main comprises the construction of a new 675 mm Mild Steel Cement Lined (MSCL) pipeline approximately 160 m in length (comprising two 31 m and 129 m long intersecting pipeline alignments). The new incoming main would run parallel and to the west of the existing 450 mm diameter pipeline across Mittagong Creek, and in the low lying areas on the southern bank of the creek, as an aerial crossing, supported by approximately 15 reinforced concrete piers installed at 6 m intervals. The new main would be connected to the two existing incoming mains on the southern and northern side of the creek. The number, height (max. 1.5 m) and position of the new piers would be based on the design of the existing incoming main's piers.

An approximately 40 m long section of the new incoming main within the STP site would be installed below ground within concrete encasing, following an alternative alignment to the new STP inlet works, as shown in Figure 1-3 and Figure 4-1.

Four new concrete access chambers (man holes) with secured lids would also be constructed; two at the locations where the new incoming main connects with the existing mains, one where the proposed new mains connect, and one at a change in direction to align to the inlet works. One access chamber would be located on the northern side of Mittagong Creek and three access chambers would located on the southern side of the creek within the STP site (see Figure 4-1).

Once the construction of the new section of the incoming gravity main has undergone hydrostatic testing, commissioning and is operational, the existing disconnected sections of the existing incoming main would be made redundant.

A copy of the designs is provided in Appendix B.

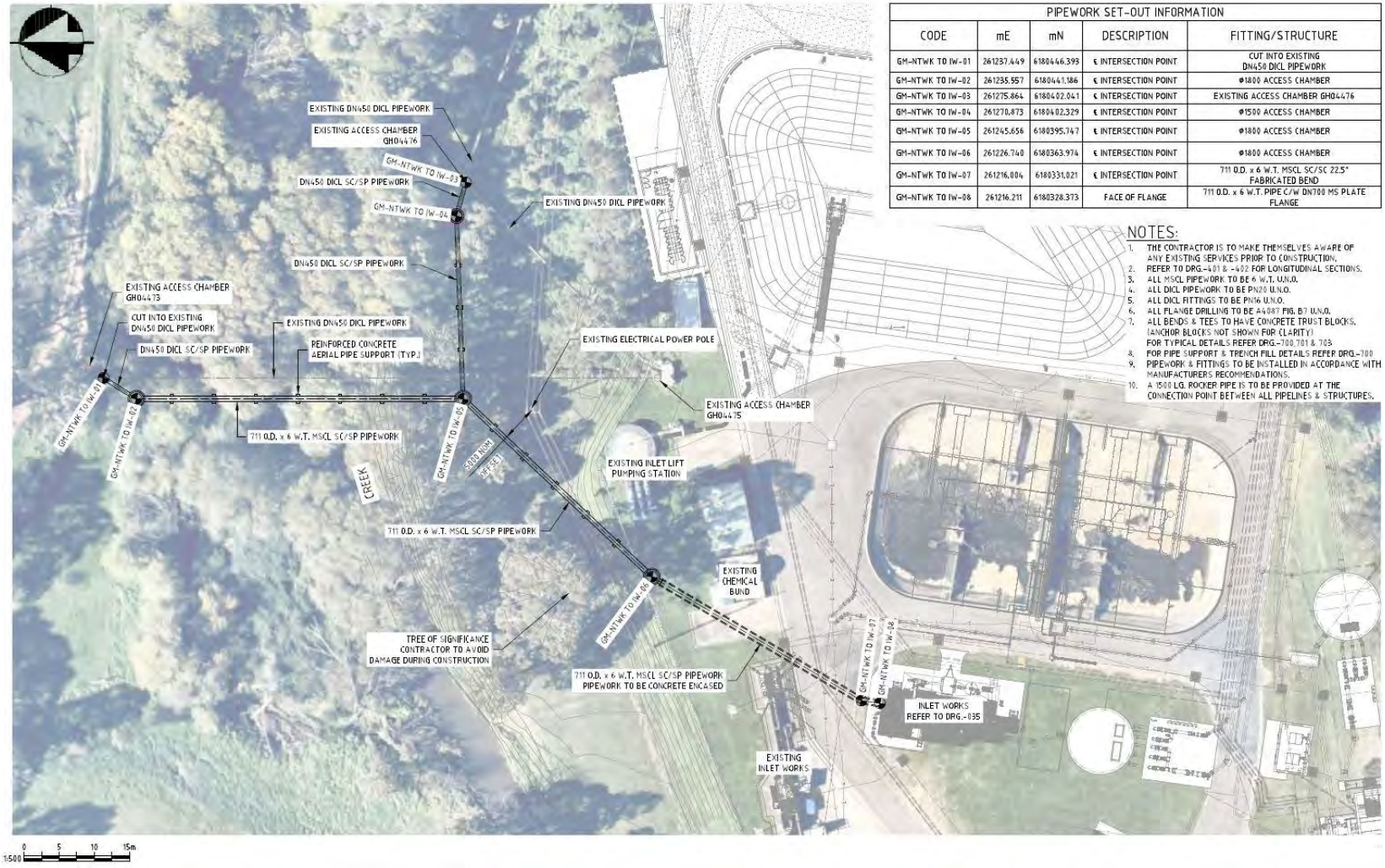


Figure 4-1 Replacement Incoming Main Layout (refer to Appendix B for annotation details)

Source: hunter h_20, 2021

4.2 Construction Methodology

The proposed construction methodology would be dependent on a number of factors including the detailed design specification and the contractor's method, equipment and program. A general construction methodology has been predicted based on past experience with construction of similar sized pipelines. Further details regarding the STP upgrade works construction methodology and staging is provide in the original REF, as the new incoming main works would form a works package of the Bowral STP upgrade construction works.

4.2.1 Construction Equipment

The following construction equipment may be required:

- Bobcat;
- Excavator/ backhoe;
- Trucks carrying construction materials;
- Mobile crane/lifting equipment;
- Compressors ,concrete mixers;
- Dewatering pump (to pump out groundwater if required);
- Concrete/pipe cutter;
- Hand Tools (pneumatic and manual)
- Passenger vehicles to transport construction workers.

It is anticipated that the Mittagong Creek crossing construction works would be completed during low rainfall/stream flow conditions and that only several of the 15 piers would need be installed in the area of the creek line.

A detailed construction methodology would be prepared and submitted by the Construction Contractor prior to commencement of the STP upgrade works. The methodology would include the following in relation to the new incoming main works:

- A plan showing the existing pipeline, new pipeline alignment, temporary work areas and protective areas
- A long section of the proposed pipeline indicating invert levels, details of bends and length of pipe etc.
- Details of access upgrades necessary for the construction
- Details of machines and trucks and their indicative movement pattern
- A program indicating the anticipated the time taken for the construction of the new incoming main
- Detailed methodology of construction including erosion and sediment controls, dewatering, shoring, concreting, trenching (where applicable), pipe installation, concreting, removal of redundant pipework, removal of excavated material, pressure testing, ground stabilisation and site restoration.

The redundant section of pipeline would be removed as part of the construction works. Creek bank areas and ground surface would be stabilised post-works using groundcover vegetation and mesh if required.

A Staging Plan and Interface Strategy has been prepared as part of the Detailed Design Report for the proposed Bowral STP upgrade (hunterh$_2$o, 2021). The incoming main construction works and commissioning would be carried out as part of the cut over to the new STP treatment process once sufficient new upgraded plant infrastructure is available to be operated..

This phase involves connecting the incoming gravity main to the new inlet works. Diverting the rising main from the existing inlet works would be completed within a normal shutdown window for the upstream pump station. The new pipework would be laid from the inlet works back to the incoming main interface point ahead of the shutdown and then cutover when required.

The design allows for as much of the new incoming main pipework as possible to be constructed ahead of the cutover. The two existing incoming mains are also combined within a common pit outside of the existing STP footprint to minimise the quantity of pipework / crossing required.

The new incoming main arrangement accommodates a number of constraints;

- Avoiding the drip line of the 'significant' tree adjacent to the existing inlet lift pump station, zone of influence of the existing power pole and edge of the existing chemical bund
- The East Bowral Main has to cross the Bowral Main on grade
- Crossing the gravity feed pipes from the existing inlet works to existing secondary process
- Crossing the ring road on grade into the new inlet works.

The majority of the new pipeline and all access chambers (man holes) would be constructed prior to any shutdowns. Some sections of pipeline crosses gravity pipes on similar grades (Bowral Trunk Main, gravity pipework from the existing inlet works to the secondary process and inlet works bypass pipework) and once work commences on these sections, it would not be possible to revert back to the existing operational configuration (i.e. works must be completed within a single shutdown). As a result, these cutover works would require careful planning and effective execution to mitigate non-compliance risks (i.e. avoid any sewage spills).

The Construction Contractor would develop a detailed construction methodology prior to the commencement of construction works, including cutover plans and extensive consultation with WSC to effectively mitigate risks.

4.3 Construction Environmental Management

Construction of the proposal would be undertaken in accordance with a Construction Environmental Management Plan (CEMP) that would be prepared by the construction contractor/s and approved by WSC prior to commencement. The CEMP would incorporate all mitigation measures identified in the original REF and this REF addendum, as well as any conditions of approval and any other licence/approval conditions. The CEMP would also

incorporate an emergency response plan in case of a pollution incident, a complaints handling procedure and a 24 hour telephone contact number. A list of the mitigation measures recommended for the Proposal is provided in the original REF, with additional mitigation measures to be provided in Section 6.

5 Environmental Assessment

This section identifies and characterises the existing environment, the likely potential impacts associated with the construction and operational phases of the Proposal and any associated mitigation measures. Where considered necessary, feasible mitigation measures are identified for implementation as part of the proponent's environmental management.

5.1 Assessment Methodology

The key objectives of this assessment are to:

- Identify those facets of the environment likely to be affected by the proposal during both construction and operation;
- Identify the sensitivity of the site;
- Identify and characterise the associated impacts; and
- Identify and evaluate feasible mitigation measures for the identified impacts.

Environmental issues of potential relevance to the proposal include:

- Land use and ownership
- Topography and soils
- Water Quality
- Biodiversity
- Aboriginal heritage
- Historic heritage
- Noise and vibration
- Air quality
- Traffic and access
- Waste management
- Visual amenity
- Bushfire

5.2 Land Use and Ownership

Information on the Bowral STP site location and setting is provided in the original REF.

The new incoming main would be located within the north-eastern section of the STP site (Lot 2 DP 1119953), Mittagong Creek and a small area of freehold land (Lot 2 DP 604662) on the northern side of Mittagong Creek which comprises rural agricultural land.

The closest residential dwellings to the Proposal works site are located approximately 180 m and 280 m north-east of the works site respectively.

The new incoming main would be constructed parallel to and on the western side of the existing pipeline, across Mittagong Creek. However, the new main would be realigned within

the STP site to allow for a direct connection to the new STP inlet works. It is noted there is an existing easement from the STP via the existing sludge lagoons to the manhole located on the northern side of Mittagong Creek; this easement provides access to the northern side of the creek line.

5.2.1 Impact Assessment

The replacement incoming main construction works would be carried out in the later stages of the STP upgrade works program, as part of the change over process to the new STP treatment system. Access to the northern side of Mittagong Creek would be available via access roads within the STP side and private property to the north, as there is no designated access from a main road. The construction works on the southern side of the creek would access the site via the existing STP access roads and temporary access tracks required for the STP upgrade works. In general, a 5-10 m wide disturbance footprint is anticipated for construction of the new incoming main.

Construction works associated with the proposed new pipeline may cause some temporary disruption to the adjoining private landowner to the north, as well as local road users and residents of township through increased traffic movements during construction and construction noise. However, due to the temporary nature of the works and the location of the pipeline construction works located some distance from surrounding residences and the Bowral town centre; these impacts are not anticipated to be significant, assuming implementation of the mitigation measures listed in the original REF.

WSC or authorised parties are permitted to enter any premises for the construction and maintenance of Council's sewerage works under Section 191A of the *Local Government Act 1993*. WSC would be required to notify and preferably receive consent from the freehold landowner to the north of the STP site for access and construction works within private property on the northern side of Mittagong Creek. Council is currently preparing a 'Community Engagement Plan' for the Proposal and has identified communicating with this landowner regarding the works required to be undertaken and access during construction.

Local government authorities are required obtain a permit from the Department of Primary Industries (DPI) - Fisheries for dredging or reclamation works in waterland, or construction works which result in blockages to fish passage. Based on the location of the existing pipeline's piers, which are located on the bank adjacent to the creek line, it is anticipated that the new pipeline and piers would not be constructed within waterland. Approval should, however, be sought from DPI - Fisheries prior to undertaking any excavating and/or reclamation works or the blockage of fish passage at the Mittagong Creek crossing if the works will impact upon waterland.

The operation of the new STP infrastructure would be similar to existing STP operation and therefore would not affect current land use practices of adjoining land to the north or the STP site. The new works have been designed so as not to interfere with the provision of services (such as water and electricity supply and telecommunication), or the maintenance of assets (such as roads, and bridges) within and outside of the STP site.

5.2.2 Mitigation Measures

- Notification (including a Notice of Entry, if required) must be provided to the freehold landowner to the north of the STP site prior to the commencement of construction works, to access the private property and for the construction of the proposed sewerage infrastructure works within private land.

5.3 Topography and Soils

The general geological setting, topography and soils at the Bowral STP site is described in the original REF.

The following information on has been taken from the *Bowral Sewage Treatment Plant Geotechnical Investigation Report* (D&N Geotechnical, 2021). A copy of the report is provided in Appendix E.

Two hand augered boreholes were drilled in the northern and southern creek bank areas approximately 25 m to the west of the Proposal works site, to 0.65 m and 2 m depth, respectively.

The borehole on the northern bank found that wet, stiff to very stiff, medium plasticity Clay Residual Soil with brown, mottled orange-brown colour, with fine to medium, sub-angular gravel of present to the maximum 0.65 m depth of investigation.

The borehole investigation on the southern side of the creek line found that Sandy Silt Fill, dark brown, fine to medium sand, with rootlets underlain by Clay Fill of medium plasticity, orange and grey, trace fine to coarse, sub-angular gravel, brick and asphalt fragments >40 mm was present to 0.4 m depth. The Fill layer is underlain by Sandy Silt Topsoil with a low liquid limit, dark brown, fine to coarse sand, with rootlets between 0.4 – 0.7 m. A subsurface Residual Soil layer of Sandy Clay is present comprising stiff to very stiff, medium plasticity, grey, mottled orange-brown, fine to coarse sand, trace fine to medium, sub-angular gravel between 0.7 m to 2 m maximum depth of investigation.

Based on Atterberg Limit testing and tactile assessment, the site soils are generally of low to medium plasticity. Some high plasticity soils were observed which would be expected to return a slightly lower California Bearing Ratio (CBR) value that those observed. A design CBR of 5% is therefore recommended for design to reflect potential soaked conditions and variability from the samples tested, during the lifetime of the pavements within areas of clayey subgrades.

5.3.1 Impact Assessment

The construction of the Proposal would result in ground disturbance due to excavation required for the installation of the access chambers, the piers for the above ground sections of the main and the underground (buried) section of the new incoming main.

The geotechnical investigation noted that where natural soils are exposed, no filling is required. However, where fill is present, unless there are records confirming that the existing fill has been compacted in accordance with an engineering specification, this material should be classified as uncontrolled and is not considered suitable as a foundation for structures (such as piers) due to the potential for differential settlement. Therefore, it has been

recommended that the existing fill materials be subject to excavation and recompaction (if suitable) or replaced with engineered fill.

Site soils should generally be suitable for use as engineered fill, provided unsuitable materials such as organics, highly plastic material, waste and oversized particles are removed. Re-used material should be screened for such physical contaminants, reworked, and compacted as controlled fill.

The recommendations and specifications for earthworks and foundations works provided in the geotechnical investigation prepared for the Proposal (D&N Geotechnical, 2021) should be implemented for the pipeline pier and trenching construction works.

There is the potential for erosion and movements of excavated materials off-site during the pipeline construction works and an Erosion and Sediment Control Plan (ESCP) would need to be prepared to , prevent any impacts off-site, including sedimentation of drainage lines and waterbodies. Stabilisation of the disturbed areas following works would also be required. It should be noted that although a number of mitigation measures to protect water quality have been listed in the original REF, further site specific plans and construction details would be included in the CEMP for the works when further detail regarding the construction methodology is known.

Although a moderate volume of earthworks are proposed it is assessed that the impacts can be adequately managed through the implementation of appropriate mitigation measures and therefore the overall impact is assessed to be low.

The new incoming main would be inspected and tested post-construction to ensure all areas of disturbance are appropriately sealed and stabilised and erosion and sediment loss is not occurring. Provided the site is stabilised, no impacts to soils are expected post construction.

5.3.2 Mitigation Measures

- A detailed Erosion and Sediment Control Plan (ESCP) shall be prepared as part of the CEMP. The ESCP would describe the site specific measures to be implemented for all works areas, in accordance with the guidelines outlined in the 2004 Landcom publication *Managing Urban Stormwater: Soils and Construction*, 4th edition (“The Blue Book”) and *Volume 2A Installation of Services*.
- The recommendations and specifications provided in the geotechnical investigation (D&N Geotechnical, 2021) should be followed for earthworks and foundations works during the Proposal construction works.

5.4 Water Quality

Surface Water

Mittagong Creek would be intersected by the proposed pipeline. It is noted that the existing pipeline was constructed as an aerial crossing and the area has been subject to previous disturbance.

Flooding

The Proposal works area is mapped as within Flood Planning area under the Wingecarribee LEP 2010 (refer to Figure 2-3). Topography of the STP site is relatively flat, sloping gently from north to south making the majority of the low lying areas prone to flooding.

Groundwater

Groundwater was not observed during auger drilling within either of the boreholes adjacent to Mittagong Creek as part of the geotechnical investigation. However, groundwater levels may increase in response to rainfall. It is possible that groundwater may be temporarily perched above the rock level during and after heavy or sustained rain events. (D&N Geotechnical, 2021)

5.4.1 Impact Assessment

Surface Water

Construction of the pipeline across Mittagong Creek line has the potential to adversely impact on water quality. Effective implementation of the mitigation measures listed in the original REF in relation to erosion and sediment control and protection of aquatic habitat would minimise any adverse impacts to water quality as a result of these works. The construction of the pipeline piers adjacent to the creek line would not alter the creeks' geometry or affect natural water flow once constructed, as all of the new the piers would be located in similar positions as the existing incoming mains piers so as to prevent further impediment or blockage of creek or flood water flows.

Water may be required during construction works for use in pipeline hydrostatic testing, and it is recommended that either excess groundwater extracted during the process of dewatering during the construction works is utilised or potable water is used, if required. This is not anticipated to impact on the water quality in the nearby waterways as the water used would be captured and disposed of in a controlled manner.

Operation and maintenance of the new incoming main near Mittagong Creek is not anticipated to impact surface water quality. No raw sewage leakage issues have been associated with the operation of the existing aerial pipeline and it is unlikely that the new pipeline would result in leakage issues. The new pipeline would be subject to hydrostatic testing during the construction and commissioning phases to ensure there are no leaks and the access chambers (man holes) have been designed with sealed lids to prevent overflows. Furthermore, during operation of the replacement main, the increased capacity of the pipeline would reduce the risk of overflows upstream of the STP which are currently occurring when sewage backs up during high flow events.

During construction of the Proposal, it is anticipated that there would be a neutral effect on water quality though the implementation of the ESCP for the duration of works and once operational, the Proposal is considered to have a neutral effect on water quality within the Sydney Drinking Water Catchment. The new STP design would reduce the chance of raw sewage overflows into the adjacent Mittagong Creek, as raw sewage would be delivered via the incoming main to the inlet works first then to the lift pump station. This arrangement would allow for better management of inflows, as it would reduce the current risk where inflows are first directed to the lift pump station, where there is a risk of pump

failure/blockages which can lead to overflows. In addition, the new STP design has incorporated additional storm detention pond arrangements at the STP site to manage high inflows.

Flooding

During operation, potential damage to the aerial pipeline arising from flood debris in Mittagong Creek is unlikely to occur, as the pipeline would be built above flood levels. The pipelines would be supported by reinforced concrete piers located on higher areas of the riverbank built to replicate what is existing, and to withstand flood flow velocity. From the available flood mapping, the new pipeline invert levels are above the expected flood levels (approx. RL 659). It is also noted that the top of the new access chambers (man holes) are secured and the chambers have been designed to prevent surcharges should the pipeline become pressurised.

Groundwater

Groundwater depth has not been identified at the location of the new incoming main. Groundwater may be encountered during the construction of the access chambers (man hole) and piers as well as the trenching works for the underground section of new pipeline. Groundwater may also be encountered near the Mittagong Creek line if construction occurs at the time of a recent significant rainfall event and the water table levels are high. However, it is anticipated that any groundwater seepage encountered during the works would be managed with conventional sump and pump techniques.

Potential impacts to groundwater quality during construction may be associated with the spillage of construction materials and the management of any groundwater that is encountered during excavation.

If groundwater is encountered during the construction works, it would need to be managed so that it does not result in pollution or sedimentation of Mittagong Creek. Groundwater, devoid of sediment or contaminants, would be disposed of in a way that does not cause erosion and may need to be suitably settled (i.e. using baffle tanks or similar) or filtered prior to being dispersed of over vegetated ground surfaces or into the onsite treatment system. The mitigation measures provided in the original REF in relation to groundwater management would also apply to the works associated with the incoming gravity main.

5.4.2 Mitigation Measures

- Works should not be scheduled when heavy rainfall is forecast and works involving soil disturbance should not take place during heavy rainfall periods, other than work necessary to stabilise the site.

5.5 Biodiversity

The following summary of biodiversity impacts has been taken from the Biodiversity assessment prepared by Public Works Advisory (PWA), June 2021. A copy of the report is provided in Appendix D. The assessment was undertaken in accordance with the requirements of the BC Act and EPBC Act.

Flora

A search of the BioNet Atlas of NSW Wildlife on 28/02/2021 indicated that six (6) species of flora listed under the BC Act and/ or EPBC Act have been recorded within a 10 km x 10 km square centred on the Proposal site. Based on a desktop assessment, potential habitat exists on site for one of the six species; Camden Woollybutt (*Eucalyptus macarthurii)* which is listed as endangered under both the BC Act and EPBC Act. Two Camden Woollybutt trees were observed on site during the site assessment on 01/03/2021.

The entire Proposal site has been previously cleared. At and immediately beside the STP it now comprises mowed lawn of Buffalo Grass (*Bouteloua dactyloides**) and Common Paspalum (*Paspalum dilatatum**). Two large, old Camden Woollybutt (*Eucalyptus macarthurii*) occur on the mown lawn between the STP and Mittagong Creek (endangered under the BC Act and EPBC Act). Along the creek the vegetation is mainly introduced species of shrubs, brambles and small trees with scattered, isolated, naturally regenerating native trees. The dominant weeds along the creek are Common Hawthorn (*Crataegus monogyna**), Blackberry (*Rubus fruticosus**) and Small-leaved Privet (*Ligustrum sinense**) with some White Willow (*Salix alba**), English Ivy (*Hedera helix**), and the usual weeds of disturbed land such as Spear Thistle (*Cirsium vulgare**), Fireweed (*Senecio madagascariensis**), etc. Four of these weed species (Blackberry, Fireweed, White Willow, Black Willow) are listed priority weed species under the *Biosecurity Act 2015*.

There are several scattered young Ribbon Gum (*Eucalyptus viminalis*) on the site. On the creek bank closest to the STP some Eucalyptus trees have been planted. Two species are present, one of which appears to be a Cabbage Gum (*Eucalyptus amplifolia*). The trees are young, probably less than ten (10) years old. The area between the two existing pipelines beside the STP comprises introduced grasses such as Phalaris (*Phalaris aquatica**) and Common Paspalum that is not mown. Within this grassy area there is a patch planted out with native Cabbage Gum (*Eucalyptus amplifolia*), Flax-leaved Paperbark (*Melaleuca linariifolia*) and Flaky-barked Tea-tree (*Leptospermum trinervium*).

The DPIE (2021) vegetation mapping (VIZ_ID 4172) does not map the Proposal site as native vegetation. The site assessment confirmed that the vegetation is not native, being dominated by introduced species, although scattered native trees, shrubs and groundcover plants such as grasses and herbs do occur. The vegetation mapping for the Proposal area is shown in Figure 5-1 below.

Figure 5-1 DPIE (2019) native vegetation mapping of Proposal area (shown in red).

Fauna

A search of the BioNet Atlas of NSW Wildlife on 28/02/2021 indicated that twenty-three (23) species of fauna listed under the BC Act and/ or EPBC Act have been recorded within a 10km x 10km square centred on the Proposal site. Potential habitat does not exists on site for any of the of the listed species: No listed fauna species were observed during the site assessment.

The Proposal site provides limited habitat for native fauna due to its disturbed condition. Having been cleared, it now comprises of mainly introduced species. Two large old Camden Woollybutt are present beside the STP, however, they do not contain tree hollows. An Australia Wood Duck (*Chenonetta jubata*) was observed on the mown lawn and several Common Wombat (*Vombatus ursinus*) burrows exist beside the creek. Native species of frogs, reptiles, birds, mammals and invertebrates may utilise habitat on the Proposal site. No evidence of roosting or nesting was observed of any species other than the Common Wombat.

Two Koala use tree species listed under the SEPP (Koala Habitat Protection) were identified during the site assessment, including Cabbage Gum (*Eucalyptus amplifolia)* and Ribbon Gum (*Eucalyptus viminalis).*

Mittagong Creek is identified as Key Fish Habitat under the FM Act, as shown in Figure 5-2 below.

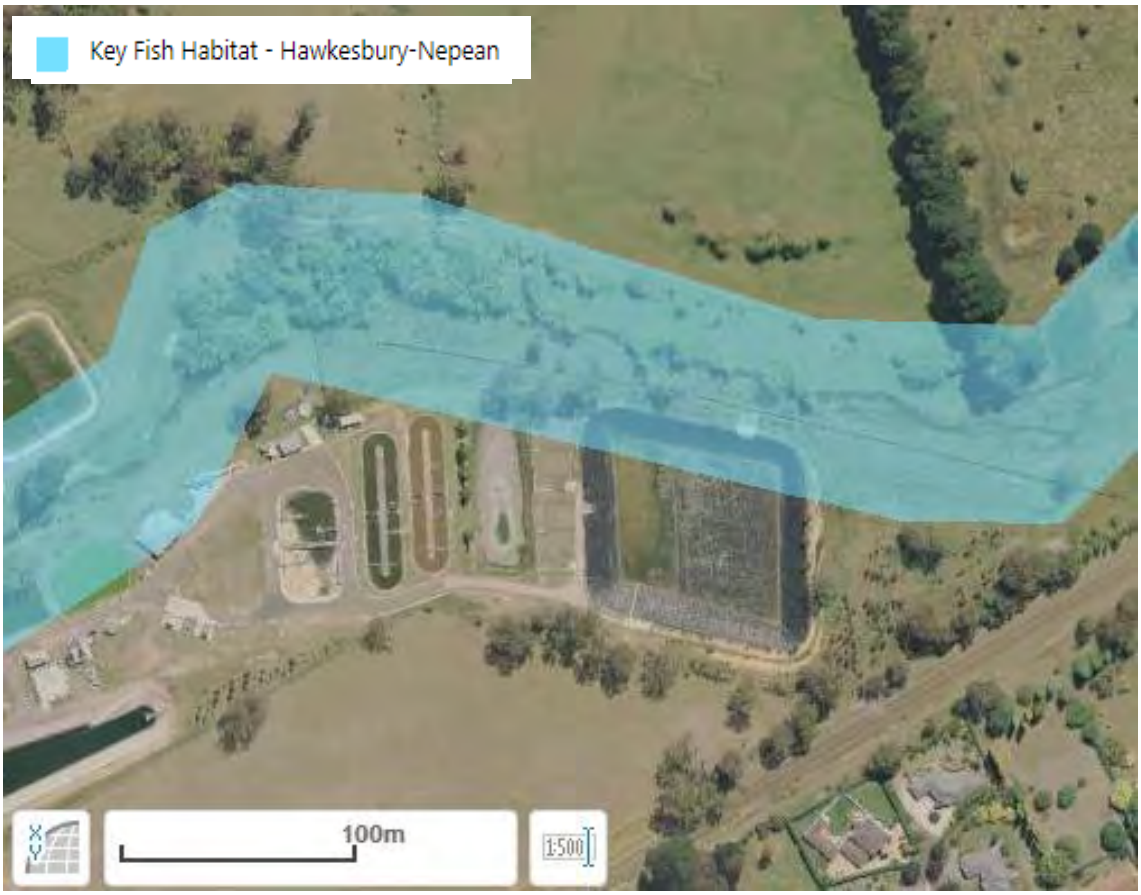


Figure 5-2 Key Fish Habitat Map Layer Extract

Source: DPI Fisheries NSW Spatial Data Portal, accessed July 2021

5.5.1 Impact Assessment

Flora

The Proposal would require the clearing of a narrow strip through the riparian vegetation on either side of Mittagong Creek, a distance of approximately 40 meters. This vegetation comprises almost entirely of introduced weed species such as Common Hawthorn, Blackberry and Small-leaved Privet. None of the naturally regenerating native Ribbon Gums, which is a Koala use species, would be impacted. Beside the creek some of the recently planted native trees and shrubs may need to be trimmed or removed. These are young, probably less than ten years old. None of these species are threatened or otherwise significant however it is recommended that more native trees and shrubs of locally occurring species be planted alongside the creek to compensate for the removal of this vegetation. It was noted during the site assessment that further along the creek, beside the STP, and where no native trees or shrubs were planted, the creek banks are eroding. It may be possible to plant out this area with native trees and shrubs to both compensate for the impacts of this Proposal and address an active erosion problem.

Away from the creek, the new incoming main would pass by an endangered Camden Woollybutt. The location of the two Camden Woollybutt trees at the site is shown below in Figure 5-3. The main would be suspended on concrete pillars spaced at approximately six (6) meters intervals as it passes the tree. The pipeline alignment has been selected specifically to keep away from this tree, with the nearest point approximately 8 m from the trunk of the tree. Excavating the holes for the pipeline support piers may impact the tree's roots, however, at this distance from the trunk impacts are likely to be minor. As a precaution, it is recommended that an Arborist be present whilst excavation is occurring around the tree, so that any impact to the tree's roots can be appropriately managed. Assessments of Significance undertaken for this species (refer to Appendix D) confirm there would be no significant impact to this endangered species and no mature Koala use trees species would require removal for the Proposal. Priority weeds at the site should be managed to avoid dispersal at the site and offsite.

Provided the recommendations in the original REF and Section 5.5.2 are effectively implemented there would be no significant impact on native flora from the Proposal and Species Impact Statement is not required for the Proposal.

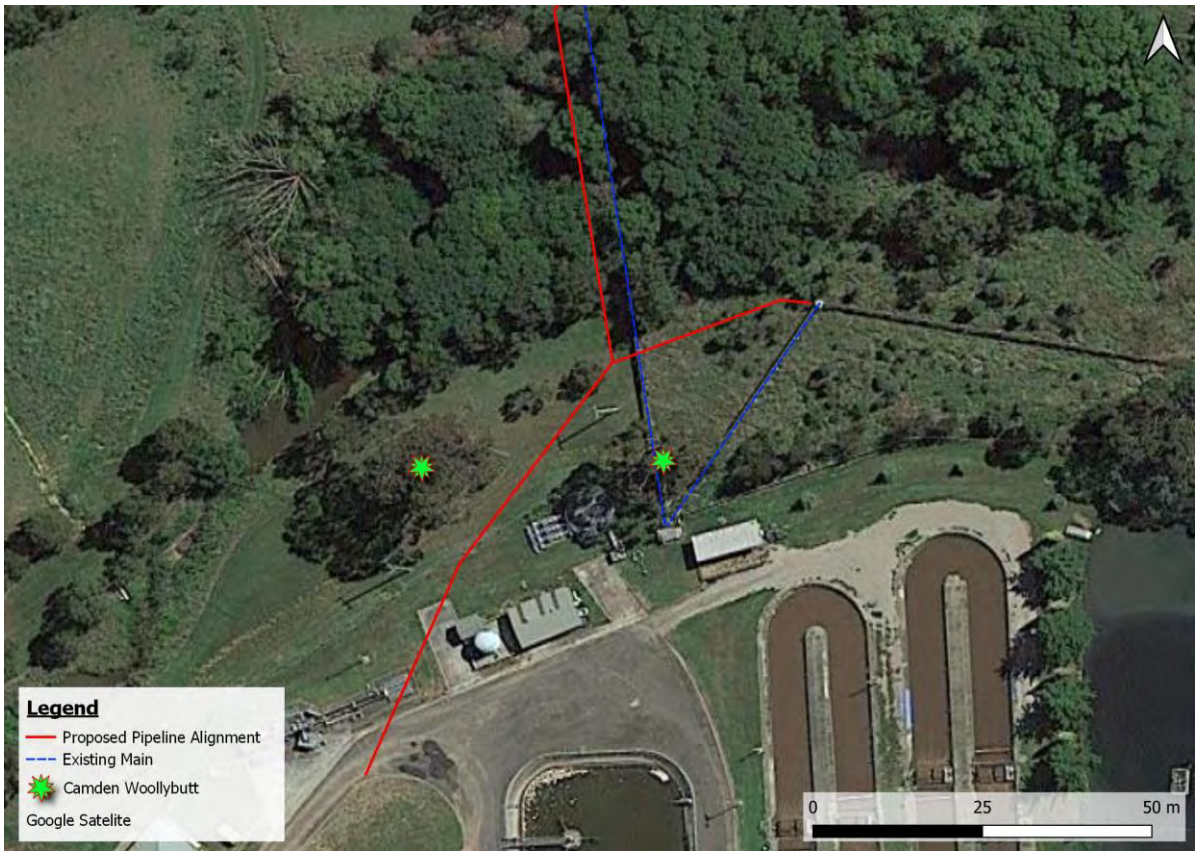


Figure 5-3 Locations of the threatened (endangered) Camden Woollybutt trees at the Proposal site.

Source: PWA, 2021

Fauna

There would be little to no impact on native fauna from the Proposal. A narrow strip of mainly introduced species would be cleared along the proposed alignment across the creek, a distance of approximately 40 meters. The vegetation would quickly regenerate following completion of the works. Some burrows of the Common Wombat occur in this area. Care should be taken during construction if manoeuvring heavy equipment in this area, or excavating the ground, to avoid accidentally harming any Wombats that may be sheltering in the burrows. Elsewhere a small number of recently planted native trees and shrubs may be impacted. It is recommended that similar species be replanted on the site to compensate for the removal of native vegetation habitat for the Proposal. This would also compensate for any potential fauna impacts that may occur.

Provided the measures provided in the original REF and below in Section 5.5.2 are implemented there would be no significant impact on native fauna from the Proposal.

Aquatic Habitat

Riparian habitat disturbance and removal

The Mittagong Creek crossing is located within an existing disturbed alignment with no unique habitat value. The works would result in the disturbance and temporary removal of a

very small area of riparian vegetation surrounding the creek during the pipe installation process and for the removal of the existing redundant pipe. However, the area is expected to return to pre-works condition following completion of the works.

The new support piers for the pipeline would be located on the bank adjacent to the creek line. Therefore dredging and reclamation works and blockage to fish passage would not occur.

Removal of riparian vegetation

The existing riparian vegetation within the proposed works footprint is highly disturbed as a result of the installation and operation of the existing pipeline. There is likely to be only a limited amount of riparian vegetation to be disturbed by the proposed works. However, any disturbance or clearing of riparian vegetation should be kept to minimum.

Spills

The use of construction machinery has the risk of potential fuel/lubricant/hydraulic fluid spillage. The close proximity to waterway exacerbates the potential impact of such an event. Appropriate mitigation measures, as provided in the original REF and Section 5.4.2 must be implemented to minimise this risk.

Overall, due to the low quality riparian habitat present at the Proposal site, the risk of aquatic habitat impacts at the incoming main aerial crossing site is considered to be low.

5.5.2 Mitigation Measures

- Prior to the commencement of works, the extent of the works footprint and works corridor would be clearly marked on site and communicated to construction personnel. No works would extend beyond the construction footprint.
- Any trees to be protected, particularly the two Camden Wollybutt trees at the site, would be identified and flagged during pre-construction survey and protected in accordance with AS 4970 – 2009 *Protection of trees on development sites*
- An Arborist should be present during any excavation works around the Camden Woollybutt tree adjacent to the pipeline, so that any impact to the tree's roots during excavation can be appropriately managed.
- Care should be taken during construction of the creek crossing when manoeuvring heavy equipment in this area, or excavating the ground, to avoid accidentally harming any Wombats that may be sheltering in burrows.
- Should injured fauna be found on the site, WIRES (1300 094 737) and/ or local veterinarians would be contacted immediately and arrangements made for the immediate welfare of the animal.
- Vegetation clearing should be limited to that necessary to undertake the works.
- Priority weeds would be managed according to requirements under the *Biosecurity Act 2016.*
- Weed-free vegetation waste should be reused on site where possible; or if disposed of offsite be transported to a suitably licences waste disposal facility.

- Trenches left open overnight should be covered or fenced to prevent wildlife falling in.
- Native trees and shrubs of locally occurring species should be planted alongside the creek to compensate for impacts to the recently planted native trees and shrubs.

5.6 Aboriginal Heritage

An Aboriginal Objects Due Diligence assessment was carried out by Niche Environment and Heritage (Niche) in March 2021 for the proposed replacement incoming main construction works. The report included an assessment against the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW.* The following summary of Aboriginal heritage impacts has been taken from the report. A copy of the report is provided in Appendix C.

An search of the Aboriginal Heritage Information Management System (AHIMS) was conducted by Niche for the Due Diligence assessment on 16 February 2021 (AHIMS Client ID: 568284) and 8 January 2020 (AHIMS Client ID: 475426) with a 1 km buffer centred on the Proposal area. No previously recorded Aboriginal sites were located within the AHIMS search area.

Searches of the Australian World Heritage Database, the Commonwealth Heritage List, National Heritage List, State Heritage Register, State Heritage Inventory, the Wingecarribee Local Environmental Plan (LEP) (2010) and the Wingecarribee Development Control Plan (DCP) (2019) (were conducted on the 16 February 2021). The database searches concluded that there are five previously recorded historic heritage items nearby the Proposal site; however, none of the heritage places possess Aboriginal heritage values or significance.

A pedestrian survey of the Proposal site was carried out on the 21 February 2021 by Niche heritage consultants. The field survey team walked the entire area of the proposed pipeline, from the ground surface connection point north of Mittagong creek, to the ground surface connection point in the STP south of Mittagong Creek.

The landforms encountered during the site inspection were predominantly slopes and floodplains. The Proposal site south of Mittagong Creek was identified as a flood plain up to the point of the elevated STP. This area has been previously subject to flooding which has disturbed the ground surface. Evidence of replanted vegetation, destroyed during flooding around the creek line, was identified. The majority of the Proposal site had been cleared of native and introduced vegetation. Large mature trees remained along the southern bank of Mittagong Creek though none had evidence of cultural modification. Dense weed growth along the northern bank of Mittagong Creek prevented a complete survey of the north section of Proposal site. No Aboriginal sites and/or Aboriginal heritage constraints were identified during the survey.

The desktop and visual inspection confirmed that, despite archaeologically sensitive landscape features being present in the Proposal site (areas within 200 m of creeks), it is unlikely that Aboriginal objects are present due to the high degree of past land use and disturbance.

5.6.1 Assessment

The Niche assessment found that, while it is possible that isolated artefacts may be present within erosional and disturbed landscapes, on the basis of this assessment, it is unlikely that Aboriginal objects have survived within the Proposal site due to the high degree of past land

use and disturbance. The land modification practices associated with the construction of the existing pipeline and the STP have disrupted the ground surface to such an extent that the possibility of in situ archaeological deposits is low. No Aboriginal objects and/or Aboriginal heritage constraints were identified within the Proposal site. Therefore, no further investigation or impact assessment is required for the Proposal site.

The Due Diligence Code (DECCW, 2010) states that where a desktop and visual inspection has occurred and concluded that Aboriginal objects are unlikely to occur, an Aboriginal Heritage Impact Permit (AHIP) application will not be necessary. The proposed activity may therefore proceed with caution without a further Aboriginal Cultural Heritage Assessment (ACHA) or AHIP.

Based on the above outcomes, the Niche assessment concluded that no further Aboriginal heritage constraints were identified for the proposed activity and, providing that the identified Aboriginal heritage constraints are avoided and mitigation measures in the original REF and below in Section 5.6.2 are followed, As such, subject to the implementation of the measures provided in the original and addendum REF, it is considered possible to avoid the Aboriginal objects and landscape features likely to indicate the presence of Aboriginal objects.

5.6.2 Mitigation Measures

- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact, must cease immediately and:
  - The location, including a 20 m curtilage, should be secured using barrier fencing to avoid further harm.
  - The NSW Police must be contacted immediately.
  - No further action is to be undertaken until the NSW Police provide written notification to Wingecarribee Shire Council.
  - If the skeletal remains are identified as Aboriginal, Wingecarribee Shire Council or their agent must contact: The Heritage NSW Enviroline on 131 555; and representatives of the Local Aboriginal Land Council.
  - No works are to continue until Heritage NSW provides written notification to the proponent or their Agent.

5.7 Historic Heritage

There are no items of environmental heritage listed under the Wingecarribee LEP 2010 or the State Heritage Register located at or in the vicinity of the Proposal works site. The closest local heritage item listed under the Wingecarribee LEP 2010 is Haling Cottage (Item: I523) which is located approximately 250 m to the south of the Proposal works site.

5.7.1 Impact Assessment

No impacts would occur to the closest listed historic heritage item as the Proposal work site would be approximately 250 m away. No historic archaeological items would be expected to be likely to be found as the proposal works area comprises land previously disturbed for construction of the existing incoming main and STP site and rural pastoral development.

5.7.2 Mitigation Measures

No additional mitigation measures required.

5.8 Noise and Vibration

The land use surrounding the Proposal site comprises the STP site to the south and rural residential and agricultural land to the north. Noise monitoring was not undertaken for the REF addendum. However, given the rural nature of the area, the background noise level is predicted to be around 40 dB(A). The closest sensitive noise receivers would be two rural residential dwellings on private properties to the north of the Proposal works site. The closest residence is located approximately 180 m north-east of the works site, with the other residence located at distance of approximately 280 m north-east of the replacement incoming main works site.

5.8.1 Impact Assessment

The typical A-weighted sound power levels for equipment which may be required to undertake the construction works are listed in Table 5-1 below (it is noted that this list is not definitive and these levels are taken from the *Australian Standard AS2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*).

Table 5-1 Construction Equipment Sound Power Level

Equipment	Typical Sound Power Levels (dB)	Sound Pressure Level at 180 m distance (dB(A))	Sound Pressure Level at 280 m distance (dB(A))
Excavator/ Backhoe	107	51	47
Truck (dump)	117	61	57
Crane (mobile)	104	48	44
Light commercial vehicles	106	50	46
Compressor (silenced)	101	45	41
Concrete agitator/pump truck	109	53	49
Concrete cutter	117	61	57
Hand Tools (pneumatic)	116	60	56

Notes:
1. The method specified in AS2436 suggests that errors are introduced for distances greater than 100m from the sound source.

The duration of construction works for of the incoming is anticipated to be six to eight weeks. Under the Interim Construction Noise Guideline (DECCW, 2009) construction noise criteria for projects where the construction duration is greater than three weeks is the rating background noise level plus 10dB(A). As the daytime background noise level at the Proposal site has been estimated to be 40 dB(A), the noise level objective would be 50 dB(A) at the nearest residence, located approximately 180 m from the works at the closest point. Using the methodology in the *Australian Standard Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites* and the *Interim Noise Construction Guideline*, the maximum predicted noise levels at this point during construction may exceed the recommended noise affected level but would not exceed the highly affected noise level (75 dB(A)) above which there may be strong community reaction to noise (DECCW, 2009).

The use of the construction equipment listed in Section 4.2.1 also has the potential to cause some vibration impacts during the works. However, the closest residences are not located in close proximity to the proposed works; therefore, significant vibration impacts are not anticipated during construction of the Proposal.

Noise and vibration levels would vary depending on the nature of the activities being undertaken. The use of several items of construction equipment simultaneously is only expected to occur intermittently, however works for other components of the STP upgrade may be taking place at the same time resulting in additional noise and vibration at the STP site. It is noted that noise generated by pipeline trenching works can be of a similar nature to the noise generated by regular agricultural/rural activities such as ploughing. In addition, construction hours would be restricted to the normal daytime construction hours as specified by EPA and the nature of the works would be temporary, with works progressively rapidly along the pipeline alignment. Construction noise impacts associated with the Proposal are therefore assessed to be low to moderate.

The control measures to minimise noise and vibration impacts provided in the original REF would be implemented during construction as part of the contractor's Construction Environmental Management Plan (CEMP).

5.8.2 Mitigation Measures

No additional mitigation measures required.

5.9 Air Quality

Air quality in the general area is expected to be good to moderate as there are no heavy industrial or manufacturing industries. However, the STP is a point source of air pollution. Air quality in the region and associated with the existing STP is discussed in the original REF.

5.9.1 Impact Assessment

The main impact to air quality during construction works is expected to arise from the generation of airborne localised dust associated with earthworks and from trucks transporting materials to and around the construction site on unsealed access tracks to and from the Proposal works site. This is not anticipated to cause notable adverse environmental impacts unless the weather is particularly windy. Dust suppression methods, including the use of water carts, would be applied on windy days to prevent dust being transported off site.

Local air quality may be affected by emissions from construction traffic. These emissions would, however, occur only intermittently, and are expected to be minor and temporary. It would be unlikely that they would contribute to a permanent detectable reduction in local air quality.

Construction vehicles and machinery would generate greenhouse gas emissions during the replacement incoming main construction works. The greenhouse gas emissions generated from the construction and operation of the replacement incoming main would not be expected to be significant as the pipeline is a gravity main.

With implementation of the recommended mitigation measures provided in the original REF, potential air quality impacts during construction are considered minor and unlikely to be significant.

5.9.2 Mitigation Measures

No additional mitigation measures required.

5.10 Traffic and Access

Access to the southern area of the work site would be via internal roads or tracks with the STP site. The northern side of Mittagong Creek would also be accessed via existing access roads within the STP site via the sludge lagoons area and an access track within an easement located within the private property to the north of the STP site. The public roads used to access the STP site are sealed local roads and regional connector roads.

The access tracks within the STP site and the private property to the north of the STP required to construct the incoming main would be located within previously cleared areas of the STP site and the property on the northern side of Mittagong Creek. The proposed location of the construction compound for the STP upgrade works has been identified within the STP site to the south-west of the Proposal site within a previously cleared area. It is anticipated that this area would also be used to store construction materials, equipment and machinery for the Proposal.

5.10.1 Impact Assessment

Construction and material delivery vehicles would utilise roads within the local area during the construction period

A Traffic Management Plan would be prepared to inform WSC of the vehicular impacts of construction of the STP upgrade project including the Proposal works and to facilitate notification to the affected landowner to the north of the STP site. The Traffic Management Plan would identify materials set down and supply, amenities areas and traffic movements associated with the construction of the Proposal.

It is anticipated that there would be approximately two semi-trailer loads of pipes and fitting to be delivered as well as several trucks to delivery concrete materials for the access chambers, piers and underground pipeline concrete encasing.

One-way vehicle movements including construction staff vehicles would increase by up to extra 4 movements per day depending on delivery and the pipe laying schedule.

The private land owner would be notified regarding access through their land for the Proposal works and utilisation of the access track reach the northern side of the creek.

5.10.2 Mitigation Measures

No additional mitigation measures required.

5.11 Waste Management

5.11.1 Impact Assessment

The construction of the Proposal would result in waste in the form of excess spoil, cleared vegetation and general building wastes such as excess/ redundant pipe, concrete, packaging, off cuts, excess materials and workers wastes such as drinks containers, food scraps, etc. Portable toilets would be provided for workers at the construction site.

To ensure that environmental harm does not occur as a result of uncontrolled or inappropriate collection, transport and disposal the relevant provisions of the following Acts would be implemented:

- *Waste Avoidance and Resource Recovery Act 2001*
- *Protection of the Environment Operations Act 1997*
- *Protection of the Environment Operations (Waste) Regulation 2014*

All spoil or cleared vegetation to be reused on site would be required meet the appropriate protection criteria under the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended 2013), National Environment Protection Council (NEPC 2013).

The waste management and contamination control procedures and/or measures listed in the original REF would be implemented for the proposed works.

5.11.2 Mitigation Measures

No additional mitigation measures required.

5.12 Visual Amenity

5.12.1 Impact Assessment

There would be minor visual impacts during construction of the Proposal due to the presence of construction equipment at the Proposal site. However, this impact is not anticipated to be significant due to the temporary nature of the construction works.

The clearing of vegetation for the new incoming main would create a visual impact however , over time the width of the visual impact would decrease as vegetation regenerates with any ongoing/maintained clearing would be restricted to that required for pipeline maintenance purposes. However, these visual impacts are unlikely to be significant. Replanting of native trees species is recommended to compensate for the removal of immature trees and vegetation adjacent to Mittagong Creek.

Once constructed, the new incoming main would be located both above and below the ground. However, existing sewerage scheme infrastructure is currently located at the creek and within the STP site; and tree replanting would assist in screening the visible above ground section of the pipeline. Therefore operational visual impacts are anticipated to be minor.

5.12.2 Mitigation Measures

No additional mitigation measures required.

5.13 Bushfire

The proposed new incoming main would be located on land which is identified as bushfire prone, including vegetation category 1 (red) and vegetation buffer (yellow) (refer to Figure 5-4).

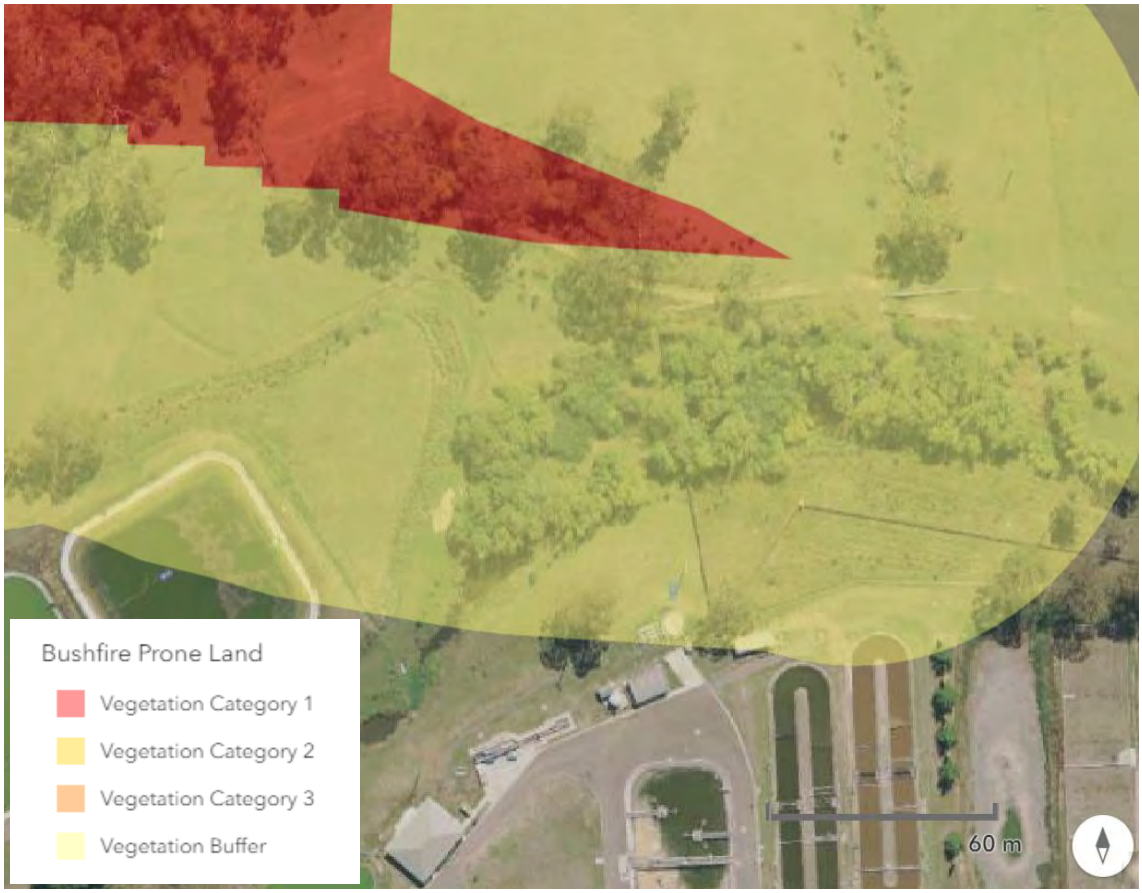


Figure 5-4 Bushfire Prone Land Map extract showing pipeline alignment
Source: NSW Planning Portal ePlanning Spatial Viewer – Bushfire Prone Land layer accessed August 2021

5.13.1 Impact Assessment

The above ground section of new incoming main pipeline would be constructed from steel with a cement lining, supported on reinforced concrete piers. The underground section of the pipeline would be encased by concrete and is therefore unlikely to be significantly affected by bushfire. Design of any above ground infrastructure for the STP would take into consideration the potential bushfire risk at the site during construction and operation of the

Proposal in accordance with the relevant principles of the RFS publication *Planning for Bushfire Protection 2019.* The construction activities are not anticipated to pose a significant bushfire risk as the site has been cleared. The mitigation measures listed in the original REF would be implemented to ensure that the works do not start a bushfire in surrounding vegetated areas.

5.13.2 Mitigation Measures

No additional mitigation measures required.

6 Environmental Management

6.1 Construction Environmental Management Plan

Preparation of a Construction Environmental Management Plan (CEMP) is mandatory for all projects undertaken by or on behalf of government agencies or where funding is being provided by the government.

The CEMP would be developed to ensure that appropriate environmental management practices are followed during a project's construction and/or operation. WSC would review the CEMP for the Proposal, which should include the following elements, as described in the Guideline for the Preparation of Environmental Management Plans (DIPNR, 2004):

Table 6-1 Construction Environmental Management Plan Structure

Background	Introduction to the document Description of the proposal and project details The context for the CEMP in regards to the overall project The CEMP objectives The contractor's environmental policy
Environmental Management	Environmental management structure of the organisation and specific team responsibilities with respect to the CEMP and its implementation Approval and licensing requirements relevant to the project Reporting requirements Environmental training Emergency contacts and response
Implementation	A project specific risk assessment A detailed list of environmental management safeguards and controls CEMP sub plans for specific environmental controls A detailed schedule assigning responsibility to each environmental management activity and control
Monitor and Review	Environmental monitoring Environmental auditing Corrective action CEMP review and document control procedures

6.2 Construction Mitigation Measures

The CEMP would include a risk assessment which ensures that the safeguards identified in this REF addendum, as well as any others that are considered relevant including the original REF, are effectively translated into actual construction techniques and environmental management activities, controls and monitoring/verification to prevent or minimise environmental impacts. The CEMP should also identify the requirements for compliance with relevant legislation and any other regulatory requirements to ensure environmental safeguards described throughout this REF addendum and the original REF are implemented. The environmental management objectives and supporting actions presented in this section are intended to assist in this process.

The following details the environmental objectives during construction and the proposed mitigation to be included in the CEMP. This list is not definitive, and additional measures detailed as part of the determination of the Proposal and conditions of any other approvals must also be included. Operational safeguards are also included, where applicable.

6.3 Environmental Management Measures

Implementation of the mitigation measures outlined below would be undertaken during several phases of the project. These phases comprise:

- Detailed design – refinement of the design details
- Pre-construction – prior to the contractor arriving on site to carry out the works
- Construction – during construction phase
- Operation – post construction

6.3.1 Location and Land Use

Objective

- Minimise impacts to surrounding land users during construction and operation of the Proposal.

Actions

Action/Phase	Responsibility
Pre-construction	
Notification (including a Notice of Entry, if required) must be provided to the freehold landowner to the north of the STP site prior to the commencement of construction works, to access the private property and for the construction of the proposed sewerage infrastructure works within private land.	WSC/Contractor

6.3.2 Water Quality and Erosion and Sediment Control

Objective

- To effectively manage sediment and erosion control during the construction stage of the Proposal.
- Prevention/minimisation of impacts to the waterways during the construction works.

Actions

Action/Phase	Responsibility
Pre-construction	
A detailed Erosion and Sediment Control Plan (ESCP) shall be prepared as part of the CEMP. The ESCP would describe the site specific measures to be implemented for all works areas, in accordance with the guidelines outlined in the 2004 Landcom publication *Managing Urban Stormwater: Soils and Construction*, 4th edition ("The Blue Book") and *Volume 2A Installation of Services*.	Contractor
Construction	
The recommendations and specifications provided in the geotechnical investigation (D&N Geotechnical, 2021) should be followed for earthworks and foundations works during the construction works.	Contractor
Works should not be scheduled when heavy rainfall is forecast and works involving soil disturbance should not take place during heavy rainfall periods, other than work necessary to stabilise the site.	Contractor

6.3.3 Biodiversity

Objective

- Avoidance/minimisation of impacts to flora and fauna
- Minimise clearing of vegetation
- Avoid weed invasion

Actions

Action/Phase	Responsibility
Pre-construction	
Prior to the commencement of works, the extent of the works footprint and works corridor would be clearly marked on site and communicated to construction personnel. No works would extend beyond the construction footprint.	Contractor

Any trees to be protected, particularly the two Camden Wollybutt trees at the site, would be identified and flagged during pre-construction survey and protected in accordance with AS 4970 – 2009 *Protection of trees on development sites*	Contractor
Construction	
An Arborist should be present during any excavation works around the Camden Woollybutt tree adjacent to the pipeline, so that any impact to the tree's roots during excavation can be appropriately managed.	Contractor
Care should be taken during construction of the creek crossing when manoeuvring heavy equipment in this area, or excavating the ground, to avoid accidentally harming any Wombats that may be sheltering in burrows.	Contractor
Should injured fauna be found on the site, WIRES (1300 094 737) and/ or local veterinarians would be contacted immediately and arrangements made for the immediate welfare of the animal.	Contractor
Vegetation clearing should be limited to that necessary to undertake the works.	Contractor
Priority weeds would be managed according to requirements under the *Biosecurity Act 2016.*	Contractor
Weed-free vegetation waste should be reused on site where possible; or if disposed of offsite be transported to a suitably licences waste disposal facility.	Contractor
Trenches left open overnight should be covered or fenced to prevent wildlife falling in.	Contractor
Operation	
Native trees and shrubs of locally occurring species should be planted alongside the creek to compensate for impacts to the recently planted native trees and shrubs.	Contractor

6.3.4 Heritage

Objective

- Minimise potential impacts to items and places of historic and Aboriginal cultural heritage due to the works

Actions

Action/Phase	Responsibility
Construction	
In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact, must cease immediately and: • The location, including a 20 m curtilage, should be secured using barrier fencing to avoid further harm. • The NSW Police must be contacted immediately. • No further action is to be undertaken until the NSW Police provide written notification to Wingecarribee Shire Council. • If the skeletal remains are identified as Aboriginal, Wingecarribee Shire Council or their agent must contact: The Heritage NSW Enviroline on 131 555; and representatives of the Local Aboriginal Land Council. • No works are to continue until Heritage NSW provides written notification to the proponent or their Agent.	Contractor

7 Conclusion

WSC is currently augmenting the Bowral STP capacity and treatment system to meet existing and future population demand in the region and to improve treated effluent quality.

Previous sewer flow containment modelling undertaken on the Bowral sewage conveyance system on 2014 identified a number of improvement opportunities including the upsizing of the incoming main directly upstream of the STP, in order to resolve predicted overflows from access chambers (manholes) located upstream of the STP.
To reduce the risk of sewage overflows, the incoming main to the Bowral STP site requires an upgrade to increase capacity. The Bowral STP is currently being upgraded and the inlet works are being relocated within the STP site. To accommodate this change and to reduce the risk of sewage overflows upstream of the STP, a new larger capacity gravity main is to be established to the new STP inlet treatment works.

The Proposal would potentially cause short term impacts such as increased noise and traffic and a reduction in community amenity for the residents and users of local streets during the construction phase. However, these impacts are considered to be minor and temporary.

The construction of the replacement pipeline across Mittagong Creek has the potential to adversely affect water quality if sediment and erosion controls are not adequately managed. However, it is considered that the risk associated with this activity can be managed to avoid impacts to water quality and biodiversity.

The proposed works would require the clearing of a 40 m long corridor of previously disturbed native vegetation. The biodiversity assessment determined that the works would not have a significant impact on any threatened flora or threatened species.

Provided that the recommendations are implemented to avoid impacts, the due diligence Aboriginal heritage assessment found that impacts to Aboriginal heritage are not anticipated and the works can proceed without further investigation or the requirement for an AHIP.

Given that the works predominantly comprise the replacement of a relatively short section of pipeline, adverse environmental impacts potentially associated with the operation phase of the Proposal are considered to be minimal. Potential operational impacts have generally been mitigated as part of the design of the works.

This REF addendum has been prepared in accordance with Sections 5.5 and 5.7 of the *Environmental Planning and Assessment Act 1979* and Clause 228 of the *Environmental Planning and Assessment Regulation 2000.*

This REF addendum provides a true and fair assessment of the proposed activity in relation to its likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposed activity.

On the basis of the information presented in this REF addendum it is concluded that:

(1) the proposed activity is not likely to have a significant impact on the environment and therefore an Environmental Impact Statement is not required.

(2) the proposed activity is not likely to significantly affect threatened species, populations, ecological communities, or critical habitat. Therefore, a Species Impact Statement (SIS) is not required

(3) the proposed activity is not likely to affect any Commonwealth land, is not being carried out on Commonwealth land, or significantly affect any Matters of National Environmental Significance.

Subject to implementation of the measures to avoid, minimise or manage environmental impacts listed in the original REF and this REF addendum, the proposed activity is recommended to proceed.

8 References

Australian Standard *AS2436-2010 Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites*

DEC (2006), *Assessing Vibration: A Technical Guide*

DECC (2008) *Managing Urban Stormwater: Soils and construction - Volume 2A: Installation of services*

DECCW (2009), *Interim Construction Noise Guideline*

Department of Primary Industries - Fisheries (2021*) Fisheries NSW Spatial Data Portal – Key Fish Habitat Layer*, accessed via https://webmap.industry.nsw.gov.au/Html5Viewer/index.html?viewer=Fisheries_Data_Portal

DPINR (2004), *Guideline for the Preparation of Environmental Management Plans*

DPIE (2021), *Priority 5 Mapping Area (P5MA) Vegetation Extent (VIS_ID 4172).* NSW Department of Planning, Industry and Environment.

D&N Geotechnical (2021*), Bowral Sewage Treatment Plant Geotechnical Investigation Report*

Hunterh$_2$0 (2021), *Bowral Sewage Treatment Plant Upgrade Detailed Design Report*

Landcom (2004), *Managing Urban Stormwater: Soils and Construction – Vol 1, 4th Edition* (The Blue Book)

Niche Environment and Heritage (2021), *Aboriginal Objects Due Diligence Assessment Bowral Sewage Treatment Plant Upgrade, Bowral, NSW*

Public Works Advisory (2021), *Bowral STP - Incoming Main Works Biodiversity Assessment*

Urban Water Solutions (2014) *Bowral Sewerage Catchment Flow Containment Report*

Appendix A - Consideration of Clause 228

Clause 228 of the EP&A Regulation 2000 indicates, for purposes of Part 5 of the Act, the factors that must be taken into account when consideration is being given to the likely impact of an activity on the environment.

A determining authority is only required to consider the following matters where an EIS has been prepared for a Part 5 activity under the EP&A Act. However, the following information is provided to assist determining authorities in making determinations consistent with those made for an activity requiring preparation of an EIS.

The various factors and findings following environmental assessment are presented below.

***(a) any environmental impact on a* community,**

There is the potential for some minor and temporary noise, dust and traffic and access impacts during construction works for the replacement incoming main at Bowral STP. A positive impact to the local community is predicted post construction through improved sewerage treatment infrastructure.

(b) any transformation of a locality,

The majority of the replacement pipeline route will be located immediately adjacent the existing pipeline. As a result, the new pipeline is not expected to transform the locality.

(c) any environmental impact on the ecosystems of the locality,

Clearing of vegetation would be required along the pipeline corridor. A biodiversity assessment has concluded that there will be no significant impact to threatened species or ecological communities . The pipeline would also traverse a creek line as an aerial crossing. Measures have been proposed to ensure that any impacts are minor and temporary.

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality,

Minimal impact to the aesthetic quality of the area would occur due to minor vegetation clearing and the construction of new infrastructure in a currently disturbed rural setting.

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations,

Given the highly disturbed nature of the pipeline alignment there is low potential for any Aboriginal objects protected under the *National Parks and Wildlife Act 1974* or historic relics as defined in the *Heritage Act* 1977 to be present, and it is considered unlikely that the works would impact upon any Aboriginal objects or sites or historic relics.

(f) any impact on the habitat of protected animals (within the meaning of the Biodiversity Conservation Act 2016),

No impacts identified.

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air,

No impacts identified.

(h) any long-term effects on the environment,

No effects identified

(i) any degradation of the quality of the environment,

There would be temporary and minor degradation of the quality of the environment during the construction phase which would involve shrubs, immature trees and groundcover vegetation clearing and excavation works. The works would result in some short-term impacts including construction noise and dust during the construction period. Control measures to minimise these impacts would be implemented during construction as part of the contractor's Construction Environmental Management Plan (CEMP).

(j) any risk to the safety of the environment,

There are potential traffic safety risks to construction staff and residents using local roads during construction of the pipeline. However, control measures to minimise this safety risk would be implemented during construction as part of the contractor's TMP.

(k) any reduction in the range of beneficial uses of the environment,

No impacts to the range of beneficial uses identified.

(l) any pollution of the environment,

There is the potential for some minor and temporary noise and air pollution during the construction works. Sediment and erosion controls would be implemented to protect earthworks from water pollution. With the implementation of appropriate mitigation measures during construction there would be no long term or significant pollution of the environment.

(m) any environmental problems associated with the disposal of waste,

Minimal waste is predicted. All construction waste would be taken off site for disposal at a licensed landfill. The Contractor would prepare a Waste Management Plan to ensure waste is managed appropriately during construction works, so as not to cause off-site impacts.

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply,

No impacts identified.

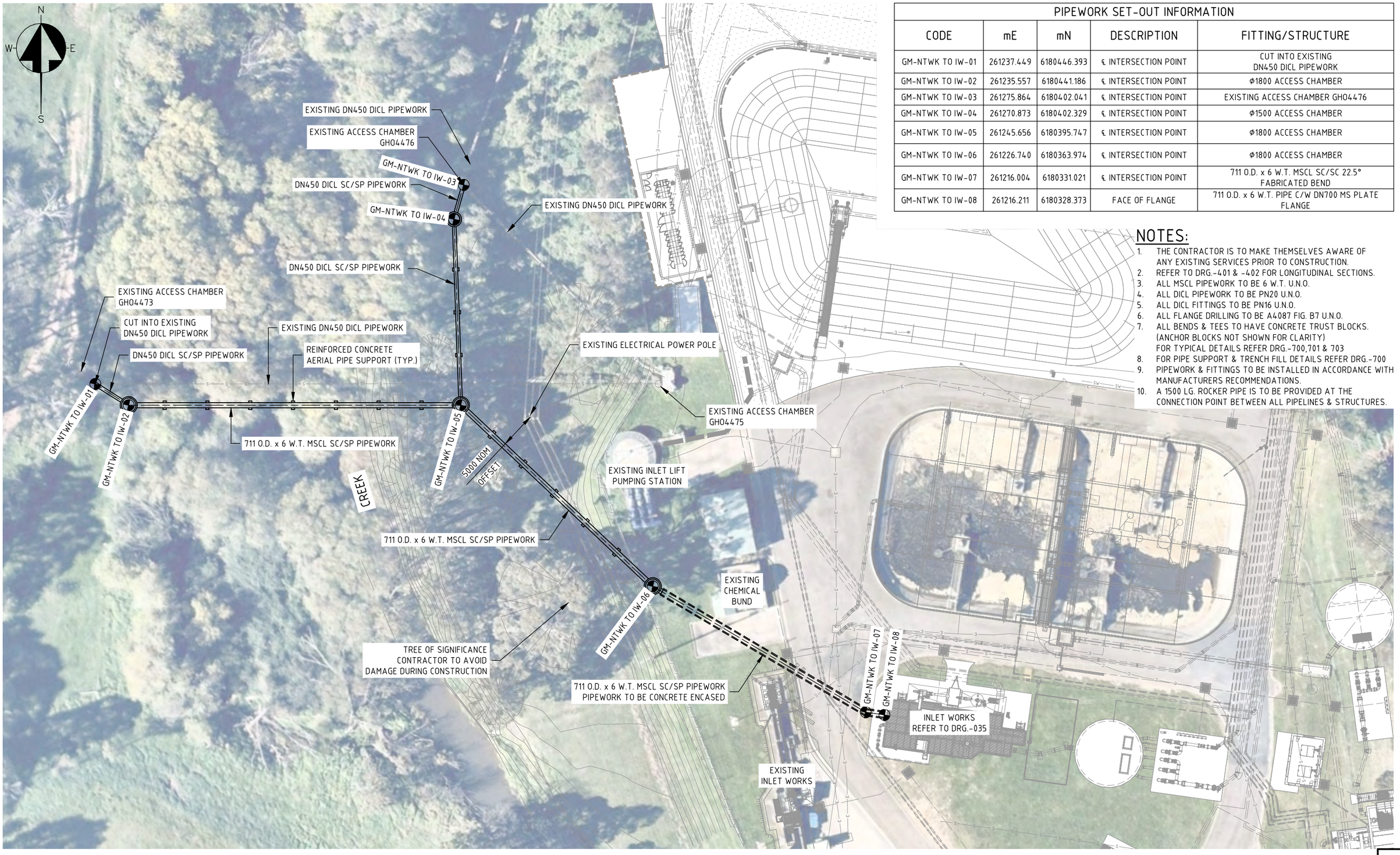
(o) any cumulative environmental effect with other existing or likely future activities,

No effect identified. The STP upgrade works are being staged and coordinated to minimise any cumulative effects.

(p) any impact on coastal processes and coastal hazards, including those under projected climate change conditions.

Not relevant to this Proposal.

Appendix B – Designs



PIPEWORK SET-OUT INFORMATION

CODE	mE	mN	DESCRIPTION	FITTING/STRUCTURE
GM-NTWK TO IW-01	261237.449	6180446.393	℄ INTERSECTION POINT	CUT INTO EXISTING DN450 DICL PIPEWORK
GM-NTWK TO IW-02	261235.557	6180441.186	℄ INTERSECTION POINT	⌀1800 ACCESS CHAMBER
GM-NTWK TO IW-03	261275.864	6180402.041	℄ INTERSECTION POINT	EXISTING ACCESS CHAMBER GH04476
GM-NTWK TO IW-04	261270.873	6180402.329	℄ INTERSECTION POINT	⌀1500 ACCESS CHAMBER
GM-NTWK TO IW-05	261245.656	6180395.747	℄ INTERSECTION POINT	⌀1800 ACCESS CHAMBER
GM-NTWK TO IW-06	261226.740	6180363.974	℄ INTERSECTION POINT	⌀1800 ACCESS CHAMBER
GM-NTWK TO IW-07	261216.004	6180331.021	℄ INTERSECTION POINT	711 O.D. x 6 W.T. MSCL SC/SC 22.5° FABRICATED BEND
GM-NTWK TO IW-08	261216.211	6180328.373	FACE OF FLANGE	711 O.D. x 6 W.T. PIPE C/W DN700 MS PLATE FLANGE

NOTES:

1. THE CONTRACTOR IS TO MAKE THEMSELVES AWARE OF ANY EXISTING SERVICES PRIOR TO CONSTRUCTION.
2. REFER TO DRG.-401 & -402 FOR LONGITUDINAL SECTIONS.
3. ALL MSCL PIPEWORK TO BE 6 W.T. U.N.O.
4. ALL DICL PIPEWORK TO BE PN20 U.N.O.
5. ALL DICL FITTINGS TO BE PN16 U.N.O.
6. ALL FLANGE DRILLING TO BE A4087 FIG. B7 U.N.O.
7. ALL BENDS & TEES TO HAVE CONCRETE TRUST BLOCKS. (ANCHOR BLOCKS NOT SHOWN FOR CLARITY) FOR TYPICAL DETAILS REFER DRG.-700,701 & 703
8. FOR PIPE SUPPORT & TRENCH FILL DETAILS REFER DRG.-700
9. PIPEWORK & FITTINGS TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
10. A 1500 LG. ROCKER PIPE IS TO BE PROVIDED AT THE CONNECTION POINT BETWEEN ALL PIPELINES & STRUCTURES.

A3

AMENDMENTS

Ver	Date	Description	Drawn
B	06/08/21	TENDER ISSUE	GG
A	26/03/21	PRELIMINARY	GG

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Drawn	GG	Checked	RKB
Approved	J.L.SMITH		
Date	06/08/21		
HH2O Project Number	5804		

HORIZONTAL
Co-ordinate System -
BM Adopted -
East - North -

VERTICAL
Datum -
BM Adopted -
Reduced Level -

Wingecarribee SHIRE COUNCIL

WINGECARRIBEE SHIRE COUNCIL
BOWRAL STP UPGRADE
PLANT PIPEWORK
GM-NTWK TO IW
GENERAL ARRANGEMENT

Scale 1:500 at A3

Document No **5804- C - 400**

Status **TENDER**

Version **B**

Plot Date: 23/08/21 - 09:39 Cad File: P:\Wingecarribee Shire Council\5804 Bowral STP Detailed Design\2. Tasks\CIVIL DWGS\1 - CURRENT WORKING\5804-C-400 to 402 (GM-NTWK to IW).dwg

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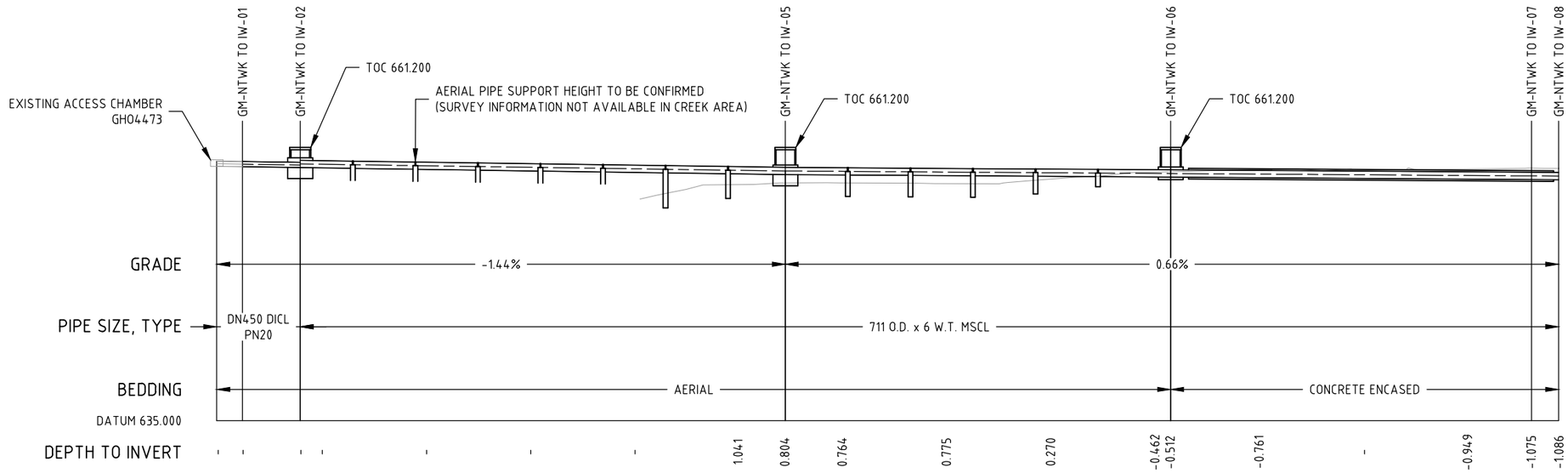

GRAVITY MAIN - NETWORK TO INLET WORKS
LINE 1 LONGITUDINAL SECTION

A3

AMENDMENTS			
B	06/08/21	TENDER ISSUE	GG
A	26/03/21	PRELIMINARY	GG
Ver	Date	Description	Drawn

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Approved	J.L.SMITH		
Date	06/08/21		
HH2O Project Number	5804		

HORIZONTAL
Co-ordinate System -
BM Adopted -
East - North -

VERTICAL
Datum -
BM Adopted -
Reduced Level -

Wingecarribee SHIRE COUNCIL

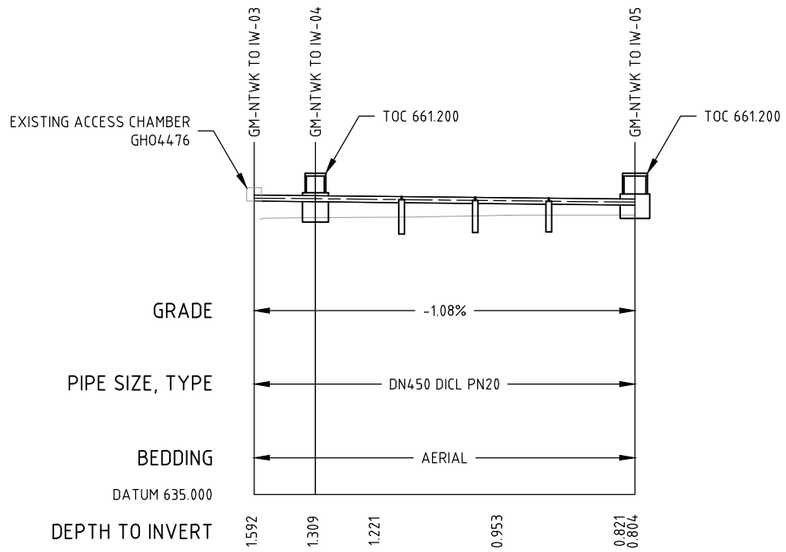
WINGECARRIBEE SHIRE COUNCIL
BOWRAL STP UPGRADE
PLANT PIPEWORK
GM-NTWK TO IW
LONGITUDINAL SECTION - SHT. 1 OF 2

Scale **1:500** at A3

Document No **5804- C - 401**

Status **TENDER**

Version **B**



GRAVITY MAIN - NETWORK TO INLET WORKS
LINE 2 LONGITUDINAL SECTION

A3

AMENDMENTS			
B	06/08/21	TENDER ISSUE	GG
A	26/03/21	PRELIMINARY	GG
Ver	Date	Description	Drawn

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Drawn	GG	Checked	RKB
Approved	J.L.SMITH		
Date	06/08/21		
HH2O Project Number	5804		

HORIZONTAL
Co-ordinate System -
BM Adopted -
East - North -

VERTICAL
Datum -
BM Adopted -
Reduced Level -

Wingecarribee SHIRE COUNCIL

WINGECARRIBEE SHIRE COUNCIL
BOWRAL STP UPGRADE
PLANT PIPEWORK
GM-NTWK TO IW
LONGITUDINAL SECTION - SHT. 2 OF 2

Scale **1:500** at A3

Document No **5804- C - 402**

Status **TENDER**

Version **B**

Appendix C – Aboriginal Heritage Due Diligence Assessment

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Ecology and biodiversity
Heritage management
Environmental management and approvals
Environmental offsetting

Aboriginal Objects Due Diligence Assessment
Bowral Sewage Treatment Plant Upgrade
Bowral, NSW

Wingecarribee Shire Local Government Area

Prepared for NSW Public Works Advisory on behalf of Wingecarribee Shire Council

Prepared by Niche Environment and Heritage | 2 March 2021

A leading independent specialist environmental and heritage consultancy

niche
Environment and Heritage

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Excellence in your environment

2 March 2021

Ms Michelle Moodley
Environmental Scientist Infrastructure Services
NSW Public Works Advisory
Department of Planning, Industry and Environment

Dear Ms Moodley,

Re: Aboriginal Objects Due Diligence Assessment for Bowral Sewage Treatment Plant Upgrade, Bowral, New South Wales (Niche ref #6505)

Based on this Aboriginal Objects Due Diligence Assessment (DD), it is unlikely that Aboriginal objects have survived within the Activity Area due to the high degree of existing disturbance and modification to the ground surface. The land modification practices associated with the clearing of vegetation and the construction and maintenance of the existing Bowral Sewage Treatment Plant (STP) within the Activity Area has disturbed the ground surface to such an extent that the possibility of in situ deposits is low. The location of the Activity Area within the floodplains of the Mittagong Creek have further lowered the potential for *in situ* archaeological remains to almost nil.

No Aboriginal heritage constraints were identified for the proposed activity and no further investigation or impact assessment is required.

The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010) states that where a desktop and visual inspection has occurred and concluded that Aboriginal objects are unlikely to occur, an Aboriginal Heritage Impact Permit (AHIP) application will not be necessary. The proposed activity may therefore proceed with caution without a further Aboriginal Cultural Heritage Assessment (ACHA) or AHIP. It is recommended that:

- All site workers and contractors should be inducted to the area and informed of their obligations under the *National Parks and Wildlife Act 1974.*
    - In the unlikely event that any Aboriginal objects are found, all activities with the potential to impact the objects must stop. A temporary fence is to be erected around the Aboriginal cultural heritage site, with a buffer zone of at least 10 metres around the known edge. An appropriately qualified archaeologist is to be engaged to assess the findings, and notification is provided to Heritage NSW (Aboriginal Cultural Heritage Regulation) in the Department of Premier and Cabinet. Works should not proceed without advice from Heritage NSW or an appropriately qualified archaeologist.
- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact, must cease immediately and:
    - The location, including a 20 m curtilage, should be secured using barrier fencing to avoid further harm.
    - The NSW Police must be contacted immediately.
    - No further action is to be undertaken until the NSW Police provide written notification to NSW Public Works Advisory.

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- If the skeletal remains are identified as Aboriginal, NSW Public Works Advisory or their agent must contact: The Heritage NSW Enviroline on 131 555; and representatives of the Local Aboriginal Land Council.
- No works are to continue until Heritage NSW provides written notification to the proponent or their Agent.

Please do not hesitate to contact me should you have any questions or would like to clarify details of this assessment.

Yours sincerely,

Chelsea Freeman
Heritage Consultant
Niche Environment and Heritage

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Is the proposed activity a low impact activity as defined by the Regulation? 8

Step 1 - Will the activity disturb the ground surface or any culturally modified trees? 8

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Step 2b - Are there any other sources of information of which a person is already aware? 11

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1. Introduction

1.1 The proponent

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by NSW Public Works Advisory on behalf of Wingecarribee Shire Council (the Proponent) to undertake an Aboriginal Objects Due Diligence Assessment (DD) to assess the proposed replacement of the existing incoming main to the Bowral Sewage Treatment Plant (STP), which operates over the Mittagong River and ends at the STP located north of the intersection between Railway road and Burradoo road, Burradoo, NSW (hereafter referred to as the 'Activity Area').

1.2 The Activity Area

The Activity Area is located within the Southern Highlands region of NSW, located at the intersection between the towns of Bowral and Burradoo. The Activity Area covers an area of approximately 2.4 ha and is situated within the Moss Vale Tablelands and the Woronora Plateau.

The Activity Area includes:

- The area north of Mittagong Creek to the existing pipe connection point,
- The are south of Mittagong creek up to the existing STP,
- And the area across Mittagong Creek.

The Activity Area is located within the Wingecarribee Local Government Area and the boundaries of the Gandangara Local Aboriginal Land Council (LALC) (Figure 1 and Figure 2). The pipe alignment is situated within Lot 2 DP 604662 and Lot 2 DP 1119953.

1.3 The proposed activity

The Wingecarribee Shire Council provides a water supply to over 18,000 people in the Southern Highlands region of NSW. Part of their infrastructure includes the Bowral STP. The proposed works intend to replace and realign the existing incoming 450 DN cast iron main with a 675 DN main in order to provide a direct route for the new inlet to the proposed new inlet works on the STP site. This will involve the removal of the existing 450 DN cast iron pipe over approximately 80 m and its replacement with a new 675 DN main. As it is a gravity main, the pipe will begin at the existing pipe connection point located on the north side of Mittagong creek and will be elevated on piers in order to cross the Mittagong Creek and the low-lying area south of the creek. The activity will involve earthworks and vegetation clearance associated with the upgrade works.

1.4 Statutory controls

This DD will inform an Addendum to the Review of Environmental Factors (REF) that is being prepared to assess the potential environmental impacts of the proposed STP works in accordance with the requirements of Part 5 of the *Environmental Planning and Assessment Act 1979*.

The *National Parks and Wildlife Act 1974* (NPW Act), administered by Heritage NSW of the Department of Premier and Cabinet (previously the Office of Environment and Heritage (OEH)), is the primary legislation for the protection of some aspects of Aboriginal cultural heritage in New South Wales[1]. Part 6 of the NPW Act provides specific protection for Aboriginal objects and declared Aboriginal places by establishing offences of harm.

[1] For further information visit: https://www.environment.nsw.gov.au/licences/achregulation.htm

The NPW Act provides that a person who exercises due diligence in determining that their actions will not harm Aboriginal objects has a defence against prosecution if they later unknowingly harm an object without an Aboriginal Heritage Impact Permit (AHIP).

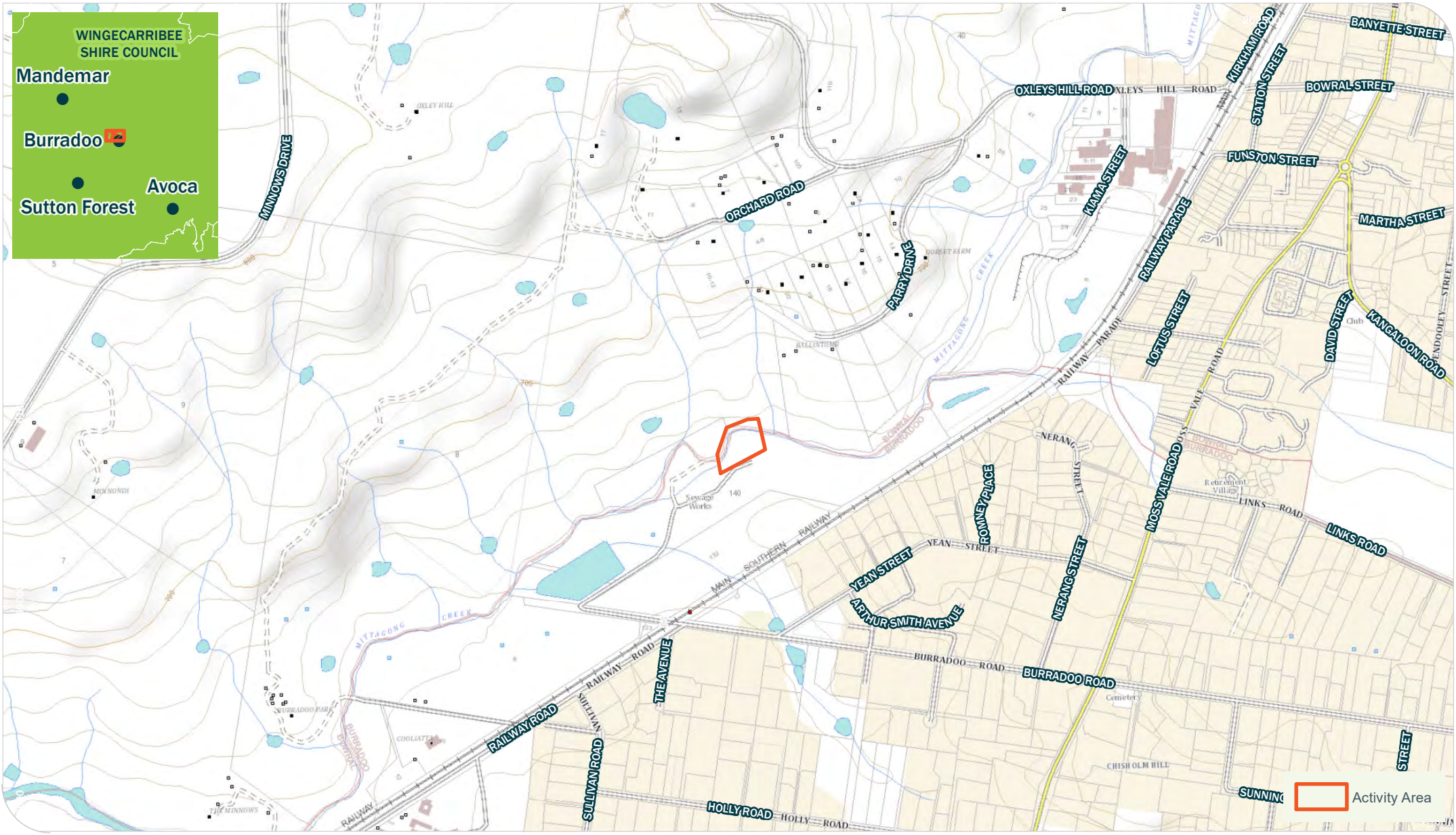
The *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (DECCW, 2010) sets out a process for individuals and organisations to follow to determine whether an Aboriginal object will be harmed by an activity, whether further investigation is needed, and whether that harm requires an AHIP (Figure 3).

1.5 Objectives

The aim of the assessment was to assess whether Aboriginal objects and/or places are present and/or are likely to occur within, or in close proximity to, the Activity Area and, if present whether they may be harmed by the proposed works and if further investigation is required.

1.6 Assessment methodology

This DD follows the process outlined in Figure 3 and included a site inspection with a representative of the Bowral STP, conducted on 24 February 2021.



niche Environment and Heritage

GDA 1994 MGA Zone 56

Niche PM: Chelsea Freeman
Niche Proj. #: 6505
Client: Public Works Advisory

Location Map
Bowral STP Upgrade

Figure 1

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0 30
m
GDA 1994 MGA Zone 56

Niche PM: Chelsea Freeman
Niche Proj. #: 6505
Client: Public Works Advisory

Location of the Activity Area
Bowral STP Upgrade

Figure 2

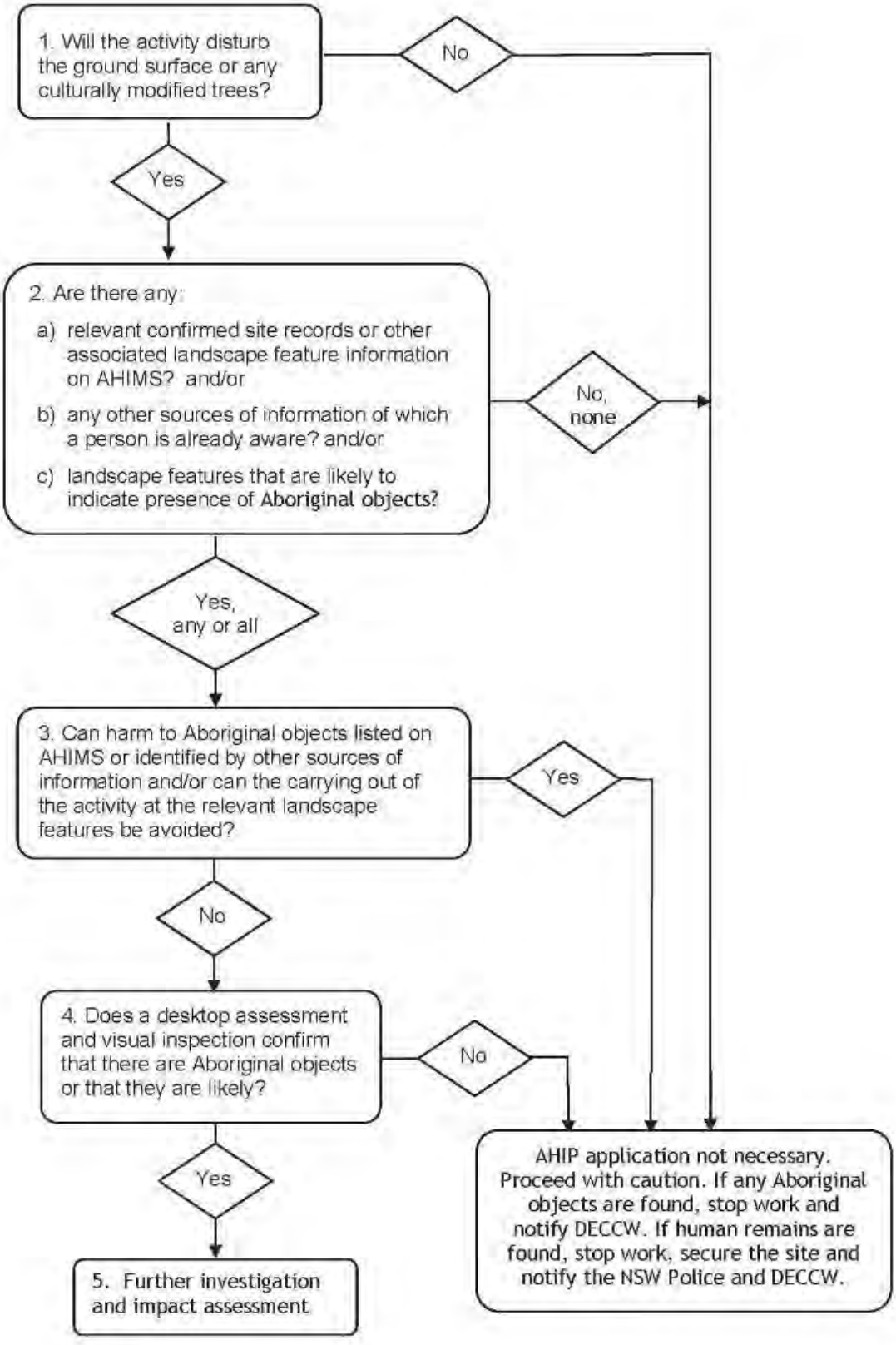

Figure 3: *The Due Diligence* assessment process

2. Environmental Context

2.1 Topography, Landforms and Hydrology

The Activity Area is located within the Southern Highlands region of NSW, located at the intersection between the towns of Bowral and Burradoo. The Activity Area covers a length of approximately 2.4 ha and is situated within the Moss Vale Tablelands and the Woronora Plateau. The Activity Area is characterised by the Kangaloon landscape and consists of foot slopes with local relief of 0-9 m, and slopes of 1-3 %. The Activity Area is bisected by Mittagong Creek, a second order perennial stream connected to the Wingecarribee River to the south east. Mittagong Creek connects to a number of non-perennial first order tributaries.

2.2 Geology and soils

The Activity Area is situated within the Kangaloon soil landscape which is a transferral landscape type with deep deposits generally consisting of brown kurosols (Yellow Podzolic Soils) and hydrosols (Humic Gleys) (Figure 4). Geologically, the Activity Area is located within the Wianamatta Shale group, consisting of alluvium, colluvium and shale.

2.3 Vegetation

The Activity Area has undergone extensive vegetation clearance and is generally characterised by extensively cleared open grasslands. Due to the high rainfall and moisture content, the Kangaloon landscape generally consists of trees hosting mosses and liverworts. Common trees included are *Salix fragilis* (crack willow), *Eucalyptus stellulata* (black sallee), *E. macarthurii* (Paddy's river box), *E. viminalis* (ribbon gum), *Pinus radiata* (radiata pine), *Acacia decurrens* (green wattle), *A. melanoxylon* (blackwood) and *Ligustrum lucidum* (large leaf privot). Common groundcover species of the Activity Area include *Phalaris aquatica* (phalaris), *Themeda australis* (kangaroo grass), *Plantago lanceolata* (ribwort), *Paspalum dilatatum* (paspalum), *Hypochaeris radicata* (catsear), *Foeniculum vulgare* (fennel), *Lomandra longifolia* (spinyheaded mat-rush), *Juncus sp.* (rush).

The Southern Highlands region of NSW has a temperate climate. The Kangaloon landscape is subject to waterlogging due to the result of tree clearing and an annual mean rainfall of 930 mm (accessed on 16 February 2021 at: http://www.bom.gov.au/climate/averages/tables/cw_068102.shtml).

2.4 Past land use and disturbance

The Aboriginal people who inhabited the Bowral landscapes belong to the Gundungarra people. Known as ‘mountain people’, the Gundungarra people extended from the Southern Highlands, to Camden in the north, the Blue Mountains in the west and Goulburn to south. The Gundungarra people lived in small communities that were nomadic, moving according to season, following the food sources available (Mount Gibraltar Landcare and Bushcare, 2007).

Bowral was first settled by Europeans in 1816, with Lieutenant John Oxley establishing a cattle farm and stockyards at ‘Wingie Karrabee’. This 4,200-acre property was established well before a permanent township was developed. The building of the Southern Highland Railway from Sydney allowed for the sale of town allotments. Bowral was established in 1867 in conjunction with the opening of the railway. The extension of the railway in the 1870s to Moss Vale, providing a business and population boom in Bowral. The Municipality of Bowral was later established in 1889 (Berrima District Historical and Family History Society, 2013).

The Activity Area has been historically cleared for farming and the initial construction of the STP and associated upgrades. Historical aerial imagery can provide further information about previous land use and

impact on the ground surface (Figure 5). The image from 1963 shows that the Bowral STP has yet to be established but the land has been previously cleared for pastoral use. The image from 1990 shows that the Bowral STP has been established in its current location, with clearance of vegetation for the STP and surrounding areas have been cleared for property development. An augmentation of the STP was completed in 2006 in order to provide a facility with the capacity to deal with the increasing population in the Wingecarribee Shire. The augmentation included the installation of a new inlet works and a lift pump station.

The majority of the Activity Area is within an area which meets the definition of 'Disturbed' under the Due Diligence Code. The Due Diligence Code (DECCW, 2010) provides the following definition of 'disturbed land':

> *"Land is disturbed if it has been the subject of human activity that has changed the land surface, being changes that remain clear and observable. Examples include ploughing, construction of rural infrastructure (such as dams and fences), construction of roads, trails and tracks (including fire trails and tracks and walking tracks), clearing vegetation, construction of buildings and erection of other structures, construction or installation of utilities and other similar services (such as above or below ground electrical infrastructure, water and sewerage pipelines, stormwater drainage and other similar infrastructure) and construction of earthworks" (OEH 2010:18)*

The overall landscape context of the Activity Area provides a picture of a landscape that has been subject to significant levels of disturbance relating to the clearing of native and introduced vegetation, farming, landscaping, the installation of the original pipeline, and the nearby 450DN cast iron pipe and construction of assorted infrastructure.

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Client: Public Works Advisory

Soil landscapes and hydrology in the local area
Bowral STP Upgrade

Figure 4

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Historical Aerial Photographs
Bowral STP Upgrade

Figure 5

3. Aboriginal objects due diligence assessment

Is the proposed activity a low impact activity as defined by the Regulation?

No.

The activity is not a low impact activity as defined under section 80B of the National Parks and Wildlife Regulation 2009 ('the Regulation') because:

- It involves earthworks associated with new installation/construction.
- It is not listed as a low impact activity as defined under section 80B.

Step 1 - Will the activity disturb the ground surface or any culturally modified trees?

Yes.

The proposed activity will involve earthworks and ground disturbance associated with trenching, the construction of piers, and the installation of the new pipe and associated infrastructure as outlined in the Introduction section of the assessment. The proposed activity will also involve some vegetation clearance associated with the upgrade works. No culturally modified trees will be harmed by the proposed activity.

Step 2a - Are there any relevant confirmed site records or other associated landscape feature information on AHIMS (or other heritage registers)?

No.

Heritage Registers

AHIMS

A basic Aboriginal Heritage Information Management System (AHIMS) search was conducted on 16 February 2021 (AHIMS Client ID: 568284) centred on the Activity Area with a buffer of 1 km (Figure 6 and Attachment 1).

No previously recorded sites were located within the AHIMS search area (Attachment 1).

It must be noted that care should be taken when using the AHIMS database to reach conclusions about site prevalence or distribution. The distribution of registered sites does not reflect patterns of occupation, but rather is often indicative of survey coverage and conditions.

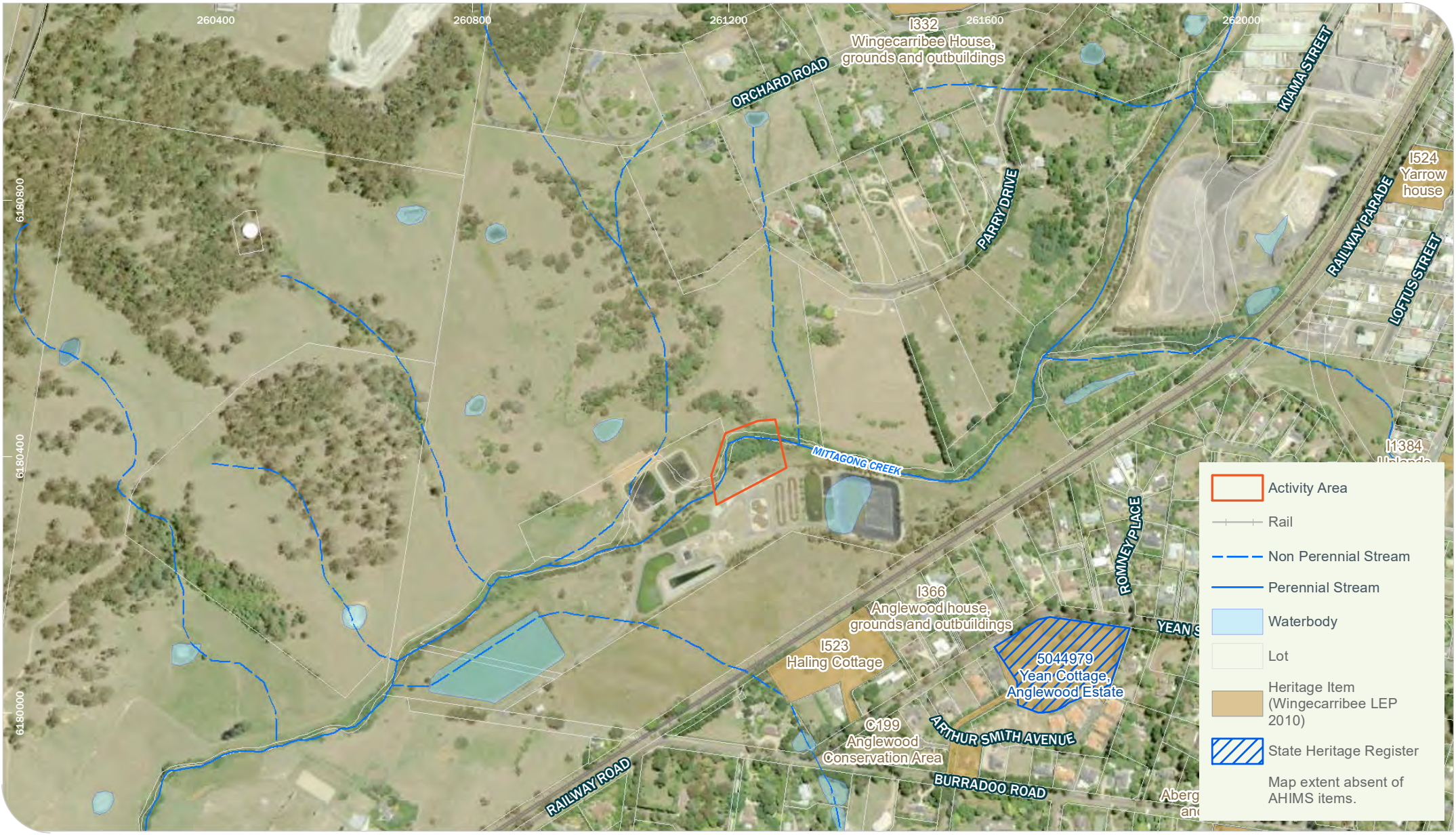
Other heritage registers

Searches of the Australian World Heritage Database, the Commonwealth Heritage List, National Heritage List, State Heritage Register, State Heritage Inventory, the Wingecarribee Local Environmental Plan (LEP) (2010) and the Wingecarribee Development Control Plan (DCP) (2019) (were conducted on the 16 February 2021).

The searches concluded that there are five previously recorded historic heritage items nearby the Activity Area, as detailed in Table 1 and seen in Figure 6; however, none of the heritage places possess Aboriginal heritage values or significance. Therefore, further assessment of these places is outside of the scope of this DD.

Table 1: Listed heritage items in proximity to the Activity Area

Heritage Register	Items in the Activity Area	Items nearby to the Activity Area	
Australian World Heritage Database	None	None	
Commonwealth Heritage List	None	None	
National Heritage List	None	None	
State Heritage Register	None	None	
State Heritage Inventory	None	None	
Schedule 5 of the LEP	None	**ID**	**NAME**
		I523	Haling Cottage, 58–68 Yean Street, Burradoo NSW
		I366/ I188	"Anglewood" house, grounds and outbuildings, 17–19 Yean Street, Burradoo NSW
		I512	Cooliatta Farm house, grounds and outbuildings, Burradoo Rd, Burradoo NSW
		I374	Riverside Park garden, 127 Osborne Road, Burradoo NSW
		I1374	"Southdown" house, garden and trees, 559 and 563–565 Moss Vale Road, Burradoo NSW
Wingecarribee Development Control Plan	Section 8.7 of the Wingecarribee DCP Part A describes the Burradoo Landscape Conservation Area. 8.7.1 describes the area as: • The Burradoo Landscape Conservation Area encompasses the green space on either side of Moss Vale Road between Bowral/Burradoo and Moss Vale. It includes the Bong Bong Common which was the site of the Government settlement of the village of Bong Bong of which only archaeological evidence remains. Section 8.7.3 Controls for the Burradoo Landscape Conservation Area • A landscape plan is required for all plantings that are expected to reach a mature height of greater than 1000mm. • Development on Bong Bong Common to be in accordance with the Bong Bong Common Conservation Management Plan.		



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Client: Public Works Advisory

Location of AHIMS Sites and Heritage Items
Bowral STP Upgrade

Figure 6

Step 2b - Are there any other sources of information of which a person is already aware?

Yes.

Previous heritage assessments within of relevant to the Activity Area:

The purpose of a review of previous archaeological and cultural heritage assessments is to provide a context and baseline for what is known about Aboriginal cultural heritage in the Activity Area. The following Aboriginal heritage assessments have occurred nearby to the Activity Area:

Archaeological Survey and Test Excavations at a Proposed Clay Extraction Pit at Bowral (Silcox, 1987, as cited in EMM, 2017)

This report outlines the results of an archaeological survey and test excavation undertaken by Silcox (1987) on behalf of Bowral Brickworks (located approximately 1.2 km north east of the Activity Area). An initial survey of the proposed area of extension, approximately 8 km north of the existing clay pit, was undertaken and identified two stone artefacts. Test excavations were then undertaken due to the high potential for subsurface artefacts. The Subject Area was located on a floodplain, bordered by Mittagong Creek to the east and south and a basalt outcrop to the west. The Subject Area had previously been disturbed through extensive ploughing. Location for test pits were identified based on three primary factors:

- The proximity to water,
- The elevation of the landscape
- Location of artefacts identified during survey.

The test excavation recovered a total of 41 artefacts from 17 25cm² pits. A total of 12 artefacts were located in a singular pit. This was argued to be evidence of remnants of a knapping floor due to the high density of artefacts. The majority of artefacts identified were flakes, broken flakes and flaked pieced primarily of composed quartz. Analysis of artefact locations showed low density of artefacts on lower slopes and higher density of artefacts on the upslope of an alluvial fan. This assessment is of relevance to the current activity area as it provides an understanding of the archaeology associated with an area located in a similar environmental context (i.e. associated with Mittagong Creek).

Archaeological Survey Exeter, NSW (Resource Planning Pty Limited, 1992)

The report presents the results of an Archaeological survey that was undertaken by Resource Planning Pty Limited (1992) as part of an environmental Impact Statement (EIS) on behalf of Southern Highland Quarries Pty Limited. The survey was conducted for the proposed extension of an existing hard rock quarry located approximately 550 m east of Exeter Village in the Southern Highlands, NSW (located approximately 15 km south east of the Activity Area). Prior to the survey, the Subject Area was identified as disturbed through the clearance of vegetation and the pastoral use of land. Four known Aboriginal sites were identified within 8 km of the Subject Area prior to survey. The results of the survey, however, identified no additional evidence of Aboriginal occupation in the Subject Area. Ground Surface Visibility (GSV) was limited in areas, preventing reasonable view of the ground surface. The results of the survey were expected due to the minimal GSV, the lack of previously identified sites surrounding the Subject Area and the disturbance of the surface due to vegetation clearance and pastoral use. This assessment is of relevance to the current activity area as it provides an understanding of the archaeology associated with an area located in a similar environmental context (i.e. associated with Mittagong Creek).

Wingecarribee River Proposed Management Project: Archaeological Survey for Aboriginal and Historic Sites (Rich, 1988)

This report presents the results of an Archaeological survey was undertaken by Rich (1988) on behalf of The Water Board (located approximately 1.7 km south east of the Activity Area at the closest point of survey). This survey was conducted as it was identified that the proposed works would damage or destroy identified Aboriginal sites. A desktop assessment and a field survey were conducted from Wingecarribee Reservoir downstream to Black Springs Creek. The assessments identified six historic sites, twelve Aboriginal sites, six isolated Aboriginal artefacts, one shelter with potential archaeological deposit and one potential open camp site. All sites were identified located above the natural flood level. The survey identified that the majority of the surveyable land was characterised by a high level of exposure resulting from previous pastoral use of the land surrounding the river and resulting in the disturbance to vegetation and the ground surface within the assessment area. It was concluded that identified camp sites were selectively occupied by Aboriginal people, whereas isolated finds indicated a wider area of occupation. Campsites were generally identified further from the river than isolated finds, suggesting isolated finds near the river were probably sites that were casually occupied. This assessment is of relevance to the current activity area as it provides an understanding of the archaeology associated with an area located in a similar environmental context (i.e. associated with a creek and in an area associated with previous flooding and disturbance).

Step 2c - Are there landscape features that are likely to indicate the presence of Aboriginal Objects?

Yes.

The following landscape features listed in the Due Diligence Code (DECCW, 2010) signify a high potential for the presence of Aboriginal objects:

- Within 200 m of waters, or
- Located within a sand dune system, or
- Located on a ridge top, ridge line or headland, or
- Located within 200 m below or above a cliff face, or
- Within 20 m of or in a cave, rock shelter, or a cave mouth.

Based on the desktop assessment above (Section 2, Steps 2a and 2b), the Activity Area contains the following landscape features that are likely to indicate the presence of Aboriginal objects, as identified by the Due Diligence Code of Practice (DECCW, 2010):

- within 200 m of waters.

However, the degree of disturbance evident throughout the Activity Area means that the likelihood of *in suit* Aboriginal objects surviving is low.

Step 3 - Can the harm or the activity be avoided?

Not applicable.

The desktop and visual inspection (see Step 4) indicate that Aboriginal objects are unlikely to occur within the Activity Area due to the degree of existing disturbance and as such there is no compelling reason to move or avoid the activity.

Step 4 - Does a desktop assessment and visual inspection confirm that there are Aboriginal Objects or that they are likely?

No.

The desktop and visual inspection confirmed that Aboriginal objects are unlikely to occur within the Activity Area due to the high degree of past land use and disturbance.

Site inspection details

A pedestrian survey of the Activity Area was carried out on the 24 February 2021 by Chelsea Freeman, (Niche heritage consultant), Renée Regal (Niche Heritage Team Leader) and Richard Batty (Wingecarribee Shire Council representative).

The field survey team walked the entire area of the proposed pipeline, from the ground surface connection point north of Mittagong creek, to the ground surface connection point in the STP south of Mittagong Creek (Plate 3).

The landforms encountered during the site inspection were predominantly slopes and floodplains. The Activity Area south of Mittagong Creek was identified as a flood plain up to the point for the elevate STP. This area has been previously subject to flooding which has disturb the ground surface. Evidence of replantation of vegetation destroyed during flooding around the creek line was identified (Plate 4). The majority of the Activity Area had been cleared of native and introduced vegetation. Large mature trees remained along the southern bank of Mittagong Creek though none had evidence of cultural modification. Dense weed growth along the northern bank of Mittagong Creek prevented a complete survey of the north section of Activity Area (Plate 7 and Plate 8). No Aboriginal sites and/or Aboriginal heritage constraints were identified during the survey.

Plate 1: General location of revised pipeline facing north.

Plate 2: General location of revised pipeline facing north.

Plate 3: General location of where the revised pipeline will connect to subsurface, facing south.

Plate 4: General shot of Mittagong Creek, facing north.

Plate 5: Existing pipeline in Activity Area, facing north-east.

Plate 6: Location of ground surface connection of existing pipes, facing east.

Plate 7: General location of proposed connection point of pipeline, facing south.

Plate 8: General location of proposed connection point of pipeline and existing connection point of pipeline, facing south.

Step 5 - Further investigations and impact assessment

No.

The desktop and visual inspection confirmed that, despite archaeologically sensitive landscape features being present in the Activity Area (areas within 200 m of creeks), it is unlikely that Aboriginal objects are present due to the high degree of past land use and disturbance. While it is possible that isolated artefacts may be present within erosional and disturbed landscapes, the nature and extent of disturbance evident throughout the Activity Area in this specific case reduces this likelihood to low. As such, no further investigation or impact assessment is required for the Activity Area.

4. Conclusions and Recommendations

On the basis of this assessment, it is unlikely that Aboriginal objects have survived within the Activity Area due to the high degree of past land use and disturbance. The land modification practices associated with the construction of the existing pipeline and the STP have disrupted the ground surface to such an extent that the possibility of *in situ* archaeological deposits is low.

No Aboriginal objects and/or Aboriginal heritage constraints were identified within the Activity Area and no further investigation or impact assessment is required.

The Due Diligence Code (DECCW, 2010) states that where a desktop and visual inspection has occurred and concluded that Aboriginal objects are unlikely to occur, an Aboriginal Heritage Impact Permit (AHIP) application will not be necessary. The proposed activity may therefore proceed with caution without a further Aboriginal Cultural Heritage Assessment (ACHA) or AHIP. It is recommended that:

- All site workers and contractors should be inducted to the area and informed of their obligations under the *National Parks and Wildlife Act 1974*
- In the unlikely event that any Aboriginal objects are found, all activities with the potential to impact the objects must stop. A temporary fence is to be erected around the Aboriginal cultural heritage site, with a buffer zone of at least 10 metres around the known edge. An appropriately qualified archaeologist is to be engaged to assess the findings, and notification is provided to Heritage NSW (Aboriginal Cultural Heritage Regulation) in the Department of Premier and Cabinet. Works should not proceed without advice from Heritage NSW or an appropriately qualified archaeologist.
- In the unlikely event that suspected human remains are encountered during construction, all work in the area that may cause further impact, must cease immediately and:
    - The location, including a 20 m curtilage, should be secured using barrier fencing to avoid further harm.
    - The NSW Police must be contacted immediately.
    - No further action is to be undertaken until the NSW Police provide written notification to NSW Public Works Advisory.
    - If the skeletal remains are identified as Aboriginal, NSW Public Works Advisory or their agent must contact: The Heritage NSW Enviroline on 131 555; and representatives of the Local Aboriginal Land Council.
    - No works are to continue until the Heritage NSW provides written notification to the proponent or their Agent.

5. References

Berrima District Historical and Family History Society, 2013. *When Bowral Began…* . Southern Highland News, www.southernhighlandnews.com.au/story/1941264/when-bowral-began/

Department Environment, Climate Change and Water NSW, 2010b. *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*, Department of Environment, Climate Change and Water NSW.

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EMM Consulting Pty Limited, 2017. Appendix S: Aboriginal Cultural Heritage Assessment Report. In *Hume Coal Project: Environmental Impact Statement*. Prepared for Hume Coal Pty Limited

Mount Gibraltare Landcare and Bushcare, 2007. *The Gib: Mount Gibraltar*, Southern Highlands.

Resource Planning Pty Limited, 1992. Appendix 5: Archaeological Survey. In *Environmental Impact Statement for Proposed Extension to Hard Rock Quarry- Lot 2 DP 537292, and Part Portion 102, Parish of Sutton Forrest, Exeter, NSW*. Prepared for Southern Highlands Quarries Pty Limited.

Rich, E., 1988. *Wingecarribee River Proposed Management Project: Archaeological Survey for Aboriginal and Historic Sites.* Prepared for The Water Board.

Wingecarribee Shire Council, 2010*. Local Environmental Plan.*

Wingecarribee Shire Council, 2019*. Development Control Plan.*

Attachment 1 – AHIMS Basic Search

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 6505

Client Service ID : 568284

Niche Environment and Heritage

PO Box 3104
Umina Beach New South Wales 2257

Attention: Chelsea Freeman

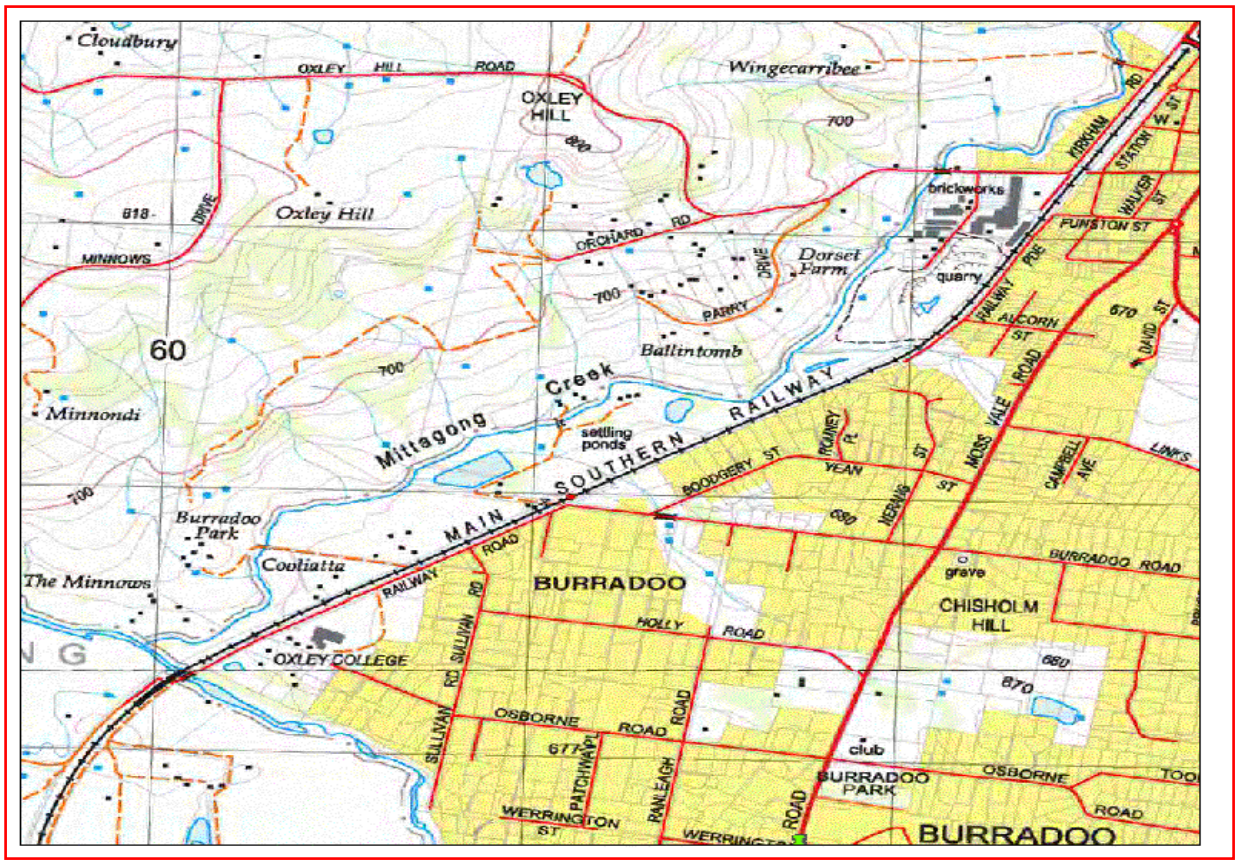
Email: cfreeman@niche-eh.com

Date: 16 February 2021

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lot : 2, DP:DP1119953 with a Buffer of 1000 meters, conducted by Chelsea Freeman on 16 February 2021.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

0	**Aboriginal sites are recorded in or near the above location.**
0	**Aboriginal places have been declared in or near the above location. ***

If your search shows Aboriginal sites or places what should you do?

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the NSW Government Gazette (http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

Important information about your AHIMS search

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

3 Marist Place, Parramatta NSW 2150
Locked Bag 5020 Parramatta NSW 2220
Tel: (02) 9585 6380 Fax: (02) 9873 8599

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Appendix D – Biodiversity Assessment

NSW GOVERNMENT | Public Works Advisory

Bowral STP - Incoming Main Works

Biodiversity Assessment

Report Number: ISR21150

September 2021

Prepared for Wingecarribee Shire Council

Report Number: ISR21150

Document Control

Version	Author(s)	Reviewer	Approved for issue	
			Name	Date
Draft	Martin James	Kristen Parmeter	Liz Mathieson	01.06.2021
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Abbreviations

BC Act	NSW *Biodiversity Conservation Act 2016*
DAWE	Commonwealth Department of Agriculture, Water and Environment
DBH	Diameter at Breast Height
DPI	NSW Department of Primary Industries
DPIE	NSW Department of Planning, Infrastructure and Environment
EEC	Endangered Ecological Community
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
LSC	Lachlan Shire Council
PCT	Plant Community Type
PWA	NSW Public Works Advisory
STP	Sewage Treatment Plant
TEC	Threatened Ecological Community

1. Introduction

Wingecarribee Shire Council is proposing to replace two short sections of incoming sewer mains at Bowral Sewage Treatment Plant (STP). The length of pipeline to be replaced is approximately 180m. Figure 1-1 below shows the proposed new section of pipelines.

This report assesses the likely biodiversity impacts from the proposal.

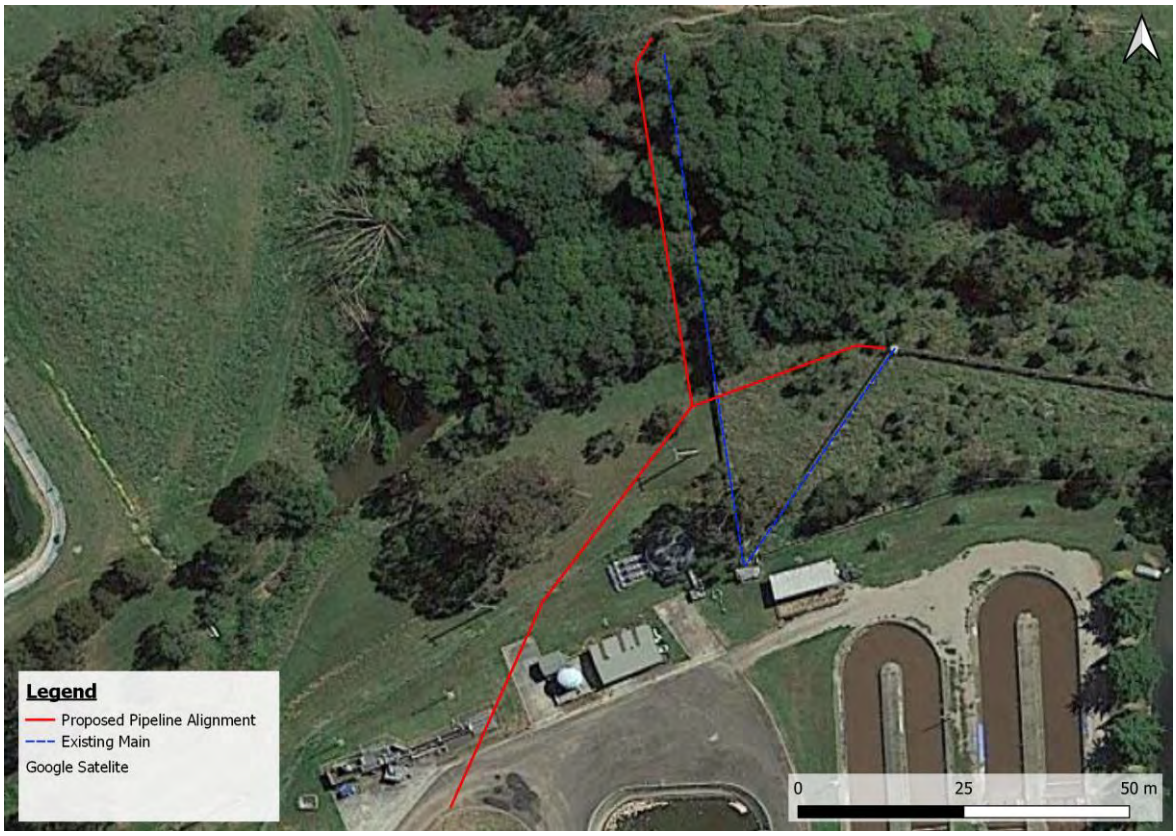

Figure 1-1 The alignment of the proposed new pipeline.

2. Assessment Methodology

Background information was collated from relevant sources and databases including, but not limited to the NSW Department of Primary Industry and Environment (DPIE) BioNet Atlas of NSW Wildlife database, NSW Government Six Viewer website, Google Maps, and DPIE vegetation mapping.

The project site was assessed on the 1st March 2021. All observed species of flora were identified, vegetation community types were identified, fauna habitat assessed, any opportunistic sightings of fauna documented, and any significant flora or fauna features identified. A brief examination of the vegetation in the adjoining areas was undertaken to establish the local context for vegetation and fauna habitat on the site. Digital photographs were taken throughout the assessment for later reference and for inclusion in this report. GPS coordinates were taken of any noteworthy features. Photos are provided in Appendix A. Species lists are provided in Appendix B.

The results of the site assessment were analysed with reference to relevant information sources and databases including, but not limited to, the NSW Flora Online PlantNET database, NSW Threatened Species Profiles, NSW Scientific Committee Determinations,

Commonwealth Listing Advices, and other relevant reference material (e.g. Field Guide to Eucalypts: South-eastern Australia (Brooker and Kleinig, 1999), Grasses of Coastal NSW (DPI, 2012), Weeds of the South-East: An Identification Guide for Australia (Richardson, Richardson & Shepherd, 2016), etc.).

3. Existing Biodiversity

3.1 Flora

The entire project site has been previously cleared. At and immediately beside the STP it now comprises mowed lawn of Buffalo Grass (*Bouteloua dactyloides**) and Common Paspalum (*Paspalum dilatatum**). Two large, old Camden Woollybutt (*Eucalyptus macarthurii*) occur on the mown lawn between the STP and Mittagong Creek. This species is listed as endangered under both the BC Act and EPBC Act. Along the creek the vegetation is mainly introduced species of shrubs, brambles and small trees with scattered, isolated, naturally regenerating native trees. The dominant weeds along the creek are Common Hawthorn (*Crataegus monogyna**), Blackberry (*Rubus fruticosus**) and Small-leaved Privet (*Ligustrum sinense**) with some White Willow (*Salix alba**), English Ivy (*Hedera helix**), and the usual weeds of disturbed land such as Spear Thistle (*Cirsium vulgare**), Fireweed (*Senecio madagascariensis**), etc. There are several scattered young Ribbon Gum (*Eucalyptus viminalis*). On the creek bank closest to the STP some Eucalyptus trees have been planted. Two species are present one of which appears to be a Cabbage Gum (*Eucalyptus amplifolia*). The trees are young, probably less than ten (10) years old. The area between the two existing pipelines beside the STP comprises introduced grasses such as Phalaris (*Phalaris aquatica**) and Common Paspalum that is not mown. Within this grassy area there is a patch planted out with native Cabbage Gum (*Eucalyptus amplifolia*), Flax-leaved Paperbark (*Melaleuca linariifolia*) and Flaky-barked Tea-tree (*Leptospermum trinervium*). The complete list of species is provided in Appendix B. Photographs are provided in Appendix A.

The DPIE (2021) vegetation mapping (VIZ_ID 4172) does not map the project site as native vegetation. The site assessment confirmed that the vegetation is not native, being dominated by introduced species, although scattered native trees, shrubs and groundcover plants such as grasses and herbs do occur. The vegetation mapping is illustrated in Figure 3-1 below.

Figure 3-1 DPIE (2019) native vegetation mapping of project area.

3.1.1 Threatened Species

A search of the BioNet Atlas of NSW Wildlife on 28/02/2021 indicated that six (6) species of flora listed under the BC Act and/ or EPBC Act have been recorded within a 10km x 10km square centred on the project site. The species are listed in Table 3-1 below. The table indicates whether potential habitat exists on site and whether the species was observed during the site assessment. One listed species, namely the Camden Woollybutt, was observed.

Table 3-1 Listed species of flora recorded within a 10km x 10km square centred on the project site.

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Helichrysum calvertianum		It occurs in dry sclerophyll forest and heathland with rock outcrops, predominantly on Hawkesbury sandstone soils. At altitudes between approximately 650 and 855 m. Rainfall ranges from 850 mm per annum at the western-most sites, to over 1500 mm at the eastern-most site. It is likely the seeds are wind dispersed. The fire response of H. calvertianum is unknown.	V/ -	No	No
Eucalyptus aggregata	Black Gum	Grows in the lowest parts of the landscape. Grows on alluvial soils, on cold, poorly-drained flats and hollows adjacent to creeks and small rivers. Often grows with other cold-adapted eucalypts, such as Snow Gum or White Sallee (Eucalyptus pauciflora), Manna or Ribbon Gum (E. viminalis), Candlebark (E. rubida), Black Sallee (E. stellulata) and Swamp Gum (E. ovata). Black Gum usually occurs in an open woodland formation with a grassy groundlayer dominated either by River Tussock (Poa labillardierei) or Kangaroo Grass (Themeda australis), but with few shrubs. Also occurs as isolated paddock trees in modified native or exotic pastures. Many populations occur on travelling stock reserves, though stands and isolated individuals also occur on private land. There are very few stands in conservation reserves.	V/ V	No	No
Eucalyptus aggregata population in the Wingecarribee Local Government Area			E2/ V	No	No
Eucalyptus macarthurii	Camden Woollybutt	Occurs on grassy woodland on relatively fertile soils on broad cold flats.	E/ E	Yes	Yes

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Diuris aequalis	Buttercup Doubletail	Recorded in forest, low open woodland with grassy understorey and secondary grassland on the higher parts of the Southern and Central Tablelands (especially on the Great Dividing Range). Like most Diuris species, the flowers mimic native pea flowers to attract pollinators; in this case the model is a small-flowered wedge-pea (*Gompholobium* sp.), with which it always grows. Leaves die back each year and resprout just before flowering. Populations tend to contain few, scattered individuals; despite extensive surveys, only about 200 plants in total, from 20 populations are known.	E/ V	No	No
Persoonia glaucescens	Mittagong Geebung	The Mittagong Geebung grows in woodland to dry sclerophyll forest on clayey and gravely laterite. The preferred topography is ridge-tops, plateaux and upper slopes. Aspect does not appear to be a significant factor. Within its habitat, P. glaucescens is generally rare and the populations are linear and fragmented. Under ideal circumstances, the species can be locally common, though such conditions are very rare. Plants are killed by fire and recruitment is solely from seed. Like most Persoonia species this species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides.	E/ V	No	No

** E2 = Endangered Population, E = Endangered, V = Vulnerable.*

3.2 Fauna

The project site provides limited habitat for native fauna due to its disturbed condition. Having been cleared it now comprises mostly introduced species. Two large old Camden Woollybutt are present beside the STP, however, they do not contain tree hollows. An Australia Wood Duck (*Chenonetta jubata*) was observed on the mown lawn and several Common Wombat (*Vombatus ursinus*) burrows exist beside the creek. Native species of frogs, reptiles, birds, mammals and invertebrates may utilise habitat on the project site. No evidence of roosting or nesting was observed of any species other than the Common Wombat. Photographs of the project site are provided in Appendix A. The complete list of species recorded is provided in Appendix B.

3.2.1 Threatened species

A search of the BioNet Atlas of NSW Wildlife on 28/02/2021 indicated that twenty-three (23) species of fauna listed under the BC Act and/ or EPBC Act have been recorded within a 10km x 10km square centred on the project site. The species are listed in Table 3-2 below. The table indicates whether potential habitat exists on site and whether the species was observed during the site assessment. No listed species were observed.

Table 3-2 Listed species of fauna recorded within a 10km x 10km square centred on the project site.

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Aves					
Oxyura australis	Blue-billed Duck	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six. Males take no part in nest-building or incubation. Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.	V/ -	No	No
Stictonetta naevosa	Freckled Duck	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates. Nesting usually occurs between October and December but can take place at other times when conditions are favourable. Nests are usually located in dense vegetation at or near water level.	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Hirundapus caudacutus	White-throated Needletail	In Australia, the White-throated Needletail is almost exclusively aerial, from heights of less than 1 m up to more than 1000 m above the ground. White-throated Needletails almost always forage aerially, at heights up to 'cloud level', above a wide variety of habitats ranging from heavily treed forests to open habitats, such as farmland, heathland or mudflats, though they sometimes forage much closer to the ground in open habitats, once as low as about 15 cm in a coastal saltworks. The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows, though the number of references to Needletails roosting in trees possibly over-emphasizes such occurrences. It has been suggested that they also sometimes roost aerially, and it was formerly erroneously thought that the species did not alight while in Australia. The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests. White-throated Needletails may take refuge during extreme conditions. Many birds were seen perching on the trunks of trees during a bushfire; during cold weather, one was found roosting during the day in the hollow branch of a eucalypt and some were seen sheltering in stunted scrub during bad weather on the high plains. They may also alight on the trunks or branches of trees during hot or inclement weather; and there is a record of Needletails resting on a lawn under sprinklers during hot weather.	-/ V	No	No
Botaurus poiciloptilus	Australasian Bittern	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (Typha spp.) and spikerushes (Eleocharis spp.). Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains.	E/ E	No	No
Haliaeetus leucogaster	White-bellied Sea Eagle	Habitats are characterised by the presence of large areas of open water including larger rivers, swamps, lakes, and the sea. Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. Terrestrial habitats include coastal dunes, tidal flats, grassland, heathland, woodland, and forest (including rainforest). Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
		sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'. Nests are large structures built from sticks and lined with leaves or grass. Feed mainly on fish and freshwater turtles, but also waterbirds, reptiles, mammals and carrion. Hunts its prey from a perch or whilst in flight (by circling slowly, or by sailing along 10–20 m above the shore). Prey is usually carried to a feeding platform or (if small) consumed in flight, but some items are eaten on the ground. May be solitary, or live in pairs or small family groups consisting of a pair of adults and dependent young. Typically lays two eggs between June and September with young birds remaining in the nest for 65-70 days.			
Hieraaetus morphnoides	Little Eagle	Occupies open eucalypt forest, woodland or open woodland. She-oak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion. Single population in NSW.	V/ -	No	No
Callocephalon fimbriatum	Gang-gang Cockatoo	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. Nests in tree hollows, often near water. Eucalypt trees and acacia shrubs are used for foraging. Feeds on seeds mostly from eucalypts and wattles, though it eats some seeds of introduced trees and shrubs around human settlements in winter, and also insect larvae (galls, sawflies).	V/ -	No	No
Calyptorhynchus lathami	Glossy Black-Cockatoo	Inhabits open forest and woodlands of the coast and the Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods. Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. A single egg is laid between March and May.	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Ninox connivens	Barking Owl	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Ringtail Possums, but when loss of tree hollows decreases these prey populations the owl becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats.	V/ -	No	No
Ninox strenua	Powerful Owl	Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest. The Powerful Owl requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally hunts in open habitats. It roosts by day in dense vegetation comprising species such as Turpentine (Syncarpia glomulifera), Black She-oak (Allocasuarina littoralis), Blackwood (Acacia melanoxylon), Rough-barked Apple (Angophora floribunda), Cherry Ballart (Exocarpus cupressiformis) and a number of eucalypt species. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider. Flying foxes are important prey in some areas; birds comprise about 10-50% of the diet depending on the availability of preferred mammals. As most prey species require hollows and a shrub layer, these are important habitat components for the owl. In good habitats a mere 400 ha can support a pair; where hollow trees and prey have been depleted the owls need up to 4000 ha. Powerful Owls nest in large tree hollows (at least 0.5 m deep), in large eucalypts (diameter at breast height of 80-240 cm) that are at least 150 years old. While the female and young are in the nest hollow the male Powerful Owl roosts nearby (10-200 m) guarding them, often choosing a dense "grove" of trees that provide concealment from other birds that harass him.	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Daphoenositta chrysoptera	Varied Sittella	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	V/ -	No	No
Artamus cyanopterus	Dusky Woodswallow	The eastern population is found from Atherton Tableland, Queensland south to Tasmania and west to Eyre Peninsula, South Australia. This population migrates north in autumn. The Dusky Woodswallow is found in open forests and woodlands, and may be seen along roadsides and on golf courses. The Dusky Woodswallow feeds on insects taken on the wing, as well as from foliage and on the ground. It also eats nectar from flowers. The Dusky Woodswallow nests colonially in 'neighbourhoods'. The nest is a loose bowl of twigs, grass and roots, lined with fine grass, and is placed in a tree fork, behind bark, in a stump hollow or in a fence post, about 1 m - 10 m above the ground. Each pair builds the nest, incubates the eggs and feeds the young.	V/ -	No	No
Petroica boodang	Scarlet Robin	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees.	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Petroica phoenicea	Flame Robin	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains). Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas.	V/ -	No	No
Mammalia					
Dasyurus maculatus	Spotted-tailed Quoll	Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock outcrops and rocky-cliff faces as den sites. Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and will hunt possums and gliders in tree hollows and prey on roosting birds. A generalist predator with a preference for medium-sized (500g-5kg) mammals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits, reptiles and insects. Also eats carrion and takes domestic fowl. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares. Are known to traverse their home ranges along densely vegetated creeklines.	V/ E	No	No
Phascolarctos cinereus	Koala	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Home range size varies according to quality of habitat, ranging from less than two hectares to several hundred hectares. Around Sydney, red gums and mahoganies are their most favoured trees. In northern areas of the State, Tallowwood and Forest Red Gum are important, Manna Gum tops the bill in the south, and in the west koalas prefer River Red Gum and Ribbon Gum.	V/ V	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Petaurus norfolcensis	Squirrel Glider	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	V/ -	No	No
Petauroides volans	Greater Glider	Greater Gliders are forest dependent and prefer older tree age classes in moist forest types. They use hollow-bearing trees for shelter and nesting, with each family group using multiple den trees within its home range. They eat mainly young eucalypt leaves, with a preference for certain species.	-/ V	No	No
	Greater Glider population in the Mount Gibraltar Reserve Area		E2/ V	No	No
Pteropus poliocephalus	Grey-headed Flying-fox	Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Can travel up to 50 km from the camp to forage; commuting distances are more often <20 km. Feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines.	V/ V	No	No
Falsistrellus tasmaniensis	Eastern False Pipistrelle	Prefers moist habitats, with trees taller than 20 m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Hunts beetles, moths, weevils and other flying insects above or just below the tree canopy. Hibernates in winter.	V/ -	No	No
Scoteanax rueppellii	Greater Broad-nosed Bat	Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although this species usually roosts in tree hollows, it has also been found in buildings. Forages after sunset, flying slowly and directly along creek and river corridors at an altitude of 3 - 6 m. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species.	V/ -	No	No

Scientific Name	Common Name	Habitat	TSC Act/ EPBC Act Status *	Potential Habitat On-site	Observed On-site
Miniopterus orianae oceanensis	Large Bentwing-bat	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. At other times of the year, populations disperse within about 300 km range of maternity caves. Hunt in forested areas, catching moths and other flying insects above the tree tops.	V/ -	No	No

** E2 = Endangered Population; E = Endangered; V = Vulnerable.*

4. Impact Assessment

4.1 Flora

The project would require the clearing of a narrow strip through the creekline vegetation, a distance of approximately 40 meters. This vegetation comprises almost entirely weeds such as Common Hawthorn, Blackberry and Small-leaved Privet. None of the naturally regenerating native Ribbon Gums would be impacted. Beside the creek some of the recently planted native trees and shrubs may need to be trimmed or removed. These are young, probably less than ten years old. None of these species are threatened or otherwise significant. It is recommended that more native trees and shrubs of locally occurring species be planted alongside the creek to compensate for this impact. It was noted during the site assessment that further along the creek, beside the STP, and where no native trees or shrubs were planted the creek banks are eroding. It may be possible to plant out this area with native trees and shrubs to both compensate for the impacts of this proposal and address an active erosion problem.

Away from the creek the new main would pass by an endangered Camden Woollybutt. Figure 4-1 below shows the location of the tree. The main would be suspended as it passes the tree on concrete pillars spaced approximately every six (6) meters. The pipeline alignment has been selected specifically to keep away from this tree. At the nearest point the pipeline is approximately 8m from the trunk of the tree. Excavating the holes for pillars may impact the tree's roots. However, at this distance from the trunk any impact is likely to be minor. As a precaution, it is recommended that an Arborist be present during construction around the tree, so that any impact to the tree's roots can be appropriately managed. Assessments of Significance provided in Appendix C confirm there would be no significant impact to this endangered species. There would be no significant impact on flora from the proposal.

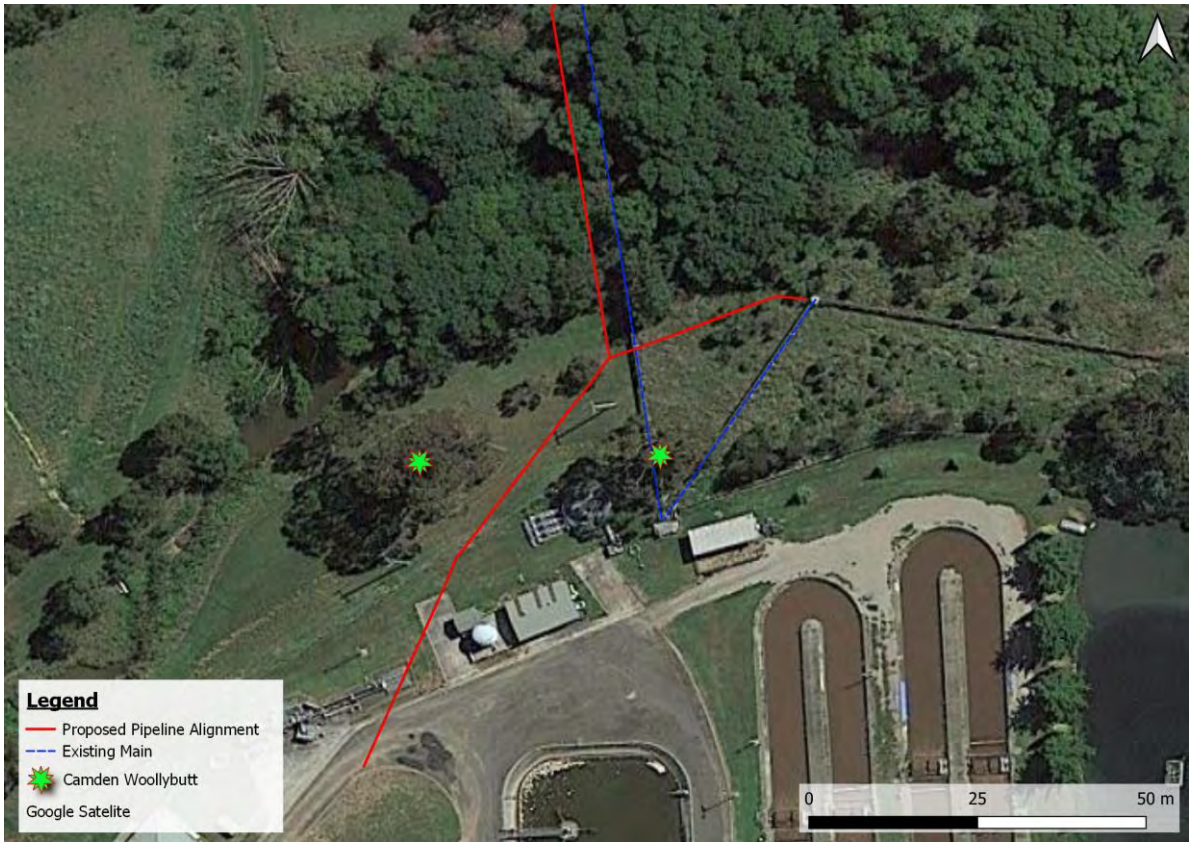

Figure 4-1 Locations of the threatened (Endangered) Camden Woollybutt.

4.2 Fauna

There would be little to no impact on native fauna from the proposal. A narrow strip of mainly introduced species would be cleared along the proposed alignment across the creek, a distance of approximately 40 meters. The vegetation would quickly regenerate following completion of the works. Some burrows of the Common Wombat occur in this area. Care should be taken during construction if manoeuvring heavy equipment in this area, or excavating the ground, to avoid accidentally harming any Wombats that may be sheltering in the burrows. Elsewhere a small number of recently planted native trees and shrubs may be impacted. It is recommended (above) that similar species be replanted to compensate for the flora impacts of this proposal. This would also compensate for any potential fauna impacts that may occur.

There would be no significant impact to native fauna from the proposal.

5. Conclusion and Recommendations

5.1 Conclusion

The project site was previously entirely cleared and now comprises mostly introduced species of trees, shrubs and groundcover vegetation. A small number of native shrubs and trees have recently been planted beside the creek through the project site. Two large, old endangered Camden Woollybutt occur between the creek and the STP.

The proposal would clear a narrow strip of vegetation across the creek comprising almost entirely introduced species. A small number of the recently planted native shrubs and trees beside the creek may be impacted. The new main would pass by one of the Camden Woollybutt. A recommendation is made to minimise impacting this tree's roots. Provided the recommendation is effectively implemented there would be no significant impact on native flora from the proposal.

There would be little to no impact on native fauna from the proposal. Native trees and shrubs would be replanted to compensate for any removal of native vegetation. A recommendation is also made to avoid accidentally harming any Wombats that may be sheltering in burrows near the creek. Provided these measures are effectively implemented there would be no significant impact on native fauna from the proposal.

5.2 Recommendations

An Arborist should be present during construction around the Camden Woollybutt, so that any impact to the tree's roots from excavating holes can be appropriately managed.

Care should be taken during construction of the creek crossing if manoeuvring heavy equipment in this area, or excavating the ground, to avoid accidentally harming any Wombats that may be sheltering in burrows.

Native trees and shrubs of locally occurring species should be planted alongside the creek to compensate for impacts to the recently planted native trees and shrubs.

6. References

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Appendix A – Photographs

Photo 1: The existing manhole from where the new main would start, cutting through the creekline vegetation.

Photo 2: The existing main through the creekline vegetation that is almost entirely weeds.

Photo 3: Recently planted Eucalypts along the creek bank. Note the existing main on the right and the approximate proposed main alignment shown.

Photo 4: The endangered Camden Woollybutt on the left and approximate main alignment marked.

Photo 5: Some recently planted native trees and shrubs that may be impacted.

Appendix B – Species Lists

Flora

TREES

Eucalyptus amplifolia	Cabbage Gum
Eucalyptus macarthurii (V)	Camden Woollybutt
Eucalyptus viminalis	Ribbon Gum
Melaleuca linariifolia	Flax-leaved Paperbark
*Salix alba**	White Willow

SHRUBS AND BRAMBLES

*Crataegus monogyna**	Common Hawthorn
Leptospermum trinervium	Flaky-barked Tea-tree
*Ligustrum sinense**	Small-leaf Privet
*Rubus fruticosus**	Blackberry

GROUNDCOVERS, CLIMBERS AND AQUATICS

*Anagallis arvensis**	Scarlet Pimpernel
*Briza subaristata**	Perennial Quaking Grass
*Cirsium vulgare**	Spear Thistle
*Conyza bonariensis**	Common Fleabane
Geranium solanderi	Native Geranium
*Hedera helix**	English Ivy
*Lotus angustissimus**	Slender Birds-foot Trefoil
*Paspalum dilatatum**	Common Paspalum
*Phalaris aquatica**	Phalaris
*Plantago lanceolata**	Common Plantain
Poa sieberiana	Snow Grass
Rytidosperma sp.	Wallaby Grass
*Salix nigra**	Black Willow
*Senecio madagascariensis**	Fireweed
*Setaria pumila**	Pale Pigeon Grass
*Taraxacum officinale**	Dandelion
Themeda triandra	Kangaroo Grass
*Trifolium repens**	White Clover
*Verbena bonariensis**	Purple Top

Fauna

Aves

Chenonetta jubata	Australian Wood Duck

Mammalia

Vombatus ursinus	Common Wombat

Appendix C – BC Act and EPBC Act Assessments of Significance

BC Act 5-Part Test for the Camden Woollybutt (*Eucalyptus macarthurii*)

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The proposal may impact the roots of one tree. Any impact would be minor and is unlikely to threaten the survival of the tree. There are nearly 500 trees of this species within a 10km x 10km square centred on the project site. The proposed activity would not place at risk of extinction the local population of this species.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

N/A.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

N/A.

(c) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposal would excavate several small holes for concrete piers to support the pipeline. One or possibly two of these holes may impact the roots of a Camden Woollybutt. This represents modification of a very small area of habitat.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

No areas of habitat would become fragmented or isolated as a result of the proposed activity.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

The area of habitat to be modified has low importance for the long-term survival of the species in the locality.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

No declared areas of outstanding biodiversity value would be impacted.

(e) whether the proposed development or activity is or is part of a key threatening process or is likely to increase the impact of a key threatening process.

The proposed activity is not a key threatening process and it would not increase the impact of any key threatening processes.

Conclusion

Based on the above assessment it is concluded that the proposed activity would not have a significant impact on the Camden Woollybutt (*Eucalyptus macarthurii*).

EPBC Act Significant Impact Assessment for the Endangered Camden Woollybutt (*Eucalyptus macarthurii*).

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

• *lead to a long-term decrease in the size of a population*

The proposal may have a minor impact on a single tree. This would not lead to a long-term decrease in the size of the local population.

• *reduce the area of occupancy of the species*

The proposal would excavate several small holes in the ground one or two of which may impact the roots of a single tree. This would not reduce the area of occupancy of the species.

• *fragment an existing population into two or more populations*

The proposal would not fragment the population of this species.

• *adversely affect habitat critical to the survival of a species*

The proposal would not affect habitat critical to the survival of the species.

• *disrupt the breeding cycle of a population*

The proposal would not disrupt the breeding cycle of the population of this species.

• *modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline*

The minor impact to the habitat of this species that would result from the proposal would not cause the species to decline.

• *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat*

The proposal would no result in invasive species that are harmful to the species becoming established.

• *introduce disease that may cause the species to decline, or*

The proposal would no introduce disease that may cause the species to decline.

• *interfere with the recovery of the species.*

The proposal would not interfere with the recovery of the species.

Conclusion

Based on the above assessment it is concluded that the proposed works would not have a significant impact on the Camden Woollybutt (*Eucalyptus macarthurii*) and no Referral to the Commonwealth Department of Energy, Water and Environment is required.

Appendix E – Geotechnical Investigation

D&N Geotechnical

Bowral Sewage Treatment Plant

Geotechnical Investigation Report

Hunter H_2O Holdings Pty Ltd

20 April 2021 – Revision 2

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1. Introduction

1.1. Background

This report presents the findings of a geotechnical investigation carried out by D&N Geotechnical Pty Ltd (D&N), at the Bowral Sewage Treatment Plant (STP) site.

The investigation was commissioned by the Hunter H_20 Holdings Pty Ltd (Hunter H_2O) on behalf of Wingecarribee Shire Council (WSC) and carried out in accordance with our fee proposal (D&N document reference: C-0760.00 P1, dated 21 January 2021).

The objective of the investigation was to assess the subsurface conditions across the general site footprint to support civil/structural design of planned upgrade works.

Our report includes a summary of the investigation methods adopted, approximate investigation locations, engineering logs and laboratory test certificates. Geotechnical discussion and recommendations are provided for the development, including excavation conditions/support requirements, footings, and subgrade design CBR.

An overview of the existing Bowral STP site/layout is shown in Plate 1 below (the approximate study area extent(s) are shown by the orange dashed line).

Plate 1 – Existing Bowral STP site layout/extents (Source: NSW Six Maps)

1.2. Proposed Site Development

On review of the initial Hunter H_2O Project Brief, we note that that development will generally comprise decommission/demolition of existing facilities and construction of numerous upgrades as summarised below. An extract from the proposed site plan is shown in Plate 2 below.

- New water retaining structures for sewage treatment with maximum anticipated foundation pressures (hydrostatic pressures and mass of concrete base / walls) in the order of 100kPa.
- New buildings including chemical dosing facility, blower building, electrical switch room and solids handling facility with maximum anticipated foundation pressures in the order of 50kPa.

- Incoming new pipework, to include about 75 m of above ground gravity sewer main, and below-ground main connecting to the incoming reticulation to the inlet works; and
- Internal new pipework, to include predominantly in-ground sewer rising main, between inlet pumping station to bioreactor, between clarifiers to filter feed pumping station, final treatment area to maturation ponds, and numerous minor (<10 m lengths of gravity/rising main.
- New pavement/hardstand areas:
  - Access (ring) roads accommodating heavy vehicle access
  - Chemical delivery areas
  - Solids handling facility outload area
  - Crane Hardstand areas

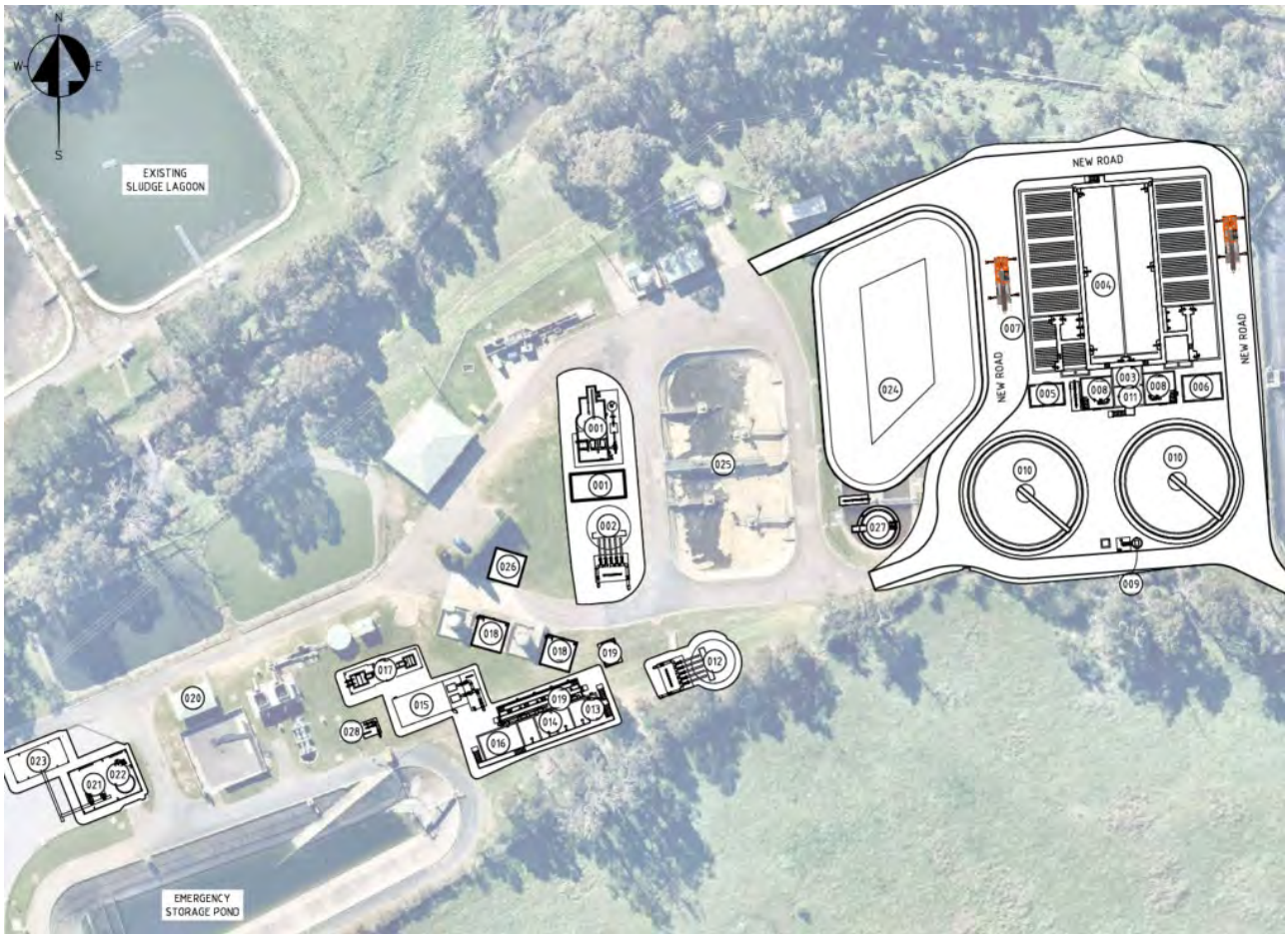


Plate 2 – Proposed new Bowral STP upgrades (extract from Hunter H_20 drawing 5804-C-001 Version C – 15 December 2020).

2. Existing Geotechnical Information

The Bowral STP site has been the subject of several previous phases of geotechnical investigation, by others.

The following existing geotechnical investigation reports were made available to D&N, companying the initial H2O Project Brief, as summarised below:

- *"Report on the Site Investigation for the Proposed Bowral Sewerage Augmentation"* prepared by NSW Department of Public Works (Report Reference: 79138, December 1979);
- *"Bowral Sewerage Treatment Plant Geotechnical Investigation"* prepared by NSW Department of Commerce (Report Reference: 03-GI95A, January 2004); and
- *"Bowral Sewage Treatment Plant Upgrade Geotechnical Investigation" prepared by NSW Public Works Advisory (Report Reference: ISR 18093, December 2018).*

The findings presented in the above referenced previous geotechnical reports were considered in the preparation of this geotechnical investigation report, geotechnical models, and geotechnical design parameters.

3. Method of Investigation

3.1. Planning

D&N prepared a safety management plan prior to commencement of fieldwork. The field supervisor was provided with a final hard copy of the plan, which was utilised on site for subcontractor induction, and retained as a reference for emergency management.

A pre-start meeting was held at the start of each day/when working conditions differed to assess specific hazards and update approaches to site works where the work activity/environment was observed to have changed.

Dial before you Dig, and client provided service plans were reviewed in detail prior to commencing intrusive fieldworks as part of borehole set-out.

3.2. Fieldwork

Fieldwork for the geotechnical investigation was carried out under a single mobilisation to site between 22 and 23 February 2021, and comprised the following main site activities:

- Walkover to note features of geotechnical significance.
- Clearance of underground services by a suitably qualified contractor.
- Advancement of seven boreholes across the general site footprint, comprising:
  - Five auger boreholes to depths of between 0.65 m and 5.5 m below ground.
  - Two cored boreholes to a depth of approximately 7.5 m below ground.
  - Installation of two monitoring wells (MW102 and MW105) with dataloggers for measurement of recharge and water levels.
- Seven Dynamic Cone Penetrometer (DCP) tests (adjacent to each borehole)
- Collection of soil and rock samples for submission to a NATA registered laboratory.

Boreholes were drilled using a purpose-built track mounted drilling rig, initially advanced using solid flight augers and Tungsten Carbide (TC) drill bit to the nominated target depth or prior refusal within bedrock. Following auger refusal, two of the boreholes (BH102 and BH105) were advanced to 7.5 m depth using NMLC diamond rock coring techniques.

On completion, other than at BH102 and BH105, all boreholes were backfilled with drill cuttings and the surface reinstated to match surrounds.

At BH102 and BH105, standpipe piezometers were installed as MW102 and MW105. Standpipe piezometers were provided as 50 mm internal diameter PVCu casing, with the annulus infilled with 2 mm clean sand, and the top of the wells plugged with bentonite and concrete as shown in Appendix A. The standpipe casing was terminated about 0.1 m below ground surface and each well was provided with a circular steel gattic cover. At the time of installation, the following procedure was carried out to provide well recharge data for estimation of soil permeability:

- The wells were purged of drill water using a manual bailer to ensure that the water within the wells provide a better reflection of groundwater conditions.
- After the removal of more than three times the well volume, a water level datalogger was installed.
- The water level dataloggers were set to collect the water level data as the well was recharged.

Monitoring was ongoing at the time of this report revision.

All fieldwork was carried out under the fulltime direction of a D&N Engineering Geologist, who was responsible for coordination of subcontractors, management of site safety, logging of subsurface conditions to AS 1726 - 2017 and collection of soil samples for subsequent laboratory analysis.

The Engineering Borehole Logs are presented in Appendix A, including piezometer installation details. DCP test results are shown on the borehole logs in graphical format. DCP data is further presented in tabular format in Appendix B.

Figure 1, attached, shows the approximate investigation locations, which were located using hand-held GPS equipment (accurate to ±3 m).

3.3. Laboratory Testing

Selected soil samples were submitted to NATA accredited laboratories for a suite of tests, as defined in Table 1 below.

For detail, reference should be made to laboratory test certificates, included as Appendix C.

Table 1 - Summary of Laboratory Testing

Test Type	No. of Tests
Field moisture content	2
California Bearing Ratio (4-day soak, 4.5 kg surcharge, 100% SMDD)	2
Atterberg Limit Incl. Linear Shrinkage	4
Particle Size Distribution	2
Aggressivity test suite - pH, Sulphate, Chloride and Conductivity	3
Uniaxial Compressive Strength (Rock Core)	2

On completion of drilling, recovered rock cores were boxed in steel core trays and transported to our core storage facility. Following photography, Point Load Index Strength (I_{s50}) tests were performed at regular intervals of approximately 1 m on average, or where specific zones of core were of interest.

4. Results of Investigation

4.1. Site Description

The site is located approximately 2 km to the south-west of Bowral Town Centre, and is accessible via a rail crossing and access road off Burradoo Road, Nr Burradoo NSW.

Regionally the site topography comprises gently undulating hillsides. The site is located between two topographic rises towards the base of a shallow valley feature, associated with formation of Mittagong Creek, running through the site, orientated roughly south west/north east. The site has been formed through modification to the existing Mittagong Creek alignment and construction of several lagoons of varying geometry, constructed through excavation and cut to fill on the southern and northern creek banks.

Other infrastructure on the site includes the facility buildings, tanks, and services to the plant.

Vegetation and site use surrounding the STP site typically comprised of grasses and pasture for agricultural purposes.

4.2. Regional Geology

An extract of the NSW Surface Geology data set (State of NSW) is shown in Plate 1.

Regional geological mapping indicates that the site is underlain variable geology. Quaternary alluvium is shown associated with a narrow flood plain band adjacent to the Mittagong Creek alignment. A sequence of sedimentary rocks of the Liverpool Sub-Group of the Wianamatta Group is shown the underlie the Quaternary Alluvium and form the adjacent creek banks, over the remainder of the site.

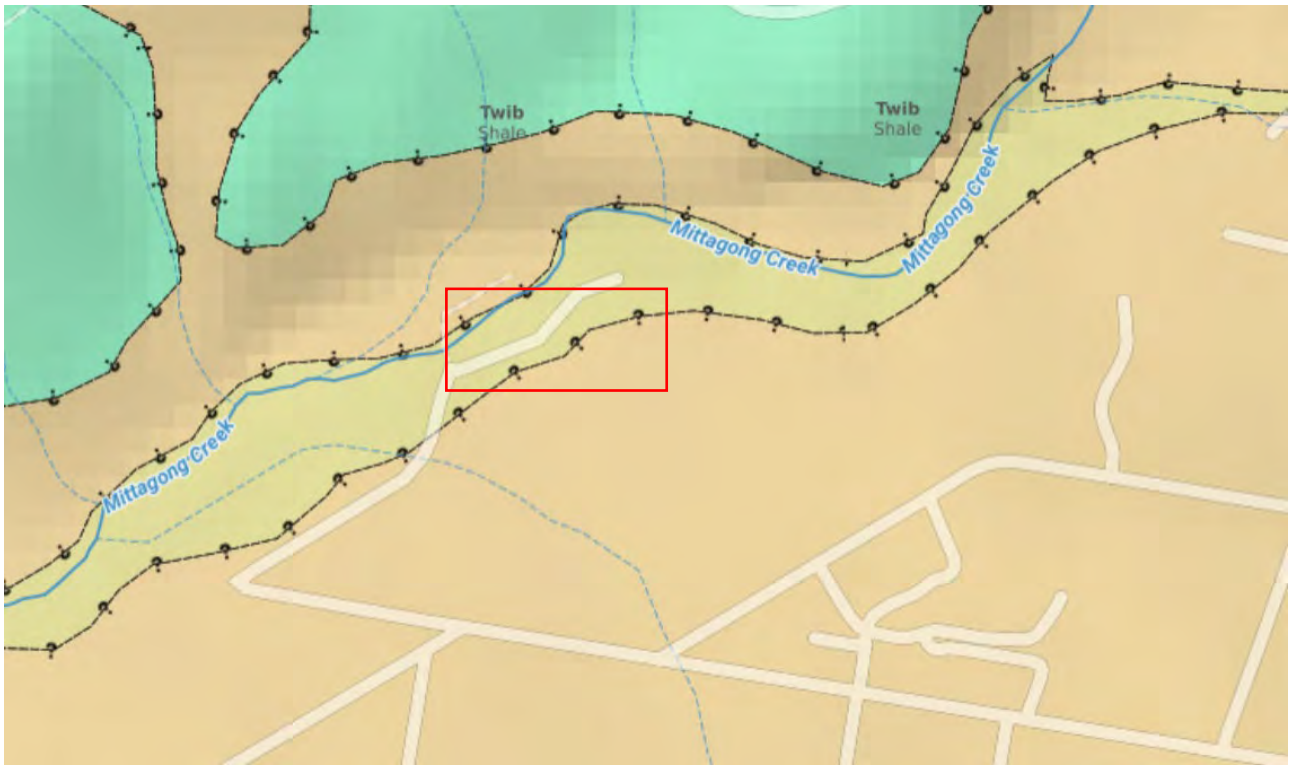


Plate 3 – Extract from NSW Surface Geology. The site is shown in Red.

4.3. Subsurface Conditions

Reference should be made to the Engineering Borehole Logs included as Appendix A for specific detail regarding subsurface conditions at each investigation location.

Dynamic Cone Penetrometer (DCP) test results are included on the engineering logs and presented again in tabular format as Appendix B. Table 2 below provides a summary of the main geotechnical units observed across the Bowral STP site.

Table 2 - Summary of the Main Geotechnical Units

Unit[1]	Material Origin		Material Description	Depth Range to Top of Unit (m)[2]	Range of Unit Thickness (m)[2]
1a	Hardstand Area	Fill – Base Course	Sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, grey, fine to coarse sand, trace medium plasticity fines.	0	0.15
1b	Topsoil/Fill - General		Sandy CLAY/sandy SILT/silty CLAY, medium plasticity clay fines, brown, fine to medium sand, with some fine to coarse, sub-rounded to sub-angular gravel, trace fragments of brick and asphalt (≤50 mm diameter), with some fine roots in landscaped areas.	0	0.2 to >2.0
2	Alluvium		Clayey SAND, fine to medium grained, grey, off-white, mottled orange-brown, medium plasticity clay fines, with fine to coarse, sub-angular gravel, typically medium dense	1.1	2.6
3	Residual Soil		Sandy/Silty CLAY, medium to high plasticity, grey, mottled orange-brown, fine to medium grained sand, with some fine to medium grained, sub-angular gravel. Typically, stiff to very stiff consistency.	0 to 0.9	1.4 to 3.3
4 a	Interlaminated Siltstone and Sandstone Bedrock		Extremely to highly weathered, inferred soil strength to low strength.	1.6 to 4.2	1.9 to 2.2
4 b			Highly to moderately weathered, low to medium strength	3.8 to 5.6	0.3 to 1.2
4 c			Slightly weathered to fresh, medium to high strength	5.0 to 5.9	unproven

Table 2 Notes:

1. Units were not encountered at every borehole location, reference should be made to specific engineering boreholes logs, included as Appendix A
2. The depths and unit thicknesses are based on information at the borehole locations and may not represent the maximum or the minimum values at other locations

4.4. Groundwater

Groundwater was encountered during auger drilling within BH105 at about 2.5 m depth but not observed during auger drilling within any of the remaining boreholes advanced as part of this investigation.

Subsequent groundwater observations during diamond core drilling within bedrock were not possible as water was added to each borehole to facilitate coring.

Groundwater levels may increase in response to rainfall. It is possible that groundwater may be temporarily perched above the rock level during and after heavy or sustained rain events.

Standpipe Piezometers were installed as MW102 and MW105 at BH102 and BH105 respectively. The standing water level was measured on Monday, 12 April 2021 as 1.25 m below ground level at MW102 and 2.73 m below ground level at MW105.

Groundwater level monitoring and the recharge rate of the wells were being monitored electronically at the time of issue of this report revision and will be reported separately in a groundwater assessment memorandum.

4.5. Laboratory Test Results

Tables 3 to 7 below provide a summary of laboratory test results for the site soils. Reference should be made to the test certificates included as Appendix C, for further detail.

Table 3 - Summary of Atterberg Limits Test Results

ID	Geotechnical Unit	Depth (m)	LS (%)	PI (%)	LL (%)	PL (%)
BH101	3	1.0 - 1.45	5.5	9	22	13
BH102	3	1.0 - 1.45	11.5	27	48	21
BH106	3	0.3 - 0.4	13.5	24	43	19
BH107	3	0.8 - 0.9	13.5	22	44	22

Table 4 - Particle Size Distribution Test Results

ID	Geotechnical Unit	Depth (m)	% Gravel	% Sand	% Fines
BH101	3/4	4.0 - 4.31	0	77	23
BH105	3/4	2.0 - 2.45	1	72	27

Table 5 - Summary of CBR Test Results

ID	Geotechnical Unit	Depth (m)	OMC (%)	Field Moisture (%)	CBR Swell (%)	MDD (t/m^3)	CBR (%)
BH103	3	0.2 - 0.4	13.5	14.1	1.0	1.84	7
BH104	1b	0.6 - 1.0	14.5	16.9	0.5	1.94	6

Table 6: Summary of UCS Test Results

BH ID	Depth (m)	Unit	UCS Strength (MPa)	Strength Classification	Nearest Point Loads (Is(50)) (MPa)
BH102	6.22 - 6.45	4c	39.3	High	1.2
BH105	6.0 - 6.2	4c	24.9	High	0.9

Table 7 - Summary of Soil Aggressivity Results

ID	Geotechnical Unit	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Resistivity (Ω.cm)
BH101	3	2.0 - 2.45	6	20	116	14,200
BH104	1b	0.3 - 0.4	6.5	19	102	11,500
BH105	2	3.0 - 3.45	6.3	20	73	17,600

5. Discussion and Recommendations

5.1. Earthworks

5.1.1. Presence of Fill

Fill was observed at most borehole locations to depths of typically between 0.3 m and 1.2 m as described in Table 2.

Given the nature of the site, it is expected that other areas of previous filling are likely to be present across the site footprint, associated with previous site development, trenching and disposal of waste materials.

Unless there are records confirming that the existing fill has been compacted in accordance with an engineering specification, where present, this material should be classified as uncontrolled and is not considered suitable as a foundation for structures or pavements due to the potential for differential settlement. Therefore, it is recommended that the existing fill materials be subject to excavation and re-compaction (if suitable) or replaced with engineered fill.

5.1.2. Site Preparation and Fill Placement

Where natural soils are exposed and no filling is required, subgrade and foundations for structures and/or pavements should consist of bulk excavation to design level(s) (including to the underside of any fill encountered on the site) followed by a geotechnical assessment of the exposed stratum.

General guidelines for earthworks are as follows:

- Strip all topsoil and unsuitable material such as softened or heaving soils, if present;
- Box out to proposed subgrade/foundation level if this is deeper than the stripped level;
- Where uncontrolled fill is noted following a geotechnical assessment, or as encountered in the geotechnical investigation, treatment should be under the direction of the project geotechnical consultant. Methods may include removal and replacement, or where fill is present to an uneconomical depth, engineer designed bridging layers may be incorporated;
    - Where existing deep (> 1.0 m) of uncontrolled fill is noted, for example, BH104, a presumptive treatment (bridging layers) may be adopted as follows:
        - Remove, moisture condition (if required) and recompact at least the upper 1.0 m of the subgrade below the underside of the pavement layers.
        - Should the existing uncontrolled fill display handling, moisture or compaction difficulties, replacement with select material or gravel and geofabric bridging courses may be required.
        - Manage risk of differential pavement settlement by providing a pavement reinforcement grid to the underside of the subbase, using for example, Tensar Tri-axial T160 geogrid.

  - Where founding pavements on uncontrolled fill as above, some residual risk of pavement performance will remain and must be accepted, as uncontrolled fill properties can vary. However, the above recommended removal and replacement of 1 m of uncontrolled fill subgrade and provision of a geogrid are aimed to reduce this risk.

- If engineered fill is to be placed to achieve subgrade or foundation level, then compact in maximum 0.3 m loose thickness layers as outlined below;
- Engineered fill at depths greater than 0.5 m below foundation level for structures or top of subgrade for pavements should be compacted to achieve a minimum Dry Density Ratio of 98% Standard Maximum Dry Density (MMDD) and moisture conditioned to Standard Optimum Moisture Content (SOMC) ±2 % at the time of compaction.
- Engineered fill and natural material at depths within 0.5 m of foundation level for structures or top of subgrade for pavements should be compacted to achieve a minimum Dry Density Ratio of 100% SMDD and moisture conditioned to SOMC ±2 % at the time of compaction.
- Once excavations are complete and prepared, assessment by the geotechnical consultant should be undertaken. This may include proof rolling of the entire formation with at least 4 passes of a non-vibratory minimum 12-tonne dead weight smooth drum roller, a loaded water cart, and/or pocket penetrometer, vane shear, and Dynamic Cone Penetrometer testing to confirm design intentions.

The subgrade should be graded to drain effectively to subsoil drains and should be cleared of any softened material prior to pouring of footings or placement of fill materials.

All fill placement and subgrade preparation should be constructed under Level 1 Geotechnical Inspection and Testing as defined in *AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments.* The extent of subgrade treatment will largely depend on preceding weathering conditions and construction methodology and should be treated as advised by the project geotechnical consultant.

5.1.3. Subgrade Trafficability

Site soils are expected to behave poorly if exposed to heavy construction traffic, particularly when wet. A platform of granular material such as road base or crushed concrete may be needed to support construction plant.

Where heavy plant such as piling rigs or mobile cranes are to traffic to site, specific analysis of working platform requirements may be required to assess working platform equipment. Such assessment could include the use of DCP testing (or similar) to confirm bearing capacity. Working platform design shall be carried out to the UK Building Research Establishment (BRE) Guideline BR470.

To help reduce, but not eliminate trafficability issues associated with wet weather, exposed subgrades should be sealed with a smooth drum roller and graded such that they promote surface drainage and prevent ponding.

5.1.4. Re-use of Site Won Materials

From a geotechnical viewpoint, site soils should generally be suitable for use as engineered fill, provided unsuitable materials such as organics, highly plastic material, waste and oversized particles are removed. Re-used material should be screened for such physical contaminants, reworked, and compacted as controlled fill.

The project geotechnical consultant should undertake further observation, sampling and testing to verify the suitability of excavated material to confirm suitability for the respective proposed usage.

Silty soils and high plasticity clays (if encountered) will be sensitive to moisture content and may be difficult to compact. Careful management of soil moisture content will therefore be required.

Unit 3 Residual Soil generally comprises of a low to medium plasticity sandy CLAY, subject to suitable blending; this material may be considered for re-use as compacted clay liner material. Moisture

conditioning is likely to be required, depending on prevailing weather conditions. In any case additional laboratory testing should be carried out on this geotechnical unit to confirm suitability, to include Atterberg limits, Hydrometer testing, Linear Shrinkage, Dispersion and Permeability tests.

It is not expected that material directly won from the geotechnical units would be suitable for pipe bedding material.

5.2. Subgrade Design CBR

Following stripping of topsoil and existing site fill, the subgrade soils are expected to typically comprise Unit 2 Alluvium and/or Unit 3 Residual Soil (sandy/silty CLAY). Laboratory testing yielded CBR values of between 6 % and 7%.

Based on Atterberg Limit testing and tactile assessment, the site soils are generally of low to medium plasticity, consistent with the above reported CBR swell values. We note that some high plasticity soils were observed which would be expected to return a slightly lower CBR value that those observed. A design CBR of 5% is therefore recommended for design to reflect potential soaked conditions and variability from the samples tested, during the lifetime of the pavements within areas of clayey subgrades.

The boxed-out profile will require subsoil drains to be installed along the shoulder on both sides of the pavement, to avoid moisture collection in the boxed-out profile and control seasonal variability. These drains shall be connected to suitable discharge points.

5.3. Excavations

5.3.1. Excavation Conditions

Based on the proposed upgrade works, we expect that the project will comprise:

- General site cut/excavation depths of typically less than 1.5m for footings and levelling;
- High level footings founded typically founded within residual soil or better;
- Pipeline depths for gravity lines are not known but anticipated to be less than 2 m depth;
- Installation of in-ground sludge lagoons to typically less than 3 m depth.

We anticipate that large (20 to 30 tonne) hydraulic excavators, equipped with ripping buckets or ripping tynes, would feasibly excavate the material up to at least the depth of auger refusal, as summarised in Table 8 below:

Table 8 - Summary of Auger Refusal Depths

BH ID	Auger Refusal Depth (m)	Inferred Unit on Termination
BH01	5.5	Unit 4b
BH02	3.3	Unit 4a
BH03	Not encountered	Unit 3
BH04	Not encountered	Unit 4b
BH05	5.9	Unit 4b
BH06	Not encountered	Unit 3
BH07	Not encountered	Unit 3

We note that BH03, BH04 and BH07 were terminated at a target depth of 2 m. BH06 was advanced using hand auger means and as such is not considered representative for assessment of material excavatability.

Early auger refusal was encountered during drilling at most of the remaining borehole locations, with earlier refusal most notably at BH02. Heavier excavation equipment, or ripping equipment, may be required to extend bulk excavation, or trenching works below the level of auger refusal, likely to be within predominantly moderately to slightly weathered, medium strength (or better) sandstone and/or siltstone. Based on Pettifer & Fookes[1] it is estimated that ripping of rock materials encountered in the cored borehole intervals (below the depth of auger refusal) would require "easy ripping" to "hard ripping", typically using D8 dozers equipped with ripping tynes.

In any event, excavation contractors shall be provided with the Engineering Logs and be required to make their own assessment of the suitability and productivity of excavation plant. Natural variation can occur from the observed conditions to be both more or less favourable for excavation. It is possible that shallower rock levels will be encountered between investigation locations. The rock surface (or level of auger refusal, or excavator refusal) may be undulating and variable across the site.

5.3.2. Excavation Support

Unsupported excavations may be practicable where there is sufficient space to allow for the creation of batter slopes. For preliminary design purposes, we recommend the following unsupported batters be adopted for the site. Ultimately, selection of batter slopes is the responsibility of the site operator in consultation with a geotechnical professional at the time of exposure.

Table 9 - Temporary and Permanent Batter Slopes

Unit	Unsupported Temporary Batter Slopes, Less than 1-month exposure	Unsupported Permanent Batter Slopes
Unit 1 - Topsoil/FILL	Strip back away from the excavation	1V:3H
Controlled Filling *Material dependent, guidance provided for re-compacted cohesive soil won from the site*	1V:1H	1V:2H
Unit 2 - Alluvium	1V:1.5H	1V:3H
Unit 3 - Residual Soil	1V:1H	1V:2H
Unit 4a - Extremely to highly weathered bedrock	1V:1H	1V:1.5H
Unit 4b - Highly to moderately weathered Bedrock	1V:0.25H See Note 4 and 5	1V:1.5H
Unit 4c - Slightly weathered to fresh Bedrock	Vertical See Note 4 and 5	1V:0.5H

Notes to Table 9:

1. Protection against erosion is required for permanent batters steeper than or equal to 1V:3H. Erosion and sediment controls are required for temporary batters.

[1] Pettifer, G. S. and Fookes, P. G. *A revision of the graphical method for assessing the excavatability of rock*. Quarterly Journal of Engineering Geology and Hydrogeology, 1994, volume 27, pp 145-164.

2. The contractor shall be responsible for batter maintenance and monitoring of batter performance. Contact D&N should batters deteriorate during construction, for example because of rain.
3. Maximum overall slope heights may include up to 3 m vertical in Units 1 to 4a and up to 5 m near vertical in Units 4b and 4c. For higher slopes, contact D&N for slope stability analysis.
4. Rock batters require geotechnical inspection on exposure for risk assessment to construction workers from defect-controlled failures. Contact D&N on exposure for this inspection.
5. Provide a min. 3 m wide bench at the top of rock.

A temporary shoring box system may be required where existing services or structures will be affected by or prevent the use the proposed temporary batters. Shoring systems shall be provided where personnel are entering excavations greater than 1.2 m vertical depth and the above batter slopes are not provided. All such entries shall be risk assessed prior to access and treated as confined space entry.

Existing services near excavations should be located at least 2 m laterally behind the batter surface, or behind a line projected backwards from the toe of the batter at an angle of 30°, whichever provides the greatest setback to the underground service or structure footing. If this setback is not achievable, the excavation will require shoring.

Permanent batters to water-holding facilities shall be considered in detail by the facility's designer. It is recommended as a minimum that such analysis be carried out using limit-equilibrium techniques, and the analysis must consider the range of water levels, seepage conditions and drawdown conditions that may occur at the facility over the operating conditions.

5.4. Retention and Shoring Methods

Shoring systems shall be designed by a qualified engineer. As a guide, Table 10 below presents typical design parameters that can be adopted for the design temporary shoring systems.

Coefficients are provided for the following cases:

- Case 1 = Active conditions, where deflections would be relatively greater to mobilise active connections.
- Case 2 = At-rest conditions, where deflections are required to be reduced (e.g. adjacent to existing infrastructure).

Table 10 - Material Parameters and Earth Pressure Co-efficients for Level Ground above the retention

Geotechnical Unit	Mohr-Strength Envelope Material Properties		Value of Lateral Earth Pressure Coefficient[1]		Passive Earth Pressure Coefficient, K_p[1]	Bulk Density (kN/m^3)
	Effective Cohesion	Effective Friction Angle	Case 1, K_a	Case 2, K_0		
Unit 1 – Topsoil/FILL	0	26	0.39	0.56	2.6	18
Controlled Filling *Material dependent, guidance provided for re-compacted cohesive soil won from the site*	2	28	0.36	0.53	2.7	20
Unit 2 - Alluvium	2	28	0.36	0.53	2.7	20
Unit 3 - Residual Soil	5	30	0.33	0.5	3.0	20
Unit 4a - HW to XW Bedrock	10	34	0.28	0.44	3.5	21
Unit 4b - HW to MW Bedrock	40	36	0.26	0.41	3.8	23

Geotechnical Unit	Mohr-Strength Envelope Material Properties		Value of Lateral Earth Pressure Coefficient[1]		Passive Earth Pressure Coefficient, K_p[1]	Bulk Density (kN/m^3)
	Effective Cohesion	Effective Friction Angle	Case 1, K_a	Case 2, K_0		
Unit 4c – SW to FR bedrock	200	40	0.22	0.36	4.6	25

Notes to Table 10:

1. These values are only applicable for a horizontal ground surface behind the shoring system.
2. Failure in rock units may be governed by defects. Rock exposures shall be assessed on site for possible defect-controlled instability.
3. Mohr-coulomb equivalent parameters for the rock units (Units 3a to 3c) may be significantly higher, however, a more detailed study on the rock would be required to characterise these.

The magnitude of adjacent ground movements within the retained fill/soil profile will depend on the ground conditions, design lateral pressure, shoring system adopted, construction sequence and workmanship. If this aspect is critical (e.g., low redundancy water supply lines or settlement sensitive infrastructure), further appraisal should be carried out to assess likely ground movements when designing the shoring system. Such analyses should include modelling of predicted deflections for comparison to the critical values of the infrastructure, and D&N can assist with these models and analysis once the design excavation profiles have been excavated.

Groundwater was observation was limited to inflow within BH105 at about 2.5 m, within Unit 2 Alluvium, which was not observed within the remaining boreholes. However, we recommend that permanent retaining walls and temporary shoring systems be designed to allow for groundwater to a height of 50% of the retained height.

5.5. Foundations

5.5.1. Site Classification to AS2870-2011

While the site classification to AS2870-2011 is based on requirements for residential structures, designers may find the classification useful to assist in design of structures from first principles or design of structures such as single level office facilities, amenities blocks, and the like.

The site classification has been considered and assessed as Class M with up to 30 mm seasonal movements due to climatic effects, based on:

- Climate Zone 2 (TMI +10 to +40);
- Depth of suction of 1.8 m;
- Cracked depth of 50%;
- Design Suction change Δu = 1.2 pF;
- Design residual soil depth of greater than the depth of suction;
- Shrink-swell index (I_{ss}) of up to 2.2% based on Atterberg Limit testing; and
- No allowance for tree effects.

Trees are to be more than two mature tree heights from the facilities. Otherwise, the designer shall make allowances for trees per AS2870-2011 using the maximum tree effects below, and actual offset of the facilities from the trees.

The maximum tree effect has been estimated as an additional movement of:

- +15 mm for a single tree (total 45 mm, up to Class H1); and
- +25 mm for a line or stand of trees (total 55 mm, up to Class H1).

The maximum tree effects may be reduced when considering the guidance from AS2870-2011 with respect to distance between trees and the facilities.

Should more than 400 mm of controlled fill be considered, please contact D&N for further advice. Controlled filling will affect the site reactivity, which may be more adverse than the natural site. For example, controlled filling using site-won soils would increase the Site Classification to Class H1 (total movement up to 45 mm. It is feasible to design fill works with lesser movement using non-reactive fill higher in the profile, however such fill would need to be imported to the site.

Footings should generally be provided on the same geotechnical unit, however, if this is not feasible due to variation of units and levels, allowances should be made for the range of support conditions.

5.5.2. Shallow Footings

The below values may be adopted for an allowable bearing capacity of shallow footings, slab stiffenings, and the like:

- Unit 1 Topsoil/Fill: Do not use for foundation support (strip before the works)
- Unit 2 Alluviul Soil: 100 kPa
- Unit 3 Residual soil: 150 kPa
- Unit 4a XW Material: 400 kPa
- Unit 4b, or better: 1,000 kPa (higher values may be feasible after site inspection)

The recommended allowable bearing pressures provided above assume that the bearing surfaces are clean and free from spoil and other soft and loose material, and free of water at the time of placement of concrete. A concrete blinding layer should be poured as soon as practical to limit the disturbance to the surface and any likely degradation of the exposed materials.

Settlements of strip and pad footings designed using the allowable values are expected to be less than 1% of the footing dimension.

On excavation, should the ground conditions differ from those outlined above, further advice should be sought from D&N. On-site verification of exposed foundation material is required by a geotechnical engineer once the contractor has exposed foundations.

5.5.3. Piled Footings

Piled footings may be considered where the high-level footing parameters do not allow economical or practical high-level footings to be constructed, or where settlement-sensitive structures or equipment are present. Piled footings may further reduce the potential for differential support between variable distribution of geotechnical units and may be used to avoid the reactivity of the site.

Parameters for pile design for those materials encountered in this investigation are provided in Table 11 below.

It is recommended that bored piles be considered, as driven piles would likely not be suitable to the site conditions and/or variable founding levels, including early refusal. However, the potential exists that bored piles may also encounter difficulty due to variable weathering, including high strength zones.

Groundwater was not observed within the majority of boreholes during our investigation, and it is considered likely that open bored piles would not need support for short periods (less than 48 hours) unless groundwater inflows or poor weather occurs; however, temporary or permanent casing support may be required for bored pile hole retention. Such casing could be recovered on completion, or alternatively left in-situ provided the pile designer considers the effect of these uses on the shaft adhesion utilised.

For the design of piled footings to comply with AS2159-2009, a limit state design method should be adopted. Recommended design parameters for piles are presented in Table 11.

Table 11 - Recommended Geotechnical Parameters for Bored (non-displacement, concrete) Piles

Unit	Unit Weight (kN/m^3)	Ultimate End Bearing Capacity (MPa) (1)	Ultimate Shaft Adhesion (kPa) (2)	Ultimate Lateral Capacity (MPa) (2)	Elastic Modulus Axial (MPa) (3)
Unit 2 – Alluvial Soil	20	0.6	35	0.05	10
Unit 3 - Residual Soil	20	0.6	35	0.5	12
Unit 4a - XW to HW Bedrock	21	3.0	80	0.8	100
Unit 4b - HW to MW Bedrock	23	5.0	200	1.5	200
Unit 4c - SW or better Bedrock	24	10.0	350	2.5	500

Table 11 Notes:

1. Assumes a minimum embedment of at least four pile diameters below ground surface.
2. Assumes a minimum embedment of at least 2 pile diameters into relevant bearing stratum. Ignore shaft adhesion or the contribution from lateral resistance in the upper 2m or first four pile diameters of the profile.
3. Lateral stiffness may be taken as 70% of vertical stiffness.
4. Steel piles will require separate consideration. Contact D&N for further advice.

For uplift loads that are reliant on low-redundancy systems (e.g., single, or isolated anchors that would result in catastrophic failure of a structure if the tension/pull-out failure occurred), the shaft adhesion values in Table 11 should be multiplied by an additional partial reduction factor or 0.7, in addition to the geotechnical strength reduction factor (outlined below). Contact D&N should for the specific uplift/stability mechanism being considered.

For limit state design a geotechnical reduction factor (ϕ_g) is to be applied to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 11 to derive the design ultimate geotechnical pile capacity.

In accordance with AS2159-2009, ϕ_g is dependent on assignment of an Average Risk Rating (ARR) which considers various geotechnical uncertainties, redundancy of the foundation system, construction supervision, and the quantity and type of pile testing. The assessment of ϕ_g therefore depends on the structural design of the foundation system as well as the design and construction method, and testing (if any) to be employed by the designer and piling contractor.

We have carried out a risk assessment per AS2159-2009 and have assessed an ARR of 3.97 (Moderate to High), and we recommend that a ϕ_g value of 0.45 be adopted. The assessment in included in Appendix D. The reduction factor shall be applied to determine the value of the factored down geotechnical resistance, R*, in accordance with AS2159-2009, as $R^* = \phi_g \times R_u$. R* is then to be compared to the factored up load action for the respective limit states, S*.

To reduce the potential for differential settlement between footings, we recommend that all footings be uniformly founded within the same geotechnical unit. Where this is not practicable, analysis should be undertaken to assess potential effects on the proposed structure.

The use of limit state design also requires that serviceability performance of the foundation system be assessed, including pile group interaction effects. Such assessment should be carried out by experienced geotechnical professional using well-established and soundly based methods. The modulus values given above may be adopted for such assessment, but it should be recognised that the accuracy of settlement prediction is a function of construction methodology as well as the assessed values of material stiffness,

both of which can involve considerable uncertainty. Therefore, the accuracy of settlement predictions may be no better than ± 50%. It is assumed that foundation settlement is critical to the performance of the structure, serviceability pile load testing should therefore be considered to confirm the design assumptions and/or assess prediction accuracy.

The recommended design parameters for bored piles assume that the bearing surfaces are clean and free from spoil and other soft and loose material and free of water at the time of placement of concrete. If the bored pile holes cannot be dewatered sufficiently, then tremmie pouring methods should be employed to displace the water from the pile hole. On excavation, should the ground conditions differ from those outlines above then further advice should be sought from D&N. The above values for shaft adhesion assume that the walls of the shaft are suitably roughened and cleaned of smear.

5.5.4. Soil Aggressivity

The results of Soil Aggressivity testing were assessed in accordance with AS2159-2009 Piling – "Design and Installation". The results are summarised in Table 12 below.

Table 12 - Soil Aggressivity Assessment to AS2159-2009

Buried Material	Assessed Aggressivity
Concrete	Non-aggressive in contact with soil
Steel	Non-aggressive in contact with soil
Concrete or steel where in contact with wastewater	Specific assessment required based on wastewater properties

5.5.5. Thrust Block Design Parameters

Lateral bearing capacities for thrust blocks are provided in Table 13 below for materials observed. The capacities are provided for limited overburden of min. 0.5 m below FSL.

Table 13 - Lateral Bearing Capacities for Thrust Blocks

Unit	Allowable lateral bearing capacity
Topsoil, uncontrolled fill, organic soil, deleterious material	Do not use for thrust block support
Controlled cohesive fill	50 kPa
Controlled granular fill, $\phi' \geq 32°$	60 kPa/m x depth (m)
Unit 2 – Alluvium	50 kPa
Unit 3 - Residual Soil	50 kPa at 0.5 m depth, increasing to 200 kPa at a depth below FSL of 5 times the bearing width
Unit 4a - XW/HW Bedrock	300 kPa (where at least deeper than 5 times the bearing width, otherwise use residual soil properties)
Unit 4b - HW to MW Bedrock, or better	500 kPa

5.6. Earthquake Design

Based on AS1170.4-2007 the following parameters should be adopted for seismic design:

- Seismic Hazard Factor (Z) 0.09
- Sub-Soil Class C_e

5.7. Acid Sulfate Soil Risk Maps

The dataset for Acid Sulfate Soils (*State of NSW and Department of Planning, Industry and Environment, eSPADE tool*) indicates that the site is not underlain by Acid Sulfate Soils.

The site geology is not commensurate with the development of actual or potential acid sulfate soils.

5.8. Pavement Thickness Design

5.8.1. Introduction

Hunter H_20 requires a pavement thickness design for flexible and for rigid pavements. The design traffic has been specified as one rigid truck (with 2.1 ESA per truck) per day over 25 years. The calculated design traffic is approximately 2 x 10^4 ESA.

Where heavy vehicles can travel as free-flowing traffic, a spray seal surfacing may be adopted. Where heavy vehicles are required to stop, turn, decelerate, etc. (and including in parking areas) an asphalt wearing course should be provided over a spray seal surfacing.

Pavement thickness designs are provided for CBR 5% (i.e., founded on the residual soils) and carried out in accordance with Austroads *Guide to Pavement Technology Part 2 - Pavement Structural Design* (2017) for lightly traffic roads.

5.8.2. Flexible Pavement

The flexible pavement analysis has been carried out using the graphical approach from AGPT02/2017 with a design tolerance and consideration of minimum pavement course layer thicknesses. The flexible pavement design is shown in Table 14 below.

Table 14 - Flexible Pavement Thickness Design

Layer Description	Pavement constructed on Residual Soil Subgrade		Pavement Constructed with min. 150 mm Selected Layer	
	Free-flowing heavy vehicles	**Otherwise**	**Free-flowing heavy vehicles**	**Otherwise**
Asphalt Course, Dense graded AC14 with C450 Binder	-	40 mm	-	40 mm
Emulsion Prime (Tack Coat) Assuming no trafficking between prime and asphalt paving	-	Required CRS Rapid Set	-	Required CRS Rapid Set
Prime and seal	AMC0/00 Prime, single/single 10 mm seal with C170 binder	-	AMC0/00 Prime, single/single 10 mm seal with C170 binder	-
Granular Course, DGB20	140 mm		195 mm	
Granular Course, DGS20	150 mm		-	
Selected Material Layer CBR ≥ 15%, PI ≤ 25%	-		150 mm	
Subgrade	Unit 3 Residual Soil, CBR 5%		Unit 3 Residual Soil, CBR 5%	

We understand that certain crane lifts will be carried out using the proposed pavement areas. Hunter H_20 have requested an assessment of the flexible granular pavement with respect to the proposed applied bearing pressures.

Crane outrigger pressures have been provided by Hunter H_20 as 270 kPa applied over a bearing area of 2.25 m^2 (1.5 m by 1.5 m). The factor of safety against bearing failure for the above pavement thicknesses is greater than 1.6, in accordance with the requirements of the UK BRE470 publication for working platforms. Accordingly, the pavement areas (where prepared and constructed in accordance with this report and the works specifications) may be used for the applied bearing pressure as described above.

5.8.3. Rigid Pavement

The rigid pavement option has been assessed based on the requirements of AGPT02/17 Section 12 - Lightly Trafficked Pavements (for concrete pavements with less than 10^6 HVAG.

The design traffic for rigid pavements are expressed as the cumulative number (N_{DT}) of Heavy Vehicle Axle Groups (HVAG). For this analysis, we have adopted a value of 1.05 ESA/HVAG to arrive at $N_{DT} \approx 1.9 \times 10^4$ HVAG.

The concrete base thickness assessment was based on the following inputs:

- Plain Concrete Pavement with Reinforcement (PCP-R) will be used;
- No integral shoulders will be provided (i.e., wheels can traffic the slab to the edge of the slab);
- The base will be un-dowelled;
- A design reliability of 90% was adopted (Load Safety Factor = 1.2); and
- Concrete for the base course shall comprise min. 32 MPa compressive strength and min. 4.5 MPa flexural strength, both values measured at 28 days.
- Inclusion of a 10 mm tolerance in the design.

The concrete pavement configurations are shown in Table 15 below.

Table 15 - Rigid Pavement Configurations

Layer Description	Pavement constructed on Residual Soil Subgrade	Pavement Constructed with min. 300 mm Selected Layer or on Unit 3A
Concrete Base Course with SL92 mesh reinforcement	190 mm	185 mm
Granular Subbase Course, DGB20	100 mm	100 mm
Selected Material Layer CBR ≥ 15%, PI ≤ 25%	-	150 mm
Subgrade	Unit 3 Residual Soil, CBR 5%	Unit 3 Residual Soil, CBR 5%

Note to Table 15: Concrete Base thickness includes a 10mm design tolerance.

The concrete pavement will need to be provided with joints to control shrinkage and warping, and to allow for construction joints.

Joints may be created by sawing or wet forming, to 25% of the slab thickness. Joints should be sealed with a backer rod and sealing compound to avoid moisture ingress. The reinforcement mesh shall be extended across joints, and cover shall be maintained to reinforcement where joints are formed. Reinforcement should be placed min. 90 mm below the finished concrete surface level and max. 75 mm above the underside of the slab. For PCP-R, the reinforcement does not contribute to flexural strength in the design but aids in reducing crack apertures.

Joints shall be provided in a rectangular pattern as far as practicable, with joint spacings between 3.0 m and 4.2 m. The aspect ratio for should be between 0.7 and 1.4. Where the geometry does not allow rectangular slabs, or acute angles will be formed, the RMS rigid pavement drawings should be consulted. \

5.8.4. Pavement Construction Specifications

All pavement materials, supply and works shall conform to Aus-Spec 1 series of specifications, or NSW RMS Specifications.

5.8.5. Hardstand Works

We recommend that hardstands be designed for the specific lifting equipment and loads proposed by the operator of the equipment at the time of the construction.

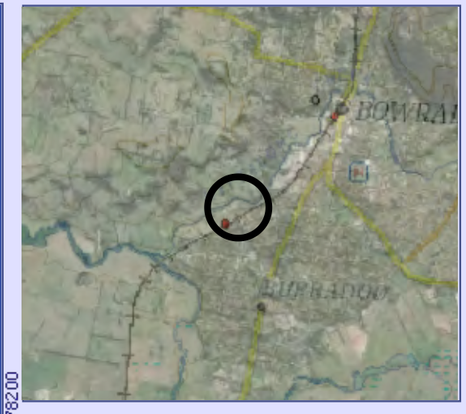
6. Limitations

Subsurface conditions can be complex and may vary over relatively short distances – and over time. The inferred geotechnical model and recommendations in this report are based on limited subsurface investigations at discrete locations. The engineering logs describe subsurface conditions only at the investigation locations.

Further investigations may be required to support detailed design if there are scope limitations or changes to the nature of the project.

Figures

C-0760.00 | Bowral Sewage Treatment Plant | Geotechnical Investigation



Legend

- Borehole
- Borehole and Standpipe Piezometer

Data Source:

https://data.nsw.gov.au/data/

Cartographic Data and Orientation:

N

1:900
Datum: GDA2020
Coordinate Unit: Metres

0 30 m

D&N Geotechnical

Company: D&N Geotechnical
Drawn: AW
Approved: LC
Original size: A3
Project: Bowral Sewage Treatment Plant
Geotechnical Investigation

Date:	Client:	Figure 1
16/04/2021	Hunter H20 Holdings PTY Ltd	

Appendix A - Engineering Borehole Logs and Core Photographs

D&N Geotechnical

Engineering Log - Borehole

Borehole ID.	**BH101**
sheet:	1 of 1
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
date started:	**23 Feb 2021**
principal:	**Wingecarribee Shire Council**
date completed:	**23 Feb 2021**
project:	**Bowral Sewage Treatment Plant Upgrade**
logged by:	**AP**
location:	**Bowral, NSW**
checked by:	**DB**

position: E: 261184; N: 6180263 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: CE 180, Track mounted | drilling fluid: N/A | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/ 100 mm) 2 4 6 8 10	structure and additional observations
AD/T — N		Not Observed	D				Cl	**FILL: Sandy CLAY**: medium plasticity, brown, fine to medium sand, with fragments of brick and asphalt >40mm.	<Wp				**FILL**
			SPT 3, 3, 3 N*=6		1.0		Cl-CH	**Sandy CLAY**: medium to high plasticity, grey, mottled orange, fine to medium sand, with fine to medium, sub-angular gravel.	>Wp	St			**RESIDUAL SOIL**
			SPT 4, 9, 9 N*=18		2.0								
										VSt to H			
			SPT 9, 14, 7 N*=21		3.0								
									>Wp	St to VSt			
			SPT 6, 16, 3/10mm HB N*=R		4.0			**SILTSTONE**: grey, highly weathered, inferred very low to low strength.					**BEDROCK**
			SPT 3/50mm HB N*=R		5.0								
								Borehole BH101 terminated at 5.5 m Target depth					
					6.0								
					7.0								

D&N_AU_LIBRARY.GLB rev:AM Log COF BOREHOLE: NON CORED + DCP C-0760.00 BOWRAL.GPJ <<DrawingFile>> 16/04/2021 14:25

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

D&N Geotechnical

Engineering Log - Borehole

Borehole ID.	**BH102**
sheet:	1 of 2
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
date started:	**22 Feb 2021**
principal:	**Wingecarribee Shire Council**
date completed:	**22 Feb 2021**
project:	**Bowral Sewage Treatment Plant Upgrade**
logged by:	**AP**
location:	**Bowral, NSW**
checked by:	**DB**

position: E: 261250; N: 6180276 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: CE 180, Track mounted | drilling fluid: Water | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	DCP (blows/ 100 mm)	structure and additional observations
AD/T	1 2 3	12/04/21	D				Cl	**Sandy CLAY**: medium plasticity, brown, fine to medium sand.	~Wp		100 200 300 400	2 4 6 8 10	**TOPSOIL**
			SPT 2, 4, 6 N*=10		1.0		Cl-CH	**Silty CLAY**: medium to high plasticity, orange.	~Wp	St to VSt			**RESIDUAL SOIL**
			SPT 9, 21, 23 N*=44		2.0			**SILTSTONE**: grey, pale brown, extremely to highly weathered, inferred soil strength to very low strength.					**BEDROCK**
N			SPT 11, 26, 18/90mm HB N*=R		3.0			Borehole BH102 continued as cored hole					
					4.0								
					5.0								
					6.0								
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

D&N Geotechnical

Engineering Log - Cored Borehole

Borehole ID.	**BH102**
sheet:	2 of 2
project no.	**C-0760.00**
client:	***Hunter H20 Holdings Pty Ltd***
date started:	***22 Feb 2021***
principal:	***Wingecarribee Shire Council***
date completed:	***22 Feb 2021***
project:	***Bowral Sewage Treatment Plant Upgrade***
logged by:	***AP***
location:	***Bowral, NSW***
checked by:	***DB***

position: E: 261250; N: 6180276 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90°

drill model: CE 180, Track mounted | drilling fluid: Water | hole diameter : 100 mm | vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 X = axial; O = diametral VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
			1.0								
			2.0								
			3.0		start coring at 3.30m						
NMLC					**NO CORE:** 0.50 m						
			4.0		INTERLAMINATED SILTSOTNE (60%) AND SANDSTONE (40%):: dark grey, fine to medium grained, pale grey sandstone.	HW to MW SW HW SW MW FR		a=0.48 a=1.27 d=1.01 a=0.94 d=0.33	13% 39% 0%		JT, 45°, ST, RO, CN JT, 80°, IR, RO, CN SM, 10°, PL, RO, CO - Silt JT, 10°, IR, RO, CN JT, 10°, IR, RO, CN JT, 10 - 30°, PL - IR, RO, CN SZ, IR, RO, SN - Fe PT, 10°, PL, RO, CN JT, 20°, UN, RO, VN - Silt PT, 10°, PL, RO, CN JT, 10°, UN, RO, CN JT, 10 - 45°, IR - UN, RO, CN JT, 10°, PL, RO, VN - Silt JT, 10°, PL, RO, VN - Silt JT, 10°, PL, RO, VN - Silt JT, 20°, UN, RO, CN JT, 10 - 30°, PL - IR, RO, CN
			5.0								
			6.0								
			7.0								
					Borehole BH102 terminated at 7.50 m Target depth						

D&N_AU_LIBRARY.GLB rev:AM Log COF BOREHOLE: CORED C-0760.00 BOWRAL.GPJ <<DrawingFile>> 16/04/2021 14:26

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- HA hand auger

water
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD
- barrel withdrawn

RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating

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BH102

Core Photograph

Job No: C-0760.00
Office: Canberra

Sheet 1 of 1

Client: Hunter H2O Holdings Pty Ltd	Date: 22 February 2021
Principal:	By: AP
Project: Bowral STP	Location: Bowral, NSW

D&N Geotechnical

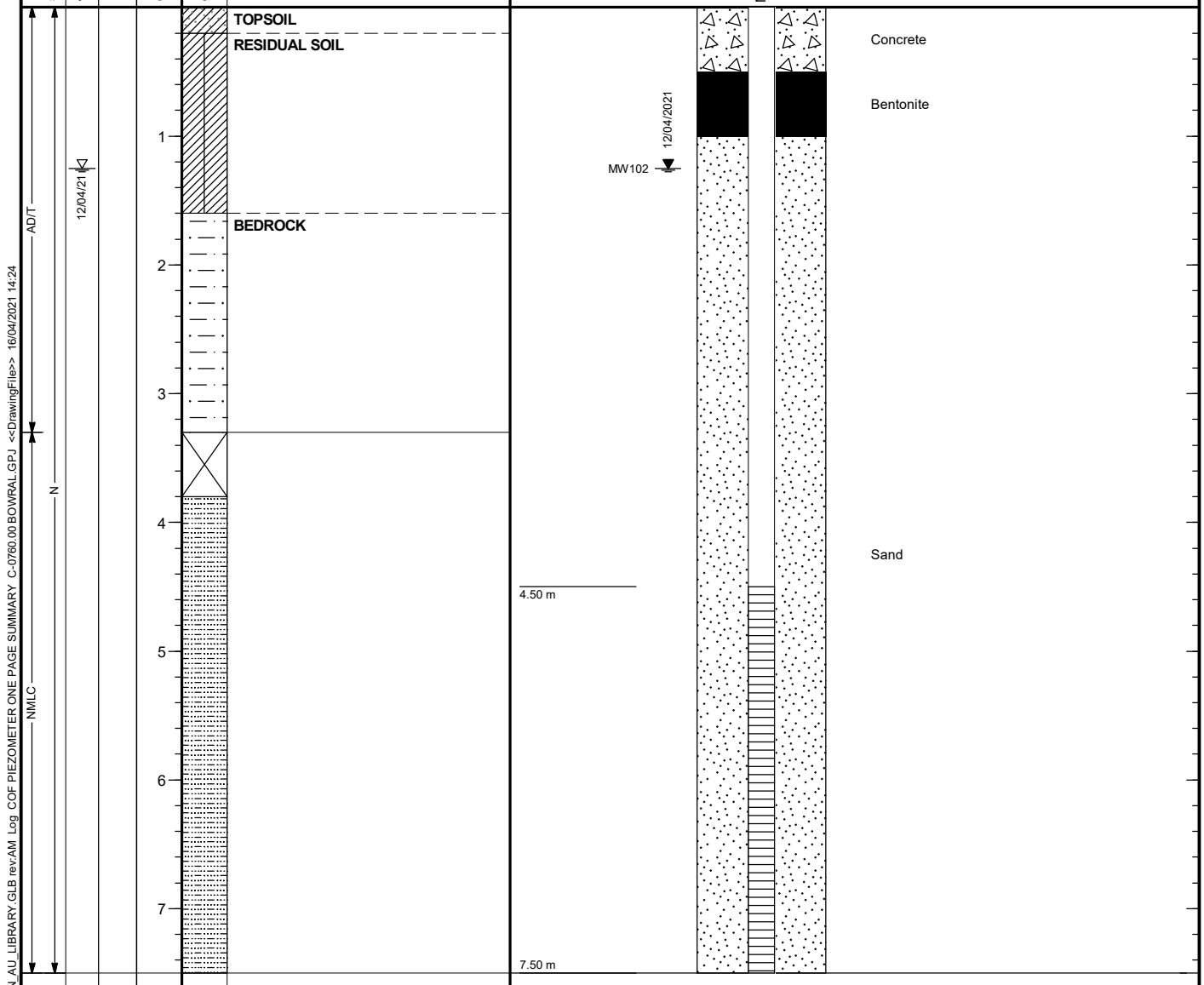
Piezometer Installation Log

Hole ID.	**BH102**
sheet:	1 of 1
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
principal:	**Wingecarribee Shire Council**
project:	**Bowral Sewage Treatment Plant Upgrade**
location:	**Bowral, NSW**
date started:	**22 Feb 2021**
date completed:	**22 Feb 2021**
logged by:	**AP**
checked by:	**DB**

position: E: 261250; N: 6180276 (MGA94)
surface elevation: Not Specified
angle from horizontal: 90°
equipment type: CE 180, Track mounted
drilling fluid: Water
hole diameter : 100 mm

drilling information | **material substance** | **piezometer construction details**

bore construction licensed: N/A
drilling company: B&G Drilling
driller: B&G Drilling
driller's permit no.: N/A



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method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
MW102	standpipe	22/02/2021	-0.10 m	7.50 m				

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Engineering Log - Borehole

Borehole ID.	***BH103***
sheet:	1 of 1
project no.	***C-0760.00***
client:	***Hunter H20 Holdings Pty Ltd***
date started:	***23 Feb 2021***
principal:	***Wingecarribee Shire Council***
date completed:	***23 Feb 2021***
project:	***Bowral Sewage Treatment Plant Upgrade***
logged by:	***AP***
location:	***Bowral, NSW***
checked by:	***DB***

position: E: 261310; N: 6180329 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: CE 180, Track mounted | drilling fluid: N/A | hole diameter : 200 mm

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	DCP (blows/ 100 mm)	structure and additional observations
AD/T, N	1, 2, 3	Not Observed	B		0.0		ML	**FILL: Sandy SILT**: low liquid limit, dark brown, fine to medium sand, trace fine to medium, sub-angular gravel, trace fine roots.	D		100, 200, 300, 400	2, 4, 6, 8, 10	**TOPSOIL / FILL**
							CI	**Sandy CLAY**: medium plasticity, orange-brown, fine to medium sand, with fine to medium, sub-angular gravel.	<Wp	VSt			**RESIDUAL SOIL**
					1.0								
					2.0			Borehole BH103 terminated at 2.0 m Target depth					
					3.0								
					4.0								
					5.0								
					6.0								
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1, 2, 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

D&N Geotechnical

Engineering Log - Borehole

Borehole ID.	**BH104**
sheet:	1 of 1
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
date started:	**23 Feb 2021**
principal:	**Wingecarribee Shire Council**
date completed:	**23 Feb 2021**
project:	**Bowral Sewage Treatment Plant Upgrade**
logged by:	**AP**
location:	**Bowral, NSW**
checked by:	**DB**

position: E: 261363; N: 6180338 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: CE 180, Track mounted | drilling fluid: N/A | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	DCP (blows/ 100 mm)	structure and additional observations
AD/T, N	1, 2, 3	Not Observed	D, B		0.0		GW, GP, CI-CH	**FILL: Sandy GRAVEL**: fine to coarse grained, sub-rounded to sub-angular, grey, fine to coarse sand.	D to M		100, 200, 300, 400	2, 4, 6, 8, 10	**BASE COURSE**
								FILL: Sandy GRAVEL: fine to medium grained, sub-rounded to sub-angular, yellow-brown, fine to coarse sand, trace low to medium plasticity fines.	~Wp				**SUBBASE COURSE**
					1.0			**FILL: Silty CLAY**: medium to high plasticity, grey, with fine to coarse, sub-rounded to sub-angular gravel.					**FILL**
					2.0			Borehole BH104 terminated at 2.0 m Target depth					
					3.0								
					4.0								
					5.0								
					6.0								
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1, 2, 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Borehole

Borehole ID.	**BH105**
sheet:	1 of 2
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
date started:	**22 Feb 2021**
principal:	**Wingecarribee Shire Council**
date completed:	**22 Feb 2021**
project:	**Bowral Sewage Treatment Plant Upgrade**
logged by:	**AP**
location:	**Bowral, NSW**
checked by:	**DB**

position: E: 261221; N: 6180302 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: CE 180, Track mounted | drilling fluid: Water | hole diameter : 100 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	DCP (blows/ 100 mm) 2 4 6 8 10	structure and additional observations
AD/T			D				ML	**FILL: Sandy SILT**: low liquid limit, dark brown, fine to coarse sand, with rootlets.	~Wl				**TOPSOIL / FILL**
							CL	**FILL: Sandy CLAY**: low plasticity, brown, fine to medium sand, with brick and asphalt fragments >50mm.	<Wp				**FILL**
			SPT 7, 7, 8 N*=15		1.0		SP	**CLAYEY SAND**: fine to medium grained, grey, off-white, mottled orange-brown, medium plasticity clay fines, with fine to coarse, sub-angular gravel.	D to M	MD			**ALLUVIUM**
		12/04/21	SPT 8, 12, 11 N*=23		2.0								
			SPT 5, 6, 5 N*=11		3.0								
N			SPT 26, 20/80mm HB N*=R		4.0			**INTERLAMINATED SILTSTONE & SANDSTONE**: brown, highly weathered, inferred very low to low strength.					**BEDROCK**
					5.0			**INTERLAMINATED SILTSTONE & SANDSTONE**: dark grey, pale grey, moderately to slightly weathered, inferred medium to high strength.					
					6.0			Borehole BH105 continued as cored hole					
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH105**
sheet:	2 of 2
project no.	**C-0760.00**
client:	***Hunter H20 Holdings Pty Ltd***
principal:	***Wingecarribee Shire Council***
project:	***Bowral Sewage Treatment Plant Upgrade***
location:	***Bowral, NSW***
date started:	***22 Feb 2021***
date completed:	***22 Feb 2021***
logged by:	***AP***
checked by:	***DB***

position: E: 261221; N: 6180302 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90°

drill model: CE 180, Track mounted | drilling fluid: Water | hole diameter : 100 mm | vane id.:

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 X = axial; O = diametral VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
			1.0								
			2.0								
			3.0								
			4.0								
			5.0		start coring at 5.90m						
NMLC			6.0		**INTERLAMINATED SILTSTONE (60%) AND SANDSTONE (40%):** dark grey, fine to medium grained, pale grey sandstone.	FR	O	a=2.43 d=0.64 a=0.92 d=0.04	100%		SM, 10°, IR, RO, CL Clay VN JT, 45°, IR, RO, CL Clay VN PT, 10°, IR, RO, CN JT, 45°, IR, RO, CN SM, 10°, IR, RO, CL Clay VN
			7.0		Borehole BH105 terminated at 7.50 m Target depth						

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method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test
- HA hand auger

water
- 10/10/12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

core run & RQD
- barrel withdrawn
- RQD = Rock Quality Designation (%)

weathering & alteration*
- RS residual soil
- XW extremely weathered
- HW highly weathered
- DW distinctly weathered
- MW moderately weathered
- SW slightly weathered
- FR fresh

*W replaced with A for alteration

strength
- VL very low
- L low
- M medium
- H high
- VH very high
- EH extremely high

defect type
- PT parting
- JT joint
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

roughness
- SL slickensided
- POL polished
- SO smooth
- RO rough
- VR very rough

coating
- CN clean
- SN stain
- VN veneer
- CO coating

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BH105

Core Photograph

Job No: C-0760.00 Sheet 1 of 1
Office: Canberra

Client: Hunter H2O Holdings Pty Ltd	Date: 22 February 2021
Principal:	By: AP
Project: Bowral STP	Location: Bowral, NSW

D&N Geotechnical

Piezometer Installation Log

Hole ID.	**BH105**
sheet:	1 of 1
project no.	**C-0760.00**
client:	**Hunter H20 Holdings Pty Ltd**
date started:	**22 Feb 2021**
principal:	**Wingecarribee Shire Council**
date completed:	**22 Feb 2021**
project:	**Bowral Sewage Treatment Plant Upgrade**
logged by:	**AP**
location:	**Bowral, NSW**
checked by:	**DB**

position: E: 261221; N: 6180302 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90°

equipment type: CE 180, Track mounted | drilling fluid: Water | hole diameter : 100 mm

drilling information | **material substance** | **piezometer construction details**

bore construction license:
drilling company: B&G Drilling
driller:
driller's permit no.:

method & support	water	RL (m)	depth (m)	graphic log	material name
AD/T	12/04/21		0		TOPSOIL / FILL
					FILL
			1		ALLUVIUM
			2		
			3		
N			4		BEDROCK
			5		
			6		
NMLC			7		

MW105 — 12/04/2021

Bentonite

Sand

4.35 m

Cuttings

7.35 m

method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 — water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
MW105	standpipe	22/02/2021	-0.08 m	7.35 m				

D&N Geotechnical

Engineering Log - Hand Auger

Borehole ID.	**BH106**
sheet:	1 of 1
project no.	**C-0760.00**
client:	***Hunter H20 Holdings Pty Ltd***
date started:	***23 Feb 2021***
principal:	***Wingecarribee Shire Council***
date completed:	***23 Feb 2021***
project:	***Bowral Sewage Treatment Plant Upgrade***
logged by:	***AP***
location:	***Bowral, NSW***
checked by:	***DB***

position: E: 261216; N: 6180396 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: Hand Auger | drilling fluid: N/A | hole diameter : 80 mm

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (**SOIL TYPE**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/ 100 mm) (2 4 6 8 10)	structure and additional observations
HA — N		Not Observed	D				Cl	**CLAY**: medium plasticity, brown, mottled orange-brown, with fine to medium, sub-angular gravel.	~Wp	St to VSt			**RESIDUAL SOIL**
					1.0			Hand Auger BH106 terminated at 0.65 m Refusal					
					2.0								
					3.0								
					4.0								
					5.0								
					6.0								
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description
based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

D&N Geotechnical

Engineering Log - Hand Auger

Borehole ID.	**BH107**
sheet:	1 of 1
project no.	**C-0760.00**
client:	***Hunter H20 Holdings Pty Ltd***
date started:	***22 Feb 2021***
principal:	***Wingecarribee Shire Council***
date completed:	***22 Feb 2021***
project:	***Bowral Sewage Treatment Plant Upgrade***
logged by:	***AP***
location:	***Bowral, NSW***
checked by:	***DB***

position: E: 261225; N: 6180384 (MGA94) | surface elevation: Not Specified | angle from horizontal: 90° | DCP id.: Canb01

drill model: Hand Auger | drilling fluid: N/A | hole diameter : 80 mm

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) (100 200 300 400)	DCP (blows/ 100 mm) (2 4 6 8 10)	structure and additional observations
HA, N		Not Observed	D		0.0		ML	**FILL: Sandy SILT**: low liquid limit, dark brown, fine to medium sand, with rootlets.	D				**FILL**
							Cl		~Wp				
							ML	**FILL: CLAY**: medium plasticity, orange and grey, trace fine to coarse, sub-angular gravel, brick and asphalt fragments >40mm.	<Wl				**TOPSOIL**
			D				Cl	**Sandy SILT**: low liquid limit, dark brown, fine to coarse sand, with rootlets.	~Wp	St to VSt			**RESIDUAL SOIL**
					1.0			**Sandy CLAY**: medium plasticity, grey, mottled orange-brown, fne to coarse sand, trace fine to medium, sub-angular gravel.					
					2.0			Hand Auger BH107 terminated at 2.0 m Target depth					
					3.0								
					4.0								
					5.0								
					6.0								
					7.0								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration (1 2 3) — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

classification symbol & soil description based on Unified Classification System

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

Appendix B - Dynamic Cone Penetrometer Test Results

D&N Geotechnical

Dynamic Cone Penetrometer Test Results

Client:	Hunter H20 Holdings Pty Ltd
Principal:	
Project:	Bowral Sewage Treatment Plant
Location:	Bowral, NSW
Job No:	C-0760.00
Date	22/02/2021

Test procedure: **Test date:**

Depth below surface (mm)	Test Numbers / Readings recorded in blows per 100mm								
	101	102	103	104	105	106	107		Test location/Remarks
100	3	2	1	20	1	4	2		
200	4	4	4	19	1	5	2		
300	10	2	6	10	5	5	4		
400	20	2	8	9	15	5	4		
500	8	3	9	11	17	5	5		
600	4	4	15	6	11	4	5		
700	7	4	17	7	9	14	6		
800	2	5	20/50mm	5	8	6	7		
900	12	5		6	5	5	4		
1000	6	4		5	20/90mm	17	4		
1100	11	3		5		17	4		
1200	9	4		5		13	5		
1300									
1400									
1500									
1600									
1700									
1800									
1900									
2000									
2100									
2200									
2300									
2400									
2500									
2600									
2700									
2800									
2900									
3000									
3100									
3200									
3300									
3400									
3500									
3600									
3700									
3800									
3900									
4000									

Remarks

General Information

AS 1289 6.3.2

- ■ Drop height 510mm ± 5
- ■ Cone tip
- □ Blunt tip

AS 1289 6.3.3

- □ Drop height 600mm ± 5

Appendix C - Laboratory Test Certificates

Canberra Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
16 Mildura Street
Fyshwick ACT 2609

Phone: +61 2 8876 0550

Material Test Report

Report No: ASM:CANB21W00413
Issue No: 1

Client: D&N Geotechnical Pty Ltd
16 Broadsmith Street
Scullin ACT 2614

Principal:
Project No.: TESTCANB00248AA
Project Name: C-0760.00 - Bowral STP
Lot No.: **TRN:**

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Approved Signatory: Jason McGurgan
(Laboratory Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/03/2021

Material Details

Location	Bowral, NSW		
Source	Insitu	**Sampled From**	
Description	Subgrade	**Specification**	Investigation
Sampling Method	Submitted by client		

Sample Details

Sample ID	CANB21S-01189	CANB21S-01190	CANB21S-01191	CANB21S-01192	CANB21S-01193	CANB21S-01194
Field Sample ID	00003	00004	00005	00006	00007	00008
Date Sampled	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021
Date Submitted:	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021
Sample Location:	BH101	BH101	BH102	BH103	BH104	BH105
	1.0 - 1.45m	4.0 - 4.31m	1.0 - 1.45m	0.2 - 0.4m	0.6 - 1.0m	2.0 - 2.45m

Particle Size Distribution

Method:
AS 1289.3.6.1
Description:
Determination of the Particle Size Distribution of a Soil - Standard Method of Analysis by
Drying by:
Oven
Washed:
Sample Washed

Sieve Size	% Passing						Limits
300mm							
250mm							
200mm							
150mm							
125mm							
100mm							
75.0mm							
63.0mm							
53.0mm							
37.5mm							
26.5mm							
19.0mm							
13.2mm							
9.5mm							
6.7mm						100	
4.75mm						99	
2.36mm						99	
1.18mm		100				98	
600µm		83				88	
425µm		62				70	
300µm		45				52	
150µm		31				35	
75µm		23				27	

Other Test Results

Description	Method	Results			Limits
Moisture Content (%)	AS 1289.2.1.1		14.1	16.9	
Date Tested			9/03/2021	9/03/2021	

Comments

N/A

Canberra Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
16 Mildura Street
Fyshwick ACT 2609

Phone: +61 2 8876 0550

Material Test Report

Report No: ASM:CANB21W00413
Issue No: 1

Client: D&N Geotechnical Pty Ltd
16 Broadsmith Street
Scullin ACT 2614

Principal:
Project No.: TESTCANB00248AA
Project Name: C-0760.00 - Bowral STP
Lot No.: **TRN:**

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Approved Signatory: Jason McGurgan
(Laboratory Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/03/2021

Material Details

Location	Bowral, NSW		
Source	Insitu	**Sampled From**	
Description	Subgrade	**Specification**	Investigation
Sampling Method	Submitted by client		

Sample Details

Sample ID	CANB21S-01189	CANB21S-01190	CANB21S-01191	CANB21S-01192	CANB21S-01193	CANB21S-01194
Field Sample ID	00003	00004	00005	00006	00007	00008
Date Sampled	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021
Date Submitted:	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021
Sample Location:	BH101	BH101	BH102	BH103	BH104	BH105
	1.0 - 1.45m	4.0 - 4.31m	1.0 - 1.45m	0.2 - 0.4m	0.6 - 1.0m	2.0 - 2.45m

Other Test Results

Description	Method	Results				Limits
Sample History	AS 1289.1.1	Oven-dried	Oven-dried			
Preparation	AS 1289.1.1	Dry Sieved	Dry Sieved			
Linear Shrinkage (%)	AS 1289.3.4.1	5.5	11.5			
Mould Length (mm)		254	254			
Crumbling		No	No			
Curling		No	No			
Cracking		No	No			
Liquid Limit (%)	AS 1289.3.1.2	22	48			
Plastic Limit (%)	AS 1289.3.2.1	13	21			
Plasticity Index (%)	AS 1289.3.3.1	9	27			
Date Tested		15/03/2021	15/03/2021			
Standard MDD (t/m³)	AS 1289.5.1.1			1.84	1.94	
Standard OMC (%)				13.5	14.5	
Retained Sieve (mm)				19	19	
Oversize Material (%)				0	0	
Curing Time (h)				48	48	
LL Method				Visual / Tactile	Visual / Tactile	
Date Tested				9/03/2021	9/03/2021	

Comments

N/A

Canberra Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
16 Mildura Street
Fyshwick ACT 2609

Phone: +61 2 8876 0550

Material Test Report

Report No: ASM:CANB21W00413
Issue No: 1

Client: D&N Geotechnical Pty Ltd
16 Broadsmith Street
Scullin ACT 2614

Principal:
Project No.: TESTCANB00248AA
Project Name: C-0760.00 - Bowral STP
Lot No.: **TRN:**

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Approved Signatory: Jason McGurgan
(Laboratory Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/03/2021

Material Details

Location	Bowral, NSW		
Source	Insitu	**Sampled From**	
Description	Subgrade	**Specification**	Investigation
Sampling Method	Submitted by client		

Sample Details

Sample ID	CANB21S-01189	CANB21S-01190	CANB21S-01191	CANB21S-01192	CANB21S-01193	CANB21S-01194
Field Sample ID	00003	00004	00005	00006	00007	00008
Date Sampled	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021	21/02/2021
Date Submitted:	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021	3/03/2021
Sample Location:	BH101	BH101	BH102	BH103	BH104	BH105
	1.0 - 1.45m	4.0 - 4.31m	1.0 - 1.45m	0.2 - 0.4m	0.6 - 1.0m	2.0 - 2.45m

Other Test Results

Description	Method	Results		Limits
CBR at 2.5mm (%)	AS 1289.6.1.1	7	6	
Dry Density before Soaking (t/m³)		1.82	1.93	
Density Ratio before Soaking (%)		99.0	99.5	
Moisture Content before Soaking (%)		13.8	13.9	
Moisture Ratio before Soaking (%)		101.0	96.5	
Dry Density after Soaking (t/m³)		1.80	1.92	
Density Ratio after Soaking (%)		98.0	99.0	
Swell (%)		1.0	0.5	
Moisture Content of Top 30mm (%)		17.8	15.2	
Moisture Content of Remaining Depth (%)		16.5	15.9	
Compaction Hammer Used		Standard	Standard	
Surcharge Mass (kg)		4.50	4.50	
Period of Soaking (Days)		4	4	
Retained on 19 mm Sieve (%)		0	0	
CBR Moisture Content Method		AS 1289.2.1.1	AS 1289.2.1.1	
Sample Curing Time (h)		96	96	
Plasticity Method		Visual/Tactile	Visual/Tactile	
Sample Moisture Content		AS 1289.2.1.1	AS 1289.2.1.1	
Date Tested		17/03/2021	17/03/2021	

Comments

N/A

Canberra Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
16 Mildura Street
Fyshwick ACT 2609

Phone: +61 2 8876 0550

Material Test Report

Report No: ASM:CANB21W00413
Issue No: 1

Client: D&N Geotechnical Pty Ltd
16 Broadsmith Street
Scullin ACT 2614

Principal:
Project No.: TESTCANB00248AA
Project Name: C-0760.00 - Bowral STP
Lot No.: **TRN:**

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Approved Signatory: Jason McGurgan
(Laboratory Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 19/03/2021

Material Details

Location	Bowral, NSW		
Source	Insitu	**Sampled From**	
Description	Subgrade	**Specification**	Investigation
Sampling Method	Submitted by client		

Sample Details

Sample ID	CANB21S-01195	CANB21S-01196
Field Sample ID	00009	00010
Date Sampled	21/02/2021	21/02/2021
Date Submitted:	3/03/2021	3/03/2021
Sample Location:	HA108	HA109
	0.3 - 0.4m	0.8 - 0.9m

Other Test Results

Description	Method	Results		Limits
Sample History	AS 1289.1.1	Oven-dried	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.5	13.5	
Mould Length (mm)		254	254	
Crumbling		No	No	
Curling		No	No	
Cracking		No	No	
Liquid Limit (%)	AS 1289.3.1.2	43	44	
Plastic Limit (%)	AS 1289.3.2.1	19	22	
Plasticity Index (%)	AS 1289.3.3.1	24	22	
Date Tested		15/03/2021	15/03/2021	

Comments

N/A

SYDNEY LABORATORY
Coffey Testing Pty Ltd
ABN 92 114 364 046
31 Hope Street, Melrose Park NSW 2114 Australia
ph: +61 2 8876 0500

Test report - uniaxial compressive strength

client:	*COFFEY TESTING PTY LTD*	job no:	***TESTSYDS 00068AA***
Principal:	*D&N GEOTECHNICAL PTY*		
project:	*TESTCANB00248AA - BOWRAL STP*	report date:	*26 March 2021*
location:	*BOWRAL NSW*	borehole:	***BH102***
	test procedure: *AS 4133.1.1.1 and 4133.4.2.1*	date received:	*5 March 2021*
	test apparatus: *Avery with 200 kN CAS load cell 4222*		*page 1 of 1*

All samples were tested in an "As Received" condition.

Top platen 228 mm, Bottom platen 120 mm

QESTLab work order ID / depth / QESTLab sample ID	date tested / test duration	height / average diameter / height/dia ratio	uniaxial compressive strength MPa	wet density / moisture content	sample description / bedding/foliation	Client's Sample ID / failure mechanism
SYDS21W00043 / *6.22 to 6.45 m* / *SYDS21S00487*	*24 Mar 21* / *11.83 min*	*148 mm* / *51.1 mm* / *2.89:1*	***24.9***	***2.6 t/m³*** / ***2.9 %***	*Sandstone with shale* / *Bedding planes are at an angle of 80° to the axis of loading*	***CANB21S-01028*** / *Shear*

6.22 to 6.45

SYDS_001R

\\Ct-fs\zct\Sydney\Data\50. ROCK TESTING_TESTSYD-Rocks-2021\TESTSYDS00068AA - Bowral STP\[BH102 UCS.xlsm]Report

Accredited for compliance with ISO/IEC 17025 - Testing
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/national standards.

NATA Accredited Laboratory No. 431

Date: *26 Mar 2021*

Authorised Signature:

Alan Cocks
Rock Testing Manager

SYDNEY LABORATORY
Coffey Testing Pty Ltd
ABN 92 114 364 046
31 Hope Street, Melrose Park NSW 2114 Australia
ph: +61 2 8876 0500

Test report - uniaxial compressive strength

client:	*COFFEY TESTING PTY LTD*	job no:	***TESTSYDS 00068AA***
Principal:	*D&N GEOTECHNICAL PTY*		
project:	*TESTCANB00248AA - BOWRAL STP*	report date:	*26 March 2021*
location:	*BOWRAL NSW*	borehole:	***BH105***
	test procedure: *AS 4133.1.1.1 and 4133.4.2.1*	date received:	*5 March 2021*
	test apparatus: *Avery with 200 kN CAS load cell 4222*		*page 1 of 1*

All samples were tested in an "As Received" condition.

Top platen 228 mm, Bottom platen 120 mm

QESTLab work order ID / depth / QESTLab sample ID	date tested / test duration	height / average diameter / height/dia ratio	uniaxial compressive strength MPa	wet density / moisture content	sample description / bedding/foliation	Client's Sample ID / failure mechanism
SYDS21W00043 / *4.50 to 4.70 m* / *SYDS21S00486*	*24 Mar 21* / *13.30 min*	*146 mm* / *51.4 mm* / *2.84:1*	***39.3***	***2.6 t/m³*** / ***2.4 %***	*Sandstone with shale* / *Bedding planes are at an angle of 90° to the axis of loading*	***CANB21S-01027*** / *Shear*

4.50 to 4.70 m

SYDS_001R

\\Ct-fs\zct\Sydney\Data\50. ROCK TESTING_TESTSYD-Rocks-2021\TESTSYDS00068AA - Bowral STP\[BH105 UCS.xlsm]Data Entry

Accredited for compliance with ISO/IEC 17025 - Testing
The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/national standards.

NATA Accredited Laboratory No. 431

Date: *26 Mar 2021*

Authorised Signature:

Alan Cocks
Rock Testing Manager

CERTIFICATE OF ANALYSIS

Work Order	: **CA2101337**	Page	: 1 of 2
Client	: **D&N Geotechnical**	Laboratory	: ALS Water Resources Group
Contact	: Mr Liam Crossby	Contact	: Client Services
Address	: PO BOX 4359 Hawker ACT 2614	Address	: 16B Lithgow Street Fyshwick ACT Australia 2609
Telephone	: ----	Telephone	: +61 2 6202 5404
Project	: Soil Agressivity	Date Samples Received	: 01-Mar-2021 15:40
Order number	: ----	Date Analysis Commenced	: 04-Mar-2021
C-O-C number	: ----	Issue Date	: 05-Mar-2021 15:28
Sampler	: Adam Phillips		
Site	: ----		
Quote number	: ----		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 992
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Geetha Ramasundara	Chemistry Teamleader	Inorganics, Fyshwick, ACT

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **For samples collected by ALS WRG, sampling was carried out in accordance with Procedure EN67**

Analytical Results

Sub-Matrix: **SOLID** (Matrix: **SOLID**)			Sample ID	**BH101 Sandy CLAY, Residual**	**BH104 CLAY, FILL**	**BH105 Clayey SAND, XW**	**----**	**----**
			Sampling date / time	[01-Mar-2021]	[01-Mar-2021]	[01-Mar-2021]	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**CA2101337-001**	**CA2101337-002**	**CA2101337-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA002CA: pH in Soil								
ø pH Value	----	0.1	pH Unit	**6.0**	**6.5**	**6.3**	**----**	**----**
EA010CA: Conductivity								
ø Electrical Conductivity @ 25°C	----	0.01	dS/m	**0.07**	**0.09**	**0.06**	**----**	**----**
EA080CA: Resistivity								
Resistivity at 25°C	----	1	ohm cm	**14200**	**11500**	**17600**	**----**	**----**
ED009CA: Anions								
Chloride	16887-00-6	1	mg/kg	**20**	**19**	**20**	**----**	**----**
Sulfate	14808-79-8	2	mg/kg	**116**	**102**	**73**	**----**	**----**

Appendix D – AS2159-2009 Risk Assessment for Geotechnical Reduction Factor

D&N Geotechnical

AS2159-2009: Piling - Design and installation - Geotechnical Risk and Reduction Factor Assessment per Section 4.3.1 and 4.3.2

Job No	C-0760.00 R2 Rev2		
Sheet	1 of 1		
Client	Hunter H20 Pty Ltd		
Principal		**Date**	19/04/2021
Project	Bowral STP	**By**	RV
Location	Bowral, NSW	**Checked**	DB

	Weighting	Typical description of risk circumstances for IRR	Individual Risk Rating	Override (e.g. IRR = 2 or 4)	Weigted IRR
Site Factors					
Geologcal Complexity of site	2	3 - Some variability over site, but without abrupt changes in stratigraphy	3		6
Extent of Ground Investigation	2	3 - Some boreholes extending at least 5 pile diameters below the base of the proposed pile foundation level	3	4	8
Amount and quality of Geotechnical data	2	5 - Limited amount of simple in situ testing (e.g., SPT) or index tests only	5		10
Design Factors					
Designer's Experience with similar foundations in similar conditions	1	3 - Limited	3	2	2
Method of Assessment of geotechnical parameters for design	2	5 - Based on non-sitespecific correlations with (for example) SPT data	5		10
Design method adopted	1	3 - Simplified methods with well-established basis	3		3
Method of utilising results of in-situ test data and installation data	2	5 - No in situ test and installation data available	5		10
Installation Factors					
Level of Construction control	2	3 - Limited degree of professional geotechnical involvement in supervision, conventional construction procedures	3		6
Level of performance monitoring of the supported structure during and after construction	0.5	5 - No monitoring	5		2.5
				Totals	57.5

System redundancy	2 - Systems with a low level of redundancy would include isolated heavily loaded piles and piles set out at large spacings.	**Average Risk Rating**	**ARR**	**3.97**
		Overall risk category		Moderate to High
		Basic Geotechnical Strength Reduction Factor	ϕ_{gb}	0.45
Intrinsic test factor	0.00 - No testing		ϕ_{tf}	0.00
Type of load testing to be performed	0.00 - No testing			
Proportion of piles tested (%)	0	Testing benefit Factor	K	0.00
		Geotechnical Strength Reduction Factor	**ϕ_g**	**0.45**

Provided Requirements of AS2159-2009 Section 8.2.4 are met, Otherwise, ϕ_g= 0.40

Appendix F – Consultation

Sydney Office
4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
Locked Bag 5022, Parramatta NSW 2124
Tel 02 9240 8500 | TTY 1300 301 181
ABN 19 948 325 463 | www.publicworksadvisory.nsw.gov.au

Department of Planning, Industry and Environment Biodiversity and Conservation Division

Via email: rog.illawarra@environment.nsw.gov.au

Dear Sir/Madam,

Bowral Sewage Treatment Plant Augmentation Replacement of Incoming Sewage Main – Review of Environmental Factors Addendum

A Review of Environmental Factors (REF) is currently being prepared by Public Works Advisory (PWA) on behalf of Wingecarribee Shire Council (WSC) for the upgrade and augmentation of the existing Bowral Sewage Treatment Plant (STP) located at Burradoo Road, Burradoo, NSW (Lot 2 DP1119953 and Lot 278 DP 91455). The REF has significantly progressed and is currently being amended to more accurately reflect the detailed design that has been developed (noting that the Office of Environment and Heritage was previously consulted with by PWA on 21/09/2018 – based on the then concept design).

WSC are now proposing the replacement of the incoming sewage main located upstream of the sewage treatment plant, which was not assessed in the drafting of the Bowral STP Upgrade REF. As the Bowral STP REF is nearing completion, and the design of the incoming sewage main is still underway, WSC have engaged PWA to prepare an addendum to the Bowral STP Upgrade REF for the replacement of the incoming main.

The proposed works for the replacement main are permissible without development consent under *State Environmental Planning Policy (Infrastructure) 2007,* and as such an addendum to the original Bowral STP Upgrade REF is being prepared in accordance with the provisions of Part 5 of the *Environmental Planning and Assessment Act* 1979, and clause 228 of the *Environmental Planning and Assessment Regulation* 2000. WSC will be the determining authority for the proposal.

The purpose of this letter is to notify Department of Planning, Industry and Environment Biodiversity and Conservation Division of the proposed works, to provide the opportunity to comment on any matters that your organisation would like to see addressed in the REF Addendum for the replacement of the incoming main and to identify if any approvals are required.

Project Background and Description

Bowral STP currently receives sewage from the town via the Bowral, East Bowral and the Burradoo sewage pump stations (SPS). The STP was last upgraded in 2006 and has a design capacity of 14,600 EP (equivalent persons or equivalent population).

The Bowral STP is being upgraded to provide capacity for future development within the catchment, as the current design capacity has already been exceeded, to improve process and operational performance improvements and to provide treatment infrastructure to meet environmental objectives from regulators such as the EPA and consider neutral or beneficial (NorBE) water quality requirements.

A design horizon of up to the year 2046, equivalent to 21,000 EP, has been adopted for the development of the proposed STP upgrade.

From ‘sewer flow containment modelling undertaken on the Bowral sewage conveyance system’ – a number of improvement opportunities were identified, including the upsizing of approximately 90m of the incoming main directly upstream of the STP, in order to resolve the predicted overflows upstream. As such it is considered practical to have the replacement of a section of the incoming main designed and constructed concurrently with the upgrades to the Bowral STP. The proposed replacement of the incoming sewage main comprises the following new components:

- New upstream manhole adjacent to the existing manhole located on the northern side of Mittagong Creek (refer to Attachment A).
- New gravity main (675mm diameter) from the new upstream manhole to the STP site to be aligned to the west of the existing main so as to provide a direct route to the proposed new inlet works on the STP site.

Similar to the existing incoming main, upon exiting the upstream manhole, the proposed main will be aligned above ground i.e. supported on piers, as it crosses Mittagong Creek (and the associated low lying area to the south of the creek) until it enters the fenced STP site. Once entering the STP fenced area the main will be laid below ground level.

The new incoming main will be constructed in conjunction with the STP augmentation works, and will be commissioned in conjunction with the commissioning of the new STP Upgrade works. Once the new STP Upgrade works are commissioned, the existing main will be made redundant.

The Addendum to the original Bowral STP REF would assess the additional construction works required to replace the incoming main and the operational impacts of the proposal.

A figure and photographs showing the existing incoming main are provided in Attachment A.

Should you have any comments on the proposal, please provide a written response by 1 April 2021 to the undersigned at:

Public Works Advisory

Level 2, 66 Harrington Street

Sydney NSW 2000

Email: liz.mathieson@finance.nsw.gov.au

Phone: 02 9273 3674

Should you require further information regarding the project, please feel free to contact me.

Yours sincerely

Liz Mathieson

Principal Scientist

Environment and Planning

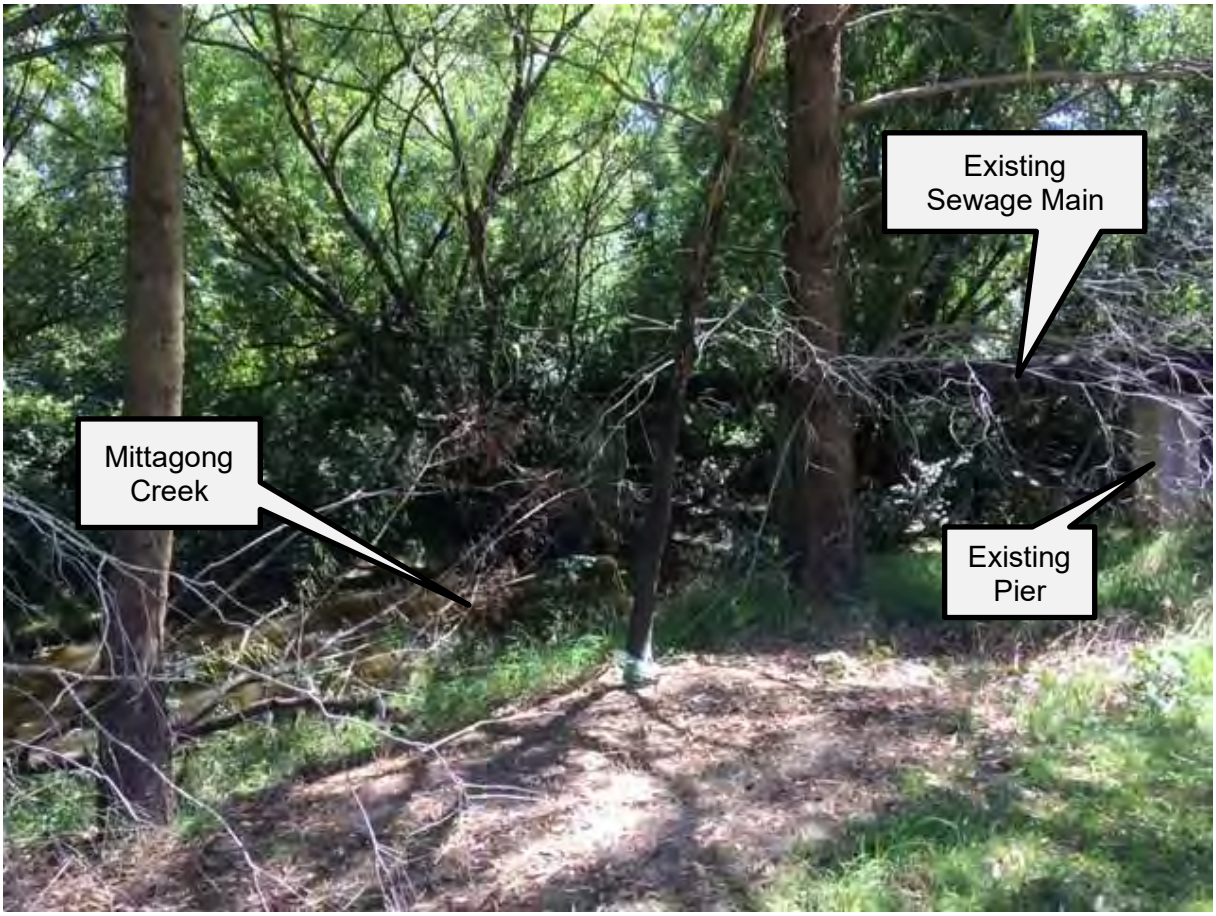
10 March 2021

Attachment A

Alignment of the existing incoming sewage main (outlined in yellow) and the section to be replaced (outlined in red)

Source: Six Maps, accessed March 2021

View of the Existing Sewage Main from the Southern side of Mittagong Creek



View of the existing manhole located on the northern side of Mittagong Creek

Source: WSC, 2021

DOC21/185525-01

Liz Mathieson
Public Works Advisory
Level 2, 66 Harrington Street
SYDNEY NSW 2000

Email: liz.mathieson@finance.nsw.gov.au

Dear Ms Mathieson

Bowral Sewage Treatment Plant (STP) Augmentation Replacement Main

I refer to your letter dated 10 March 2021 requesting comment on matters to be addressed in an addendum to the Bowral STP Upgrade Review of Environmental Factors (REF).

The addendum is being prepared for replacement of the incoming sewage main located upstream of the treatment plant, which was not assessed during drafting of the REF. The proposal involves construction of a new manhole and replacement of approximately 90m of the incoming main with a new gravity main of larger diameter (675mm). The work is intended to reduce the frequency of overflows further upstream in the sewerage system.

The EPA has reviewed the proposal and requests that the REF include consideration of the following:

- A description of the function and integration of the new sewage main in the sewerage system.
- The locations and expected reductions in frequency and volume of sewage overflows.
- Whether upstream overflows are likely to occur before STP bypasses in wet weather events.
- Whether the new manhole will function as an overflow point or be secured to prevent overflow.
- Measures to minimise construction impacts from noise emissions and stormwater pollution. For reference, the EPA's relevant guidelines are as follows:
    - Interim Construction Noise Guideline, July 2009.
    - Managing Urban Stormwater Soils, Construction, Volume 2a, Installation of Services, January 2008.

If you have questions regarding the above, please phone Mr Andrew Couldridge on (02) 4224 4100.

Yours sincerely

25/3/2021

GREG NEWMAN
Acting Unit Head Regulation
Phone 131 555
Phone 02 4224 4100
(from outside NSW)
Fax 02 4224 4110
TTY 131 677
ABN 43 692 285 758
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WOLLONGONG
NSW 2520
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AUSTRALIA
info@epa.nsw.gov.au
www.epa.nsw.gov.au

Kristen Parmeter

From: Jillian Reynolds <jillian.reynolds@dpi.nsw.gov.au>
Sent: Monday, 29 March 2021 10:27 AM
To: Michelle Moodley
Cc: Liz Mathieson
Subject: RE: Bowral Sewage Treatment Plant Augmentation Replacement of Incoming Sewage Main – Review of Environmental Factors Addendum

Hi Michelle,

Thank you for notifying us of the additional scope of works. We request that the advise issued in our initial response to this project be applied to the new scope of works.

Regards,

Jillian

Jillian Reynolds | Fisheries Manager
NSW Department of Primary Industries | Coastal Systems
4 Woollamia Road | PO Box 97 | Huskisson NSW 2540
T: 02 4428 3007 | M: 0429 918 575 | F: 02 4441 8961 | E: jillian.reynolds@dpi.nsw.gov.au
W: www.dpi.nsw.gov.au/fisheries

DPI Fisheries acknowledges that it stands on Country which always was and always will be Aboriginal land. We acknowledge the Traditional Custodians of the land and waters, and we show our respect for Elders past, present and emerging. We are committed to providing places in which Aboriginal people are included socially, culturally and economically through thoughtful and collaborative approaches to our work.

From: Michelle Moodley <Michelle.Moodley@finance.nsw.gov.au>
Sent: Wednesday, 10 March 2021 11:48 PM
To: Jillian Reynolds <jillian.reynolds@dpi.nsw.gov.au>; DPI AHP Central Mailbox <ahp.central@dpi.nsw.gov.au>
Cc: Lisabeth Mathieson (Finance) <Liz.Mathieson@finance.nsw.gov.au>
Subject: Bowral Sewage Treatment Plant Augmentation Replacement of Incoming Sewage Main – Review of Environmental Factors Addendum

Dear Jillian,

A Review of Environmental Factors (REF) is currently being prepared by Public Works Advisory (PWA) on behalf of Wingecarribee Shire Council (WSC) for the upgrade and augmentation of the existing Bowral Sewage Treatment Plant (STP) located at Burradoo Road, Burradoo NSW.

WSC are now proposing the replacement of the incoming sewage main located upstream of the sewage treatment plant, which was not assessed in the drafting of the Bowral STP Upgrade REF. As such, an addendum to the Bowral STP Upgrade REF for the replacement of the incoming main is being prepared by PWA on behalf of WSC.

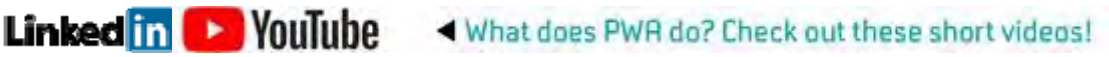
The purpose of the attached letter is to notify the Department of Primary Industries Fisheries of the proposed works and to provide the opportunity to comment on any matters that your organisation would like to see addressed in the REF Addendum for the replacement of the incoming main.

Regards,

Michelle Moodley
Environmental Scientist | Environment and Planning

Public Works Advisory | Department of Regional NSW
T 02 8276 8893 | **E** michelle.moodley@finance.nsw.gov.au
Level 2, 66 Harrington Street, The Rocks NSW 2000

publicworksadvisory.nsw.gov.au | www.regional.nsw.gov.au



The Department of Regional New South Wales acknowledges that it stands on Country which always was and always will be Aboriginal land. We acknowledge the Traditional Custodians of the land and waters, and we show our respect for Elders past, present and emerging. We are committed to providing places in which Aboriginal people are included socially, culturally and economically through thoughtful and collaborative approaches to our work.

Kristen Parmeter

From: Miles Ellis <Miles.Ellis@waternsw.com.au>
Sent: Wednesday, 17 March 2021 9:36 AM
To: Michelle Moodley
Cc: Liz Mathieson; Girja Sharma
Subject: RE: Bowral Sewage Treatment Plant Augmentation Replacement of Incoming Sewage Main – Review of Environmental Factors Addendum

Dear Ms Moodley,

WaterNSW has reviewed the scoping letter provided by Public Works Advisory for the additional/replacement sewerage main upgrade works required as part of the proposed upgrade of the Bowral Sewage Treatment Plant. Regarding the sewer main replacement works, Water NSW requests that the risks of an above ground crossing of Mittagong Creek be assessed in the Addendum REF including:

- spillage of any raw sewage into Mittagong Creek from leaks in the pipe
- any potential damage to the pipe during flooding events from debris in Mittagong Creek
- potential for flooding of the effluent management ponds in the STP from flooding caused by debris being trapped on the pipe creating unpredictable streamflow pathways during flood events.
- consideration of alternative design options including under-boring or trenching of the sewer main across Mittagong Creek.

Regards,

Miles Ellis
Catchment Assessments Officer

WaterNSW

Level 14, 169 Macquarie St.
Parramatta NSW 2150
PO Box 398
Parramatta NSW 2124
M: 0439 445 914
miles.ellis@waternsw.com.au
www.waternsw.com.au

From: Michelle Moodley <Michelle.Moodley@finance.nsw.gov.au>
Sent: Wednesday, 10 March 2021 11:38 PM
To: Girja Sharma <Girja.Sharma@waternsw.com.au>
Cc: Liz Mathieson <Liz.Mathieson@finance.nsw.gov.au>
Subject: Bowral Sewage Treatment Plant Augmentation Replacement of Incoming Sewage Main – Review of Environmental Factors Addendum

Dear Girja,

As you are aware, a Review of Environmental Factors (REF) is currently being prepared by Public Works Advisory (PWA) on behalf of Wingecarribee Shire Council (WSC) for the upgrade and augmentation of the existing Bowral Sewage Treatment Plant (STP) located at Burradoo Road, Burradoo NSW.

WSC are now proposing the replacement of the incoming sewage main located upstream of the sewage treatment plant, which was not assessed in the drafting of the Bowral STP Upgrade REF. As such, an addendum to the Bowral STP Upgrade REF for the replacement of the incoming main is being prepared by PWA on behalf of WSC.

The purpose of the attached letter is to notify WaterNSW of the proposed works and to provide the opportunity to comment on any matters that your organisation would like to see addressed in the REF Addendum for the replacement of the incoming main.

Regards,

Michelle Moodley
Environmental Scientist | Environment and Planning

Public Works Advisory | Department of Regional NSW
T 02 8276 8893 | **E** michelle.moodley@finance.nsw.gov.au
Level 2, 66 Harrington Street, The Rocks NSW 2000

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