Guidelines for Development Adjacent to the Upper Canal and Warragamba Pipelines

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WaterNSW

WaterNSW is the State-owned corporation responsible for managing bulk water supply, including management of the Upper Canal and Warragamba Pipelines critical water supply infrastructure. WaterNSW also acts to protect Greater Sydney's drinking water catchment through protecting the quality of the water supply.

More information about WaterNSW is at www.waternsw.com.au.

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Glossary and Acronyms

Term	Definition
Activity	Same meaning as in Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act)
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage.
Consent authority	The council, government agency or person having the function to determine a development application for land use under Division 4.2 of the EP&A Act.
Controlled areas	means an area of land for the time being declared under the *Water NSW Act 2014 to be a Controlled Area.* Areas declared include the Upper Canal and Warragamba Pipelines corridors and associated infrastructure owned by or vested in WaterNSW.
Determining authority	means a Minister or public authority and, in relation to any activity, means the Minister or public authority by or on whose behalf the activity is or is to be carried out or any Minister or public authority whose approval is required in order to enable the activity to be carried out (EP&A Act).
Development	Same meaning as in section 1.5 of the EP&A Act
EP&A Act	Environmental Planning and Assessment Act
Frac-out	A release of drill slurry at a fracture zone which has occurred on the surface through the building up of pressure in the borehole.
LGA	Local Government Area
Upper Canal	The water supply canal that runs from the Upper Nepean to Prospect Reservoir and includes the canal, aqueducts, tunnels, associated infrastructure and the surrounding corridor (curtilage to curtilage).
Warragamba Pipelines	The water supply pipelines, which run from Warragamba Dam to Prospect Reservoir, including the pipes, associated infrastructure and the surrounding corridor.

1. Introduction & Background

1.1 About WaterNSW

WaterNSW is the State-owned corporation responsible for managing bulk water supply, including management of the Upper Canal and Warragamba Pipelines critical water supply infrastructure. Protection and maintenance of this infrastructure is essential to ensure the supply of drinking water to people in Greater Sydney and surrounding regions.

The *Water NSW Act 2014* (the Act) and associated Water NSW Regulation 2013 include controls, restrictions and penalties designed to protect the water supply infrastructure and drinking water quality from pollution, damage, unauthorised entry or other unauthorised activities.

1.2 WaterNSW Controlled Areas

The Upper Canal and Warragamba Pipelines infrastructure and corridors are classified as 'Controlled Areas' under the Act. These areas are located in south west and western Sydney.

Upper Canal

- The Upper Canal begins at Pheasants Nest Weir on the Nepean River and transfers water 64 kilometres from the Upper Nepean Dams to the Prospect water filtration plant. The Canal corridor traverses the Wollondilly, Campbelltown, Camden, Liverpool and Fairfield local government areas (LGAs).
- The Upper Canal corridor should be referred to consistently throughout any documents (in the text as well as all figures and tables) as the 'WaterNSW Upper Canal'.

Warragamba Pipelines

- The Warragamba Pipelines transfer water from Warragamba Dam to the Prospect water filtration plant traversing the Wollondilly, Penrith, Fairfield and Blacktown LGAs.
- The Warragamba Pipelines corridor should consistently be referred to throughout documents (in the text as well as all figures etc) as the 'Warragamba to Prospect Water Supply Pipelines'.

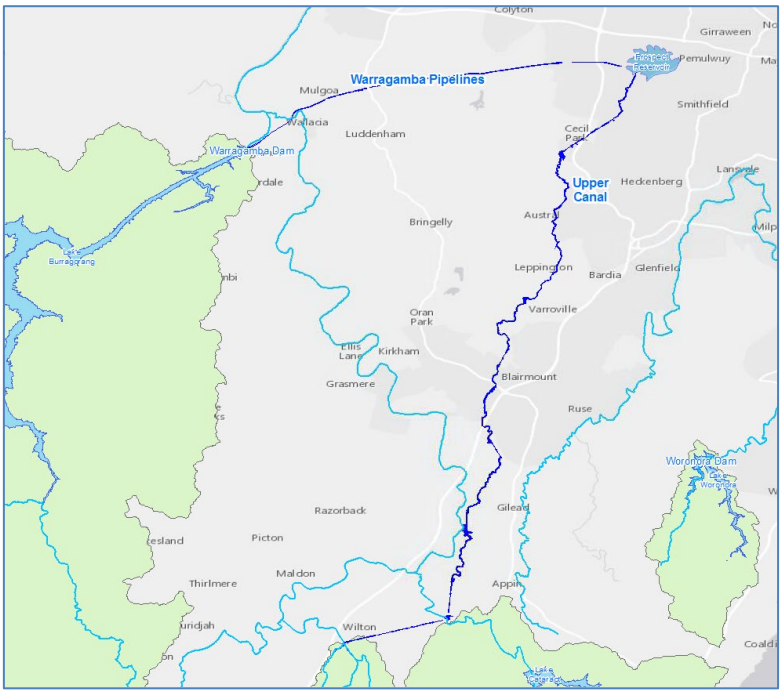


Figure 1 - Location of the Upper Canal and Warragamba Pipelines

1.3 Asset Information - about the Warragamba Pipelines and Upper Canal

The average width of the Upper Canal and Warragamba Pipelines corridors is 40 metres, but in some locations can vary between 20 and 80 metres. The infrastructure within the corridors lies both above and underground. GIS shape-files of the corridors are available on request to assist authorities and proponents identify the corridor boundaries.

The Warragamba Pipelines form the most crucial pieces of water supply infrastructure carrying water from Warragamba Dam to Prospect Water Filtration Plant. The two pipelines that originate at the valve house at Warragamba are the primary method of water release from Warragamba Dam. Of the two pipelines, one is 2.1 metres in diameter, the other 3 metres in diameter. Construction of the smaller pipeline was completed in 1954, while the large pipeline was completed in 1969. Each of the pipelines is 27 kilometres long and combined can transport 2,600 megalitres of water a day, providing on average 80% of Sydney's water supply.

The Upper Canal, constructed in the 1880s, is a precise piece of engineering and is still the only way of transferring water to Sydney from the four Upper Nepean Dams (Cataract, Cordeaux, Avon and Nepean), supplying on average 20% of Sydney's water supply. The Canal is 64km in length comprising of tunnels (19km), aqueducts (1km) and open water channel (44km). The Canal is built from a variety of materials, depending on the nature of the landscape it passes through. Where the ground is soft, the Canal is trapezoidal in shape and the sides lined with unreinforced concrete slabs. In other sections, the Canal is u-shaped and the sides are lined with sandstone masonry. Where the Canal is cut into solid rock, it is unlined.

Figure 2 - The Upper Canal runs above and below ground

Figure 3 - The Warragamba Pipelines extending underground to run under a road

1.4 Purpose of the Guidelines

The potential for impacts on the Controlled Areas and associated infrastructure is likely to increase as the surrounding land becomes more urbanised. A reduction in natural vegetation buffers and an increase in hard surfaces, traffic, population and other consequences associated with urbanisation will increase the potential for contamination, damage and unauthorised entry to occur.

These guidelines have been prepared for use by planning and consent authorities and proponents for development activities on land adjacent to or within the Upper Canal and Warragamba Pipelines corridors. The guidelines offer a range of solutions or options that are based on risk management principles.

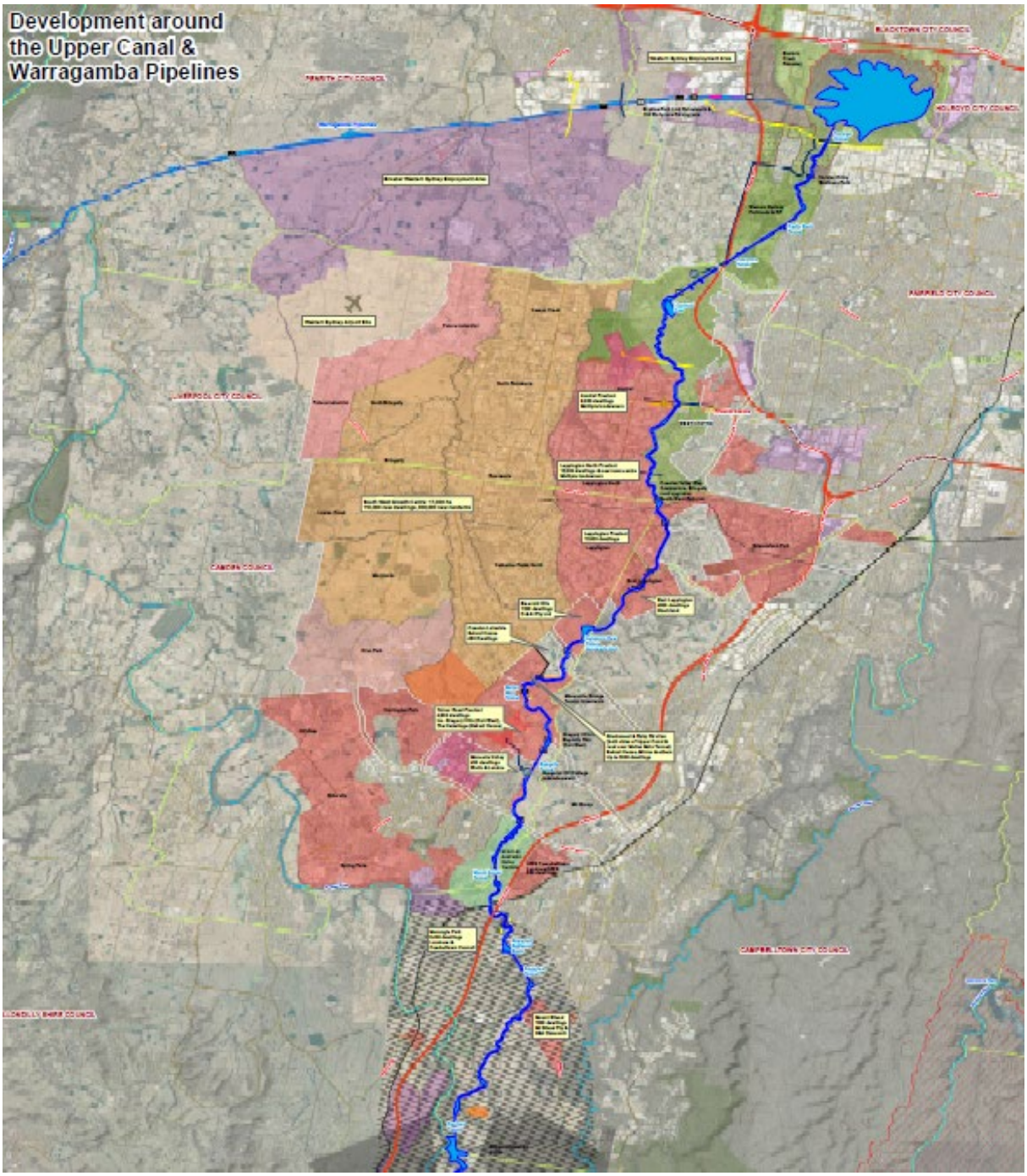


Figure 4 - Summary of development, urban release and employment areas along the Warragamba Pipelines and Upper Canal Controlled Areas

1.5 Guiding principles

Guiding Principles (Appendix 1) have been adopted by WaterNSW when considering development proposals adjacent to or within the Controlled Areas.

WaterNSW review proposed developments and activities adjacent to or within the Controlled Areas to ensure:

- the protection of water quality and WaterNSW infrastructure
- the continued safe operation and maintenance of the Upper Canal and Warragamba Pipelines, and
- the future needs of Sydney's drinking water supply are considered, including construction of new water supply infrastructure or augmentation of existing.

The key factors for WaterNSW with regards to any works or development adjacent to or within the Upper Canal and Warragamba Pipelines Corridors are:

- no adverse impact on water quality within the open waters of the Upper Canal at any stage of the development
- no increase in groundwater or surface water flows into or across the corridors or the creation of any impediments to existing flow
- demonstrated avoidance of damage to the water supply infrastructure, including the stormwater structures currently serving the corridors
- no accelerated degradation is to occur to the water supply infrastructure due to the interaction of the new development with the existing assets
- 24-hour all-weather access to the corridors must be retained or provided for WaterNSW staff and contractors
- no public entry into the Controlled Areas at any time for security and safety purposes is permitted. If access is required by the proponent and/or their contractors for any purpose during the development process, the Consent of WaterNSW will be required
- the heritage values of the State Heritage listed Upper Canal must be taken into consideration and protected at all stages of the development.

Figure 5- The Warragamba Pipelines traversing the Western Sydney Employment Area (2018)

1.5.1 Neutral or beneficial impact on water quality

A consent authority must not grant consent to any land in the Western Sydney Parklands unless the consent authority is satisfied that development will have a neutral or beneficial impact on the quality of the water in the bulk water supply infrastructure *(clause 13 - State Environmental Planning Policy (Western Sydney Parklands) 2009*). This clause is relevant as the Upper Canal is bulk water supply infrastructure.

For the remainder of the Upper Canal and the length of the Warragamba Pipelines, development proposals should not result in an adverse impact on water quality flowing onto or within the Controlled Areas.

WaterNSW advocates for demonstrated improvement to water quality for the Controlled Areas.

1.5.2 Adverse impacts from increases in water quantity

Developments that increase drainage, ground water, flood levels and velocity into or through WaterNSW land will be rejected, due to the amplified risk of failure to WaterNSW assets and infrastructure.

WaterNSW requires that post-development flows that *enter or are conveyed across* the Warragamba Pipelines or Upper Canal corridors must be equal to or less than the pre-development flows and velocity for each storm event up to and including the 1% AEP event.

1.6 Consultation with WaterNSW

It is recommended that consultation with WaterNSW occur as early as possible for any planning or development proposal potentially affecting the infrastructure corridors. Consultation will ensure key issues relevant to particular locations are identified for the information of the proponent or authority and assist in any Access Consent application from WaterNSW (see Section 2.1 for more information on Consents).

Prior to determination, WaterNSW should be provided with the opportunity to review and comment on all development applications adjacent to and/or otherwise affecting Controlled Area lands, assets or infrastructure. WaterNSW expects the consent authority to address any comments and to include requested conditions in the development consent (unless otherwise agreed by WaterNSW).

All contact should be made using the email address:
Environmental.Assessments@waternsw.com.au

Figure 6 - New suburbs under development near the Upper Canal (2018)

2. Issues to be considered

WaterNSW recommends planning and consent authorities and proponents address the issues discussed in this Section when planning, designing or assessing a proposal adjacent to or within the Controlled Area corridors.

Any proposal to construct or upgrade infrastructure within, adjacent to, or crossing the Controlled Areas should address these issues to the satisfaction of WaterNSW and as a minimum comply with WaterNSW standards and policies.

Appendix 2 provides an outline of the potential risk to the Controlled Areas and WaterNSW's preference for documentation to be included with any project for review.

2.1 Entry to controlled areas

2.1.1 WaterNSW Consent

Under the *Water NSW Act 2014*, entry to the Upper Canal and Warragamba Pipelines corridors is strictly prohibited for security and safety reasons, except when permitted through the written Consent of WaterNSW.

Proponents of development and associated infrastructure and services may need to apply for written Consent from WaterNSW for entry to the corridors for the purpose of inspections, surveys, and assessments.

Where entry is required for site inspections only, the written Consent of WaterNSW is not required providing the proponent or authority is escorted by WaterNSW personnel at all times.

WaterNSW consent is required for carrying out any construction or other works within the corridors. This can be applied for at the same time as any lease, licence or easement required for that purpose (see below for further information).

When applying for consent, the proponent must follow the consent application process, which includes submitting an on-line application covering the assessment and/or construction periods. The application form can be found on WaterNSW's website.

Consider contacting WaterNSW before submitting a Consent Application

https://www.waternsw.com.au/water-quality/catchment/manage/special-areas/access

A Consent Application may take up to 28 days to process, depending on the completeness of information supplied with the application. The minimum information that will need to be supplied with a Consent Application for various works and activities includes:

- a detailed map or description of the location
- a copy of any relevant approvals issued under the EP& A Act
- a Safe Work Plan specific to the type of activity and location – with task methodology, risk assessments, and safe work method statements, including references or include the Review of Environmental Factors (REF) or Ready Reckoner Checklist (RRC) for the activity, if relevant
- a Certificate of Currency in relation to public liability insurance (minimum $20 million).

Allowance should be made for processing time when calculating the proposed first date of entry on the application form. If the application is incomplete or more information is needed, then the assessment period will start from the time all required information is received (note that the application may be refused if the information is not received).

Additionally, unless consent is obtained, the Controlled Area corridors are not permitted to be used to access adjacent development sites, store materials or equipment, or for maintenance activities post-development.

Apply for Consent at least 28 days before entry is planned.

Make sure all relevant supporting information is attached.

Receipt of the consent application will be acknowledged by email and the determination will be given in writing. If the application is successful, the Consent will include conditions of entry that will need to be satisfied throughout the period of the Consent.

Not complying with any conditions may be an offence under the *Water NSW Act 2014* or Water NSW Regulation 2013 and may even result in a breach of the *Protection of the Environment Operations Act 1997*, and associated regulations. WaterNSW can also revoke or modify the Consent at any time.

2.1.2 Inductions

Every person who enters a Controlled Area must complete a WaterNSW induction prior to entry, unless escorted by WaterNSW personnel. The on-site supervisor must have in their possession a copy of the Consent, any environmental assessments, Statutory Approvals and associated Conditions of Approval, any related environmental management plan, the Safe Work Plan and a copy of all licences, permits and other approvals that are required in relation to the activities within the Controlled Area.

WaterNSW also recommends that contractors include a separate item in their own site induction process to acknowledge the importance of and special requirements when working within or adjacent to the Controlled Area corridors.

2.1.3 Leases, licences and easements

For any development that proposes new permanent infrastructure such as road, pedestrian or service crossings in the Controlled Areas, the applicant must enter into a separate lease, licence, or other formal property agreement with WaterNSW.

Proponents should contact the Lands Administration team at WaterNSW to discuss arrangements at the same time as applying for Consent.

2.1.4 Maintaining access for WaterNSW staff and contractors

WaterNSW and their contractors require safe 24-hour vehicular access into and along the land corridor on both sides of the Upper Canal and Warragamba Pipelines for operational, security and emergency purposes. Operational and security vehicles, including trucks with trailers and tractors with implements also need to be able to safely cross public arterial roads from one section of a Controlled Area to another.

Any works either within or outside the Controlled Areas are required to be designed, constructed and operated in a manner that does not prevent or impede WaterNSW or WaterNSW contractors from accessing, maintaining and operating the infrastructure and associated corridors. This includes:

- not restricting vehicular or machinery access to or along the existing management roadways within the corridors
- not impeding heavy vehicle and plant machinery from undertaking future upgrades/ refurbishment/replacement works proposed by WaterNSW
- ensuring allowance for transporting large sections of pipe during removal and installation
- ensuring load ratings, approach angles of roads and bridge heights accommodate access for future construction activities

- guaranteeing exit and entry points are designed in compliance with Austroads and Roads and Maritime Services (RMS) guides, technical directions and specifications, and WaterNSW requirements
- ensuring all vehicle types can safely enter/ exit WaterNSW property, including pulling off safely from public roads with adequate room to open or close gates.

Figure 7 - Heavy vehicle access into the Controlled Areas is often required to carry out repair and maintenance work

WaterNSW should be consulted early in the planning and development process for each individual site to determine, to the satisfaction of WaterNSW, the access routes and entry/exit gates and guardrails that will be maintained or provided for WaterNSW to carry out its business in a safe and efficient manner.

Figure 8 - Entry / exit point at Mamre Road

2.2 Security and public safety

The public is prohibited from entering the Controlled Areas for safety reasons and to ensure a continuous supply of uncontaminated drinking water.

Open parts of the Upper Canal present a danger to people and animals should they fall or jump into the Canal waters. The sides on many sections are steep, and the fast-flowing water can trap them with no easy way to climb out. The possibility of drowning is real.

Other adverse incidents such as rubbish dumping, vandalism, arson and threats to WaterNSW staff or contractors are all issues that can arise if the public is not adequately excluded from both the Upper Canal and Warragamba Pipeline corridors. As a priority, WaterNSW requires corridor security be maintained from trespassers and public dumping during construction works.

2.2.1 Fencing

The current fencing along the Controlled Area corridors is a mix of rural fencing, chain-link fencing, 358 mesh and palisade fencing.

For any new adjacent development where the use of the land is being intensified, WaterNSW requires appropriate, secure fencing to be constructed, as identified below, complying with WaterNSW's "*Barriers, Fences and Gates – Installation and Maintenance Manual*" (WaterNSW reference CD2011/547) and fencing specifications.

Any fencing should be erected by the developer at their own cost, to replace any existing fencing that is of a lesser security standard e.g. rural-styled fencing in undeveloped areas.

Figure 9 - Rural fencing

Figure 10 - '358' fencing

Figure 11- Chain-link fencing along the Controlled Area corridors

Figure 12 - Palisade fencing

WaterNSW's preferred standard of fencing along the corridors is dependent upon the proposed land uses as this has implications for risk. Generally, the following standards apply:

- 358 fencing to a minimum height of 2.4 metres – where the adjacent land use is of the following types: early education and care facility, educational establishment, community facility, hospital, recreation area, recreation facility, or
- 2.1 metre chain-link wire fencing topped with three barbed wire strands for a total height of 2.4 metres – where the adjacent land use is residential, commercial, retail or industrial.
- 2.1 metre (minimum) prefabricated palisade fencing, comprising hot-dipped galvanised posts, pales and rails. Fence and gate shall be robust, secure and vandal proof – on request.

WaterNSW has the following fencing requirements:

- fencing must be installed in a manner that does not leave any 'gaps' between the new fence and any existing fencing on adjoining properties, regardless of the fencing types on both sites
- temporary construction fencing of sufficient standard to prevent entry onto WaterNSW land is acceptable and must also be installed within the development site boundary to maintain security until permanent fencing is erected
- fencing must be installed prior to the occupation of any new adjacent developments or earlier if security is likely to be compromised

- any existing fencing being replaced must be removed and disposed of at a waste management facility licensed to accept the waste
- any new or upgraded road or pedestrian bridge – including approaches – across the Controlled Areas should be adequately fenced
- fencing must minimise the likelihood of vehicles entering the corridor in the event of a traffic accident. Where required, the fencing must be supplemented with barriers to the appropriate standard capable of restraining a B-Double truck
- fencing and screens must be constructed to restrict items being thrown into the corridor from the roadway or pedestrian overpass. In these instances, WaterNSW prefer the screens to be constructed of anti-climbing mesh and cranked at the top towards the overpass.

With prior written agreement of WaterNSW, alternative fencing standards may be acceptable providing the risk of entry is not greater than that achieved by the above standards.

Proponents and authorities must discuss security and fencing requirements with WaterNSW on a site by site basis, including the potential requirement for signage and approval from Heritage NSW.

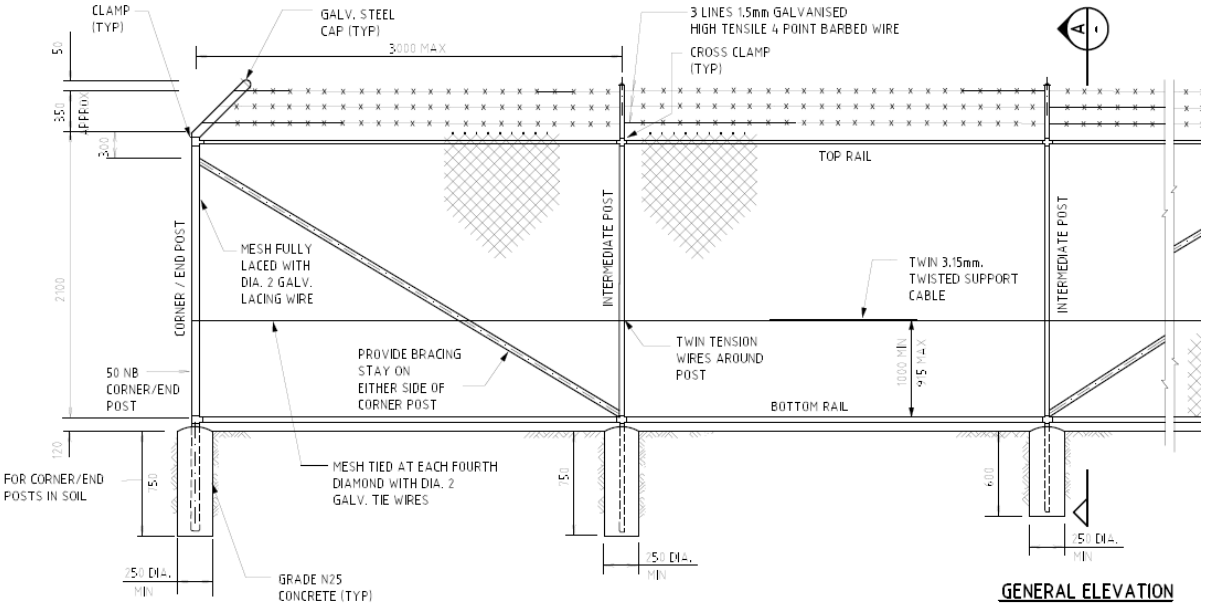


Figure 13 - Chain link fence drawing (WaterNSW ref: PL2019/264)

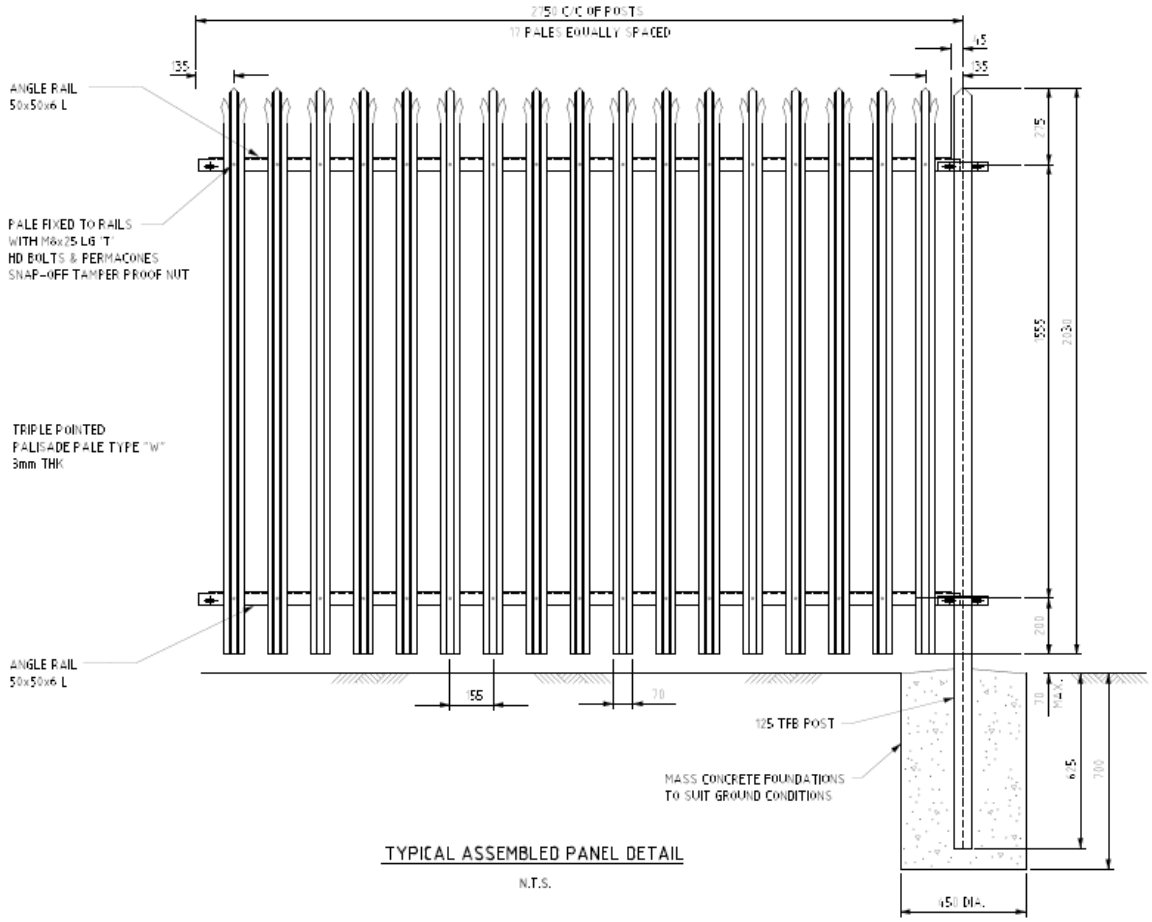


Figure 14 - Palisade fence drawing (WaterNSW ref: PL2019/254)

2.3 Road and pedestrian crossings

For proposals involving road, pedestrian or any other service or infrastructure crossing Controlled Area corridors, you must first consult with WaterNSW

There are many existing vehicular and pedestrian crossings across the Controlled Area corridors providing connections between both public and private land on either side. Some crossings are not open for use by the public, some have been built at grade, while others are overpasses.

Every new or upgraded public crossing of the Controlled Area corridors increases the potential for adverse impacts on the water supply infrastructure. Where new crossings of the corridors are essential (e.g. to connect two sides of a development precinct) WaterNSW directs proponents and authorities to plan and design them where existing crossings are already located.

For the Upper Canal, which is open for most of its length, the construction or upgrade of bridges for vehicle or pedestrian access introduces the risk of pollutants and other foreign materials such as litter entering the Canal, while even small changes to the ground conditions can damage the fragile structure.

Where crossings are considered essential infrastructure, WaterNSW has the following requirements:

- all new infrastructure (including footings, inspection pits and piles) to be located outside the WaterNSW corridor

- safe 24-hour access to all parts of the Controlled Area corridors for WaterNSW management and maintenance activities both during construction of the new development and operation of the infrastructure
- where practicable, WaterNSW prefers each new crossing to be an overpass of sufficient height that allows continuous access along and within the corridors for all vehicles
- road or pedestrian crossings must comply with relevant design standards and enable staff and contractor vehicles to directly and safely exit or enter the corridor. Load ratings and approach angles of crossings need to accommodate WaterNSW vehicles and allow for construction and maintenance activities. See also Section 2.2.1 for fencing and barrier requirements
- land beneath at-grade crossings should be paved or concreted to prevent soil erosion and should allow for suitable pedestrian access to enable visual inspections and maintenance of the corridor and structure e.g. bridge bearings
- appropriate drainage installed to prevent additional surface run-off and ground water from entering the Upper Canal and Warragamba Pipelines corridors
- a licence, lease or easement is also required from WaterNSW for any permanent structures proposed crossing Controlled Area corridors. This will include a standard market value annual fee
- geotechnical, engineering and other assessments must demonstrate that the structural integrity of WaterNSW infrastructure is maintained, risk has been assessed, that adequate stormwater and drainage controls are in place, and that construction impacts are identified. See Section 2.4 on Construction Risks for further detail.

Proponents and authorities are advised to discuss road and pedestrian requirements with WaterNSW on a site by site basis, including the potential requirement for signage and approval from Heritage NSW.

Figure 15 – Example of land treatment beneath bridge crossing – near Kenny Hill Depot

Figure 16 - Pedestrian overpass in Western Sydney Parklands

Figure 17 - The Hume Highway crossing the Upper Canal at Menangle Park

2.4 Construction risks

The site preparation and construction phase of a development can pose particular risks to the infrastructure of the Upper Canal and Warragamba Pipelines. Issues include vibration, erosion and sedimentation, stormwater impacts, damage to heritage items, contamination, windblown rubbish and illegal storage of construction materials on WaterNSW land.

As critical components of Sydney's water supply system, a proponent must ensure the Upper Canal and Warragamba Pipelines, including all support structures, are adequately protected from damage during construction within, under or adjacent to the Controlled Area corridor. Any damage that does occur to water supply infrastructure or land in the corridors, as a result of development or activities on adjoining land, will be the responsibility of the developer or builder to rectify to the satisfaction of WaterNSW.

2.4.1 Excavation

Excavation is the process of moving earth, rock or other materials with tools, equipment or explosives and includes earthworks, trenching, wall shafts, bore holes and tunnelling. Specific attention must be exercised when excavating near the Upper Canal or Warragamba Pipelines or any supporting structures and infrastructure to avoid disturbance or damage. Any construction work carried out within five (5) metres of the Canal or Pipelines is considered 'high risk' and WaterNSW will require additional justification that the risk profile will not increase, and sufficient controls or exclusions applied.

Particular care must be exercised when undertaking works to protect the stability of earth embankments within the corridors and vice versa to protect the infrastructure within the corridors from earth embankment works.

WaterNSW requirements:

- unobstructed access to all existing embankments for ongoing maintenance
- keep all plant 1 metre minimum from the crest of an embankment

No excavation is to be made within a five-metre buffer of the Warragamba Pipelines or Upper Canal without prior engineering analysis of the structural stability and effects excavation accepted by WaterNSW

Figure 18 - Embankment slippage along the Warragamba Pipelines Corridor

Depending on the nature of the proposed work, WaterNSW may require an assessment to be undertaken of the geotechnical conditions and the materials in which construction or directional drilling is proposed.

The geotechnical investigation must consider the effect of the proposed installation on WaterNSW's water supply infrastructure and must be undertaken by a qualified geotechnical engineer.

The geotechnical investigation report must include (but not be restricted to) the following:

- boreholes or test pits at entry and exit points to a minimum depth of 1,000mm below the base of the proposed excavation entry/exit points
- site description and results of investigation
- groundwater levels

  note: the Upper Canal leaks at an unknown rate, potentially recharging the groundwater and changing the level of groundwater close to the Canal structure
- an accurately surveyed cross-section along the alignment showing current ground surface, water infrastructure levels/positions, position of proposed bore line, any existing underground services, borehole or test pit information and correlation lines of subsurface layers between boreholes or test pits, and any other relevant information
- prediction of possible ground subsidence during the directional drilling and installation of any pipeline and/or casing, especially if non-cohesive soils are present

  note: due to its age, the Upper Canal structure poses a higher risk of collapse from changed conditions. WaterNSW cannot accept <u>any</u> settlement without justification that the risk profile will not increase
- recommendation for the most suitable installation method
- recommendation and justification for the minimum cover between the base of the Pipelines and/or the invert level of the Upper Canal from the proposed installation
- provision of suitable control measures to demonstrate no change to the risk profile will result from the works
- an assessment as to whether a geotechnical engineer should be in attendance during construction to monitor any suspect ground conditions and ground movement.

There have been incidents of frac-out causing damage and contamination of the Upper Canal from horizontal directional drilling activities. As such WaterNSW will only accept the use of drilling fluids when the Upper Canal is dewatered under a planned outage. Any damage under any circumstance will be the responsibility of the developer or builder to rectify to the satisfaction of WaterNSW.

Drilling fluids/muds must not be used during any horizontal drilling when the Upper Canal is in operation. Drilling using fluids/muds may be undertaken, with prior approval from WaterNSW, during an Upper Canal outage when the Canal is dewatered.

Figure 19 - Reconstruction of Upper Canal wall collapse (2008)

2.4.2 Underground pipelines and services

- Carrier and encasing pipes – All underground pipelines must be designed and constructed to withstand heavy road vehicle loads. In general, the need for an encasing pipe for underground pipelines will be assessed on a case by case basis. Encasing pipes shall be provided for all pipelines conveying high voltage cables, pressure pipelines and pipelines carrying combustible liquids and flammable fluids.
- Electrical installations – Any electrical installation must not increase the risk of Earth potential rise (EPR) and step and touch potentials on any metallic structures. Future WaterNSW excavation and construction works must not be impeded by earthing grids of electrical infrastructure from external development.
- Service pits – Wherever possible all pits, inspection points and access chambers for non-water supply services shall be located outside WaterNSW land. Any pits within WaterNSW corridors shall be designed for heavy road vehicle loads. The minimum pit class must be Class D.
- Isolation – Consideration must be given to installing two isolating valves either side of the WaterNSW boundary on pressure pipelines and pipelines carrying combustible liquids and flammable fluids to isolate the main in the event of a leak or rupture or if WaterNSW needs to undertake significant work within the corridor.

2.4.3 Load bearing

Not all sections of the Canal or Pipelines that are underground are able to bear loads e.g. there are some Upper Canal tunnels that can bear loads, but others need to be spanned.

Any buried footing, piles or load supporting member shall not induce load onto the Upper Canal walls and slab or Pipelines infrastructure. In some cases this may require sleeving the component to isolate it from the surrounding soil.

2.4.4 Suspended loads

WaterNSW heavily restricts suspended loads being conveyed over the Canal and Pipelines corridors. The use of cranes adjacent to the corridors must mitigate the potential to damage the Canal or Pipelines from dropping loads or crane failure.

2.4.5 Vibration

Vibration impacts from construction activities such as jackhammering, pile driving or earthmoving may cause indirect damage to WaterNSW lands, assets or infrastructure. The Upper Canal is particularly structurally fragile due to its age and the Warragamba Pipelines are fragile due to their inner concrete lining, footings and expansion joints.

At present, no Australian Standards exist for the assessment of damage caused by vibration. WaterNSW accepts Line 3 of Table 3 from the current *German Standard DIN 4150 – Part 3 - "Structural Vibration Part 3: Effects of vibration in structures"* as the maximum allowable limit of vibration acceptable at WaterNSW assets.

WaterNSW requires:

- all proposals to confirm velocity limits for the proposed activity and the impact the works will have on WaterNSW assets
- excavation methods (including rock breaking) that must not trigger the maximum allowable limits set within the Standard when measured at WaterNSW assets
- vibration monitoring prior to and during construction for high risk construction projects
- vibration monitoring reports to be provided to WaterNSW.

The German Standard DIN 4150-3:2016 'Structural Vibration Part 3: Effects of Vibration in Structures' should be used to assess vibration effects. The guideline vibration velocity levels to be adopted for WaterNSW structural assets are those listed in line 3 of Table 1.

2.4.6 Incident notification

WaterNSW requires notification of any health, safety or environmental incident minor or major, e.g. contact with, accident, spill, leak, rupture or fire within or potentially affecting the Controlled Areas. All incidents must be reported on the WaterNSW Incident Notification Number 1800 061 069 (24-hour service).

Report all incidents to WaterNSW on 1800 061 069

2.5 Stormwater Management

Management of stormwater during and after the construction of new development sites adjacent to the Upper Canal and Warragamba Pipelines corridors should be a major consideration for proponents and consent authorities.

WaterNSW requires that post development stormwater flows that enter the Controlled Areas, or are to be conveyed across or under the Upper Canal or Warragamba Pipelines, must be equal to or less than the pre-development flows for each storm up to and including the 1% AEP event. Adequate provision must be allowed downstream of the corridor to allow free drainage.

Existing controls within the corridors were designed to deal with runoff from rural land. For example, the Upper Canal is currently protected by a system of surface drains, flumes and stormwater culverts that prevent the flow of stormwater into the Canal.

A consequence of urban development from a predominantly rural landscape is an increase to impervious area. Without adequate controls in place, stormwater flowing in increased volume and velocity could enter the corridors, overloading the existing drainage system resulting in erosion, flooding, water pollution and damage to infrastructure through scouring (eroding the soil) and undermining, potentially leading to collapse or failure. It is important that bulk earthworks are designed and undertaken in a manner that does not increase or impede surface water and groundwater draining to and from the Upper Canal and Pipeline corridors.

Any development or construction activity and related works must be designed, constructed and operated in such a way that does not increase stormwater flows into the Controlled Area corridors.

WaterNSW requirements:

- works must be designed so that post-development stormwater flows are no greater than pre-development stormwater flows for all storm events up to and including the 1% AEP storm
- any development downstream or downslope from a Controlled Area corridor must not impede the flow of stormwater
- MUSIC modelling to be undertaken, as part of the preparation of a stormwater management plan, for all development proposals greater than 2,500m^2 adjacent to a Controlled Area.

Specifically, drainage systems shall:

- direct run-off away from the Controlled Area corridors to avoid overloading existing stormwater systems
- inhibit surface water from coming in contact with bulk water in the Upper Canal as:
  - it may contain chemical and pathogen contaminants
  - backflow will also increase turbidity and Total Suspended Solids (TSS) within the Upper Canal that is detrimental to drinking water quality.

WaterNSW occasionally dewaters the Upper Canal and Warragamba Pipelines during shutdown periods and these flows are directed into existing downstream drainage systems, known as scour valves. Specifically:

- developments must be capable of accommodating the extra water with an allowance of an additional 25% dewatering flow accommodated for from possible future augmentation of the Pipeline.

Consult with WaterNSW early in the concept and design stage of the new proposal to discuss how stormwater from the development will be managed to prevent additional impacts on the Controlled Area corridors.

Figure 20 – Examples of Upper Canal drainage systems (left – culvert, right – steel box flume)

On request, WaterNSW can provide maps showing the location of its stormwater and scour systems along the Controlled Area corridors.

2.6 Erosion and sediment control

The risk of eroded sediment being carried downslope into the Controlled Area corridors from adjacent development sites is of concern to WaterNSW and must be managed. The highest risk will be during the construction phase when the removal of vegetation and disturbance of groundcover in the currently predominately rural areas exposes the soil and increases the risk of erosion.

Developers and builders working on subdivision or major development sites adjacent to the corridors should adopt and demonstrate the practices and controls detailed in 'Managing Urban Stormwater: Soils and Construction' (Blue Book Vol.1 – Landcom, 2004 and Blue Book Vol. 2 – DECC, 2008).

WaterNSW requirements:

- an Erosion and Sediment Control Plan (ESCP) or Soil and Water Management Plan (SWMP) to be prepared in accordance with the Blue Book. The ESCP or SWMP should clearly identify how sediment will be prevented from blocking or entering the adjacent corridors
- adequate and effective erosion and sediment controls to be in place before construction and site preparation work begins to prevent soil, sand, gravel or other construction site material impacting on the corridors
- erosion and sediment controls to be checked and maintained on a regular basis and after every rainfall event to ensure they are working properly. The controls should not be removed until the site is stabilised, and no exposed soil or other material remains
- cut and fill activities in the vicinity of the Upper Canal should be avoided or minimised, due to the potential damage such works could have on the Canal.

Figure 21 - Erosion control at works adjacent to the Upper Canal

2.7 Heritage

The Upper Canal is listed as the 'Upper Canal System' on the State Heritage Register under the *NSW Heritage Act 1977* (Heritage Act). The listing includes the entire length and area of the Upper Canal corridor as well as related water supply components and drainage features such as flumes and culverts.

It is important to note that the entire Upper Canal corridor is heritage listed from boundary to boundary (including the rural fencing), not just the Canal structure alone. A useful reference prepared by the Government Architect's Office is the *Upper Canal Pheasants Nest to Prospect Reservoir Conservation Management Plan, 2016*.

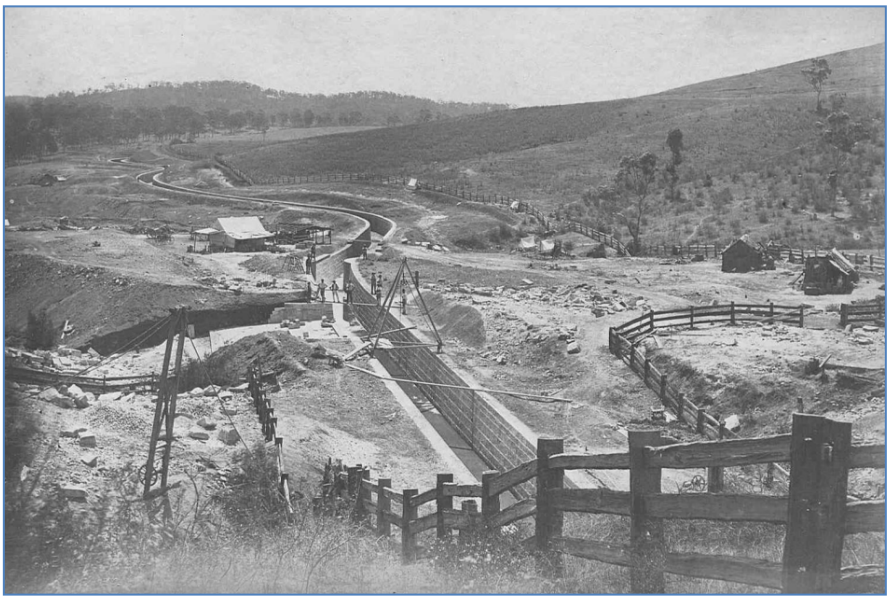


Figure 22 – The Upper Canal during construction in the 1880s north of Sugarloaf Hill

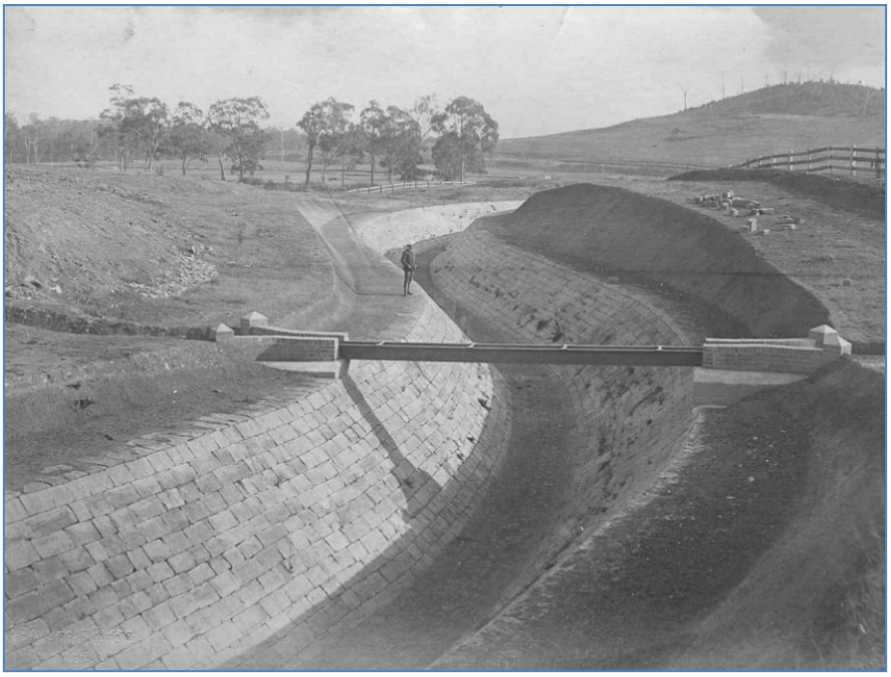


Figure 23 - The Upper Canal during construction in the 1880s south of Narellan Road

The Warragamba Pipelines have been assessed as having State heritage significance but are not listed on the State Heritage Register.

The State Heritage Database, managed by Heritage NSW, also provides detailed information and maps showing the heritage curtilage of the Upper Canal System. The information can be found on the NSW heritage website: (www.heritage.nsw.gov.au).

WaterNSW requirements:

- all activities or work undertaken adjacent to the Upper Canal corridor heritage precinct shall be carried out in a manner that will protect the fabric of the heritage item from damage or interference
- heritage impacts are to be considered and addressed, including an unexpected finds protocol.

Further detailed information on the heritage significance of the Upper Canal and Warragamba Pipelines is available from WaterNSW upon request.

Any development that could potentially affect the heritage significance of the Upper Canal requires a separate planning approval under section 60 of the Heritage Act 1977 from NSW Heritage Council.

Alternatively, the proponent may need to submit a heritage exemption notification to Heritage NSW under section 57 of the NSW Heritage Act for minor works.

The demolition and installation of boundary fencing will also require Heritage approval or exemption.

If works occur on WaterNSW owned or vested land, the Consent of WaterNSW, as landowner, is required to submit a section 60 application or section 57 exemption notification.

Figure 24 - Leafs Creek Aqueduct sometime between 1886 and 1888 showing the temporary Hudson's scheme aqueduct

2.8 Construction Environmental Management Plan (CEMP)

Consent authorities may require the preparation of a Construction Environmental Management Plan (CEMP) or WaterNSW may request a CEMP as a condition of development consent for new large subdivisions and major development adjacent to the corridors. The CEMP should be a practical plan that communicates in a concise and clear way the key environment and heritage risks of a project and the proposed management measures to avoid or control these risks to as low as reasonably practicable.

WaterNSW requires an assessment of the following (where applicable, but not limited to) be incorporated into any developed CEMP and that WaterNSW be consulted during its preparation:

- Incident and spill management procedures, including measures designed to avoid spillages and details of how spillages will be contained and the proper disposal of contaminated material.
- Vibration controls and monitoring
- Ambient air quality
- Traffic management
- Heritage management, including unexpected finds protocol
- Bushfire management
- Landscape and vegetation management

- Waste management
- Contamination management
- Stormwater protection and pollution prevention, including any dewatering procedures
- Sediment and erosion control, including stockpile management
- Induction procedures for staff that acknowledge the Controlled Areas and their significance.
- Incident notification and management
- Emergency Management.

Any CEMP should consider the 'Guideline for the Preparation of Environmental Management Plans' (DIPNR, 2004) produced by the former NSW Department of Infrastructure, Planning and Natural Resources.

2.9 Works scheduling

Each year, always in winter when Sydney's water demand is lower, WaterNSW undertakes maintenance work along the Pipeline corridor. All works that could impact on the operation of the Pipelines is encouraged to occur within that timeframe.

Routine maintenance of the Upper Canal usually occurs in autumn and spring each year and the type of works will determine if the Canal is better filled with water or dewatered at the time of the project. This is determined on a case by case basis.

2.10 Land uses and landscaping

Land uses and landscaping along the Upper Canal and Warragamba Pipelines boundaries are important considerations for proponents and authorities when planning a new development precinct. The once rural farmlands surrounding these corridors now consist of housing and industrial developments. Where possible WaterNSW would like to see the historical land use characteristics maintained and incorporated into landscaping and estate design.

2.10.1 Subdivisions

WaterNSW requirements:

- For surveillance and security reasons, provision for a local road or street to be located between new development areas and the Controlled Area boundaries. A soft landscaped verge, and/or footpath/bicycle path should be provided as a further buffer between the corridor boundaries and the local road carriageway.
- Subdivisions that locate residential lots backing directly onto the Upper Canal and Warragamba Pipelines corridors are not supported by WaterNSW. There is minimal ability to manage, control or prevent uses or activities occurring on adjoining individual properties that could impact on the corridors. If there is no other option than to locate individual residential properties directly adjacent to the corridors, building setback controls and additional security fencing should be used to minimise risk.
- For the section of the Upper Canal between Pheasants Nest Weir and Broughton's Pass Weir, which is entirely underground in the Nepean Tunnel, the land in WaterNSW ownership is to be excluded from *all* development (including open space calculations) with any road crossings to be negotiated with WaterNSW. The land corridor should be bordered by roads rather than housing lots.

- Retaining walls and footings to be constructed clear of WaterNSW property boundaries.
- All asset protection zones and fire mitigation measures must be located entirely within the development site. WaterNSW does not accept any encroachment upon WaterNSW land.

2.10.2 Landscaping

WaterNSW requirements:

- Any proposed tree planting adjacent to the Upper Canal or Pipelines Corridor boundary is not supported. To prevent potential damage to boundary fencing and infrastructure from deep-rooted trees and falling branches, WaterNSW's preference is for low-growing shrubs and grasses only to be utilised in plantings immediately adjacent to the Controlled Area boundary.
- WaterNSW prefers Landscape Plans that propose the use of Cumberland Plain Woodland grassland revegetation mix or equivalent adjacent to the corridor boundaries, to recognise the historical vegetation type and allow for passive surveillance and security of the boundary.
- The use of sandstone materials around the Upper Canal corridor is encouraged as it represents the materials used during construction of the Canal in the 1880s.

2.11 The future of the Upper Canal

Over the longer term WaterNSW plans to replace the Upper Canal. Until the final decision is made regarding the type of replacement, proponents will need to allow in their design for WaterNSW to carry out repairs, maintenance and replacement or augmentation.

Proponents should consult with WaterNSW regarding the required exclusion zone where aspects of the development (including any crossings) may not be located.

2.12 The future of the Warragamba to Prospect Reservoir pipelines

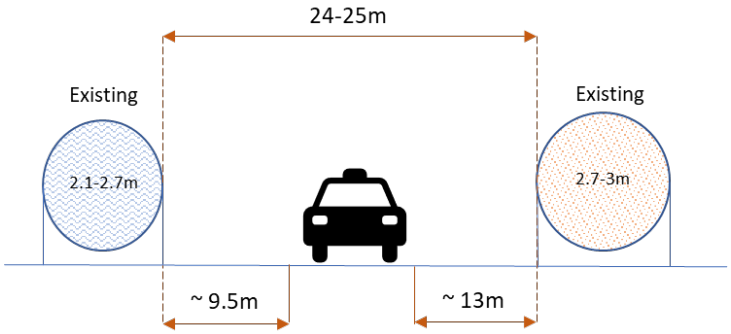
Over the longer term, WaterNSW expect that the current pipeline configuration will require augmentation to cater for the increasing demand for Sydney's drinking water supply.

Until the final decision is made regarding the type of augmentation, proponents will need to allow in their design for WaterNSW to carry out repairs, maintenance and construction activities within the corridor. Proponents should consult with WaterNSW regarding the required exclusion zone where aspects of the development (including any crossings, above or below ground, assets / infrastructure) may not be located.

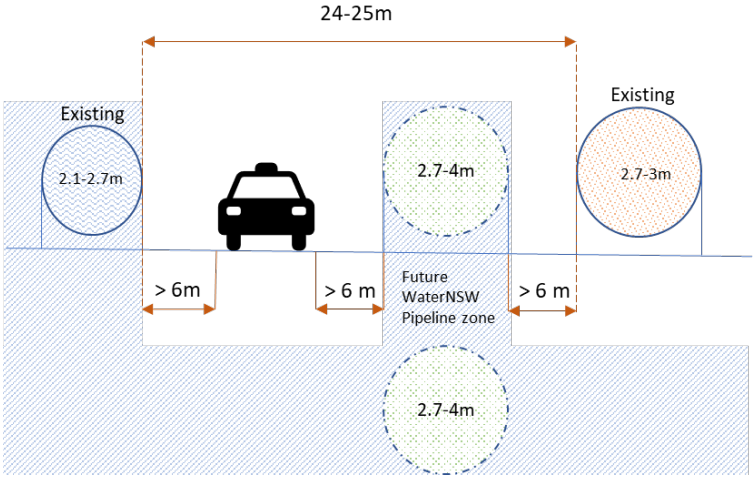
Augmentation scenarios could require installation of a 3rd pipeline (>4m diameter), which may include locations above or below ground, to the North, Centre or South of the existing Pipelines.

To enable installation of future pipeline configuration, WaterNSW require a minimum vertical clearance of at least 7.5m above the top of the Pipelines (unless otherwise agreed).

Existing Configuration



Possible augmentation scenario



APPENDIX 1– GUIDING PRINCIPLES

1. The Upper Canal and Warragamba Pipelines corridors are essential public infrastructure whose key purpose is the supply of drinking water to the Greater Metropolitan Sydney region. Water supply infrastructure must always be safe and serviceable[1].
   a. WaterNSW will not approve development proposed by external parties *within* the corridors unless:
      i) the development is for the purpose of essential infrastructure[2] and services that cannot be feasibly located elsewhere; and
      ii) the proponent can ensure to the satisfaction of WaterNSW that there will be no adverse impact on the Upper Canal and Warragamba Pipelines infrastructure. Infrastructure and services must not compromise WaterNSW's future proposals for Canal and Pipeline infrastructure.
   b. WaterNSW will not support development or planning proposals *adjacent to* the corridors unless it can be shown that there will be no adverse impact on the Upper Canal and Warragamba Pipelines infrastructure.

2. Water quality, quantity and asset reliability, availability and maintainability within the Upper Canal and Warragamba Pipelines corridors must be maintained and protected.

   a. WaterNSW will not approve infrastructure and services proposed by external providers *within* the corridors unless the providers can ensure to the satisfaction of WaterNSW that there will be no adverse impact on water quality, quantity and asset reliability, availability and maintainability.
   b. WaterNSW will not support development or planning proposals *adjacent to* the corridors unless it can be shown that there will no adverse impact on water quality, quantity and asset reliability, availability and maintainability.

3. Proponents of development or activities *adjacent* to or within the Upper Canal and Warragamba Pipelines corridors should bear any additional costs to WaterNSW arising from requirements under the above principles. This may include, but not be limited to, costs for technical or specialist studies, additional security measures, additional stormwater management measures, construction requirements, the planning and registration of easements and financial compensation for access rights and easements.

[1] Safe means no danger to users who are present, serviceable means available for its intended use.

[2] Essential Infrastructure means services that are for public use such as water supply.

APPENDIX 2– Risk to WaterNSW assets and documentation required for review

Most activities occurring within or adjacent to the Upper Canal or Warragamba Pipelines will warrant consideration of the following risks. Where applicable WaterNSW expect to review (but not limited to) the below preferred deliverables to ensure water supplies, associated infrastructure and WaterNSW lands are always safe and serviceable. The criteria, testing or other approved form of verification required by WaterNSW to assess performance and to ensure consistency across the solutions are to be developed to meet requirements.

Risk	**Preferred Deliverable**
Additional loads on our structures	• Drawings/Plans • Engineering report • Geotechnical report
Changes to groundwater	• Groundwater monitoring and modelling including quality and quantity of water & groundwater depth
Contamination	• Contamination Assessment report
Heritage Impact	• Heritage Impact Assessment or statement, including unexpected finds protocol
Security	• Fencing plan
Sedimentation and Erosion	• Sediment and Erosion Control plan (can be contained within CEMP)
Settlement/ subsidence	• Geotechnical report • Geotechnical modelling
Stormwater runoff	• Flood modelling detailing: - Quality and quantity of water, including Probable Maximum Flood (PMF) level - Flow, depth and velocity - Comparison of pre and post development figures for all events up to 1% AEP • Stormwater Management Plan, including any dam dewatering protocols
Use of proprietary construction products on WaterNSW land (e.g. pipe segments)	• Engineering report • Manufacturer details
Vibration	• Assessment of the potential effects of vibration • Vibration monitoring plan (can be contained within CEMP)