ROUS COUNTY COUNCIL

BULK WATER SUPPLY | WEED BIOSECURITY | FLOOD MITIGATION

Haughwood Canal

Active Floodgate Management Plan

2019-2022

Management Plan operational summary

Haughwood Canal is located south of Coraki in northern New South Wales. The 2.7 kilometre long drainage system enters Bungawalbyn Creek on its western bank. The canal drains a low-lying area that was historically a backswamp. The drainage system has been floodgated at its junction with Bungawalbyn Creek, with a concrete headwall and four large floodgates. Two of the floodgates have been modified with sluice windows to allow tidal exchange. It is those modified floodgates to which this Plan applies. The term 'floodgate' within this Plan refers to the two modified with sluice windows that are opened and closed to allow tidal exchange.

Active floodgate management has occurred at Haughwood Canal since 2003 and the system has been predominately open since that time, except during floods. Opening the system to allow tidal exchange has improved water quality within Haughwood Canal. The frequency and magnitude of acidic discharge has been reduced, as has the accumulation of Mono-sulfidic Black Ooze (MBO) within the drainage system (NSW DPI, 2005).

Haughwood Canal has changed significantly over the past 15 years. Apart from active floodgate management, the entire drainage system has been reshaped so it is shallower and intercepts less groundwater. The Canal has also been fully fenced to exclude cattle. The western half of the drainage system, which is located within the former backswamp, has been subdivided into smaller properties and agricultural activity has decreased. The western half of the drainage system is privately owned and maintenance activities to maintain a clear drainage channel have reduced.

As a result of these changes, the western half of the drainage system appears to be returning to a more natural water regime. Less groundwater is being drained, and surface water is slower to leave the area. In response, vegetation is changing from introduced pasture species to more native wetland vegetation. Although monitoring has not occurred, it is expected that these land management changes have reduced the amount of acidity leaving the system as well as reducing deoxygenation (blackwater) events after flooding.

Active floodgate management continues to be an important on-going strategy for Haughwood Canal to dilute any acidic water that still may enter the drainage system and reduce the environmental impact of the floodgates. This plan outlines how tidal exchange will continue into the future and suggests additional management strategies to reduce the system's impact further.

Environmental goals and strategies

The goals and strategies listed here specifically relate to Haughwood Canal and identify the desired outcome from actively managing the floodgates. Goals are listed in priority order.

Goals

1. Reduce the frequency and magnitude of acidic discharge from the system.
2. Reduce the accumulation of MBO within the system.
3. Reduce the impact of the system on its receiving waters of Bungawalbyn Creek.

Strategies

1. Continue with outlined strategy to allow tidal exchange through the floodgates.
2. Monitor the changes that have occurred within the system and use as a demonstration site to other floodplain landowners of best management practices.

Opening strategy for floodgate

Two of the floodgates on Haughwood Canal are fitted with sluice windows, which can be winched open. The sluice windows remain fully open all year, and are only lowered before flood events to protect upstream areas from riverine inundation. This is the optimal strategy for tidal exchange through the existing floodgate structure and no improvement is suggested at this time for its future management. This degree of tidal exchange is noted to improve water quality while having minimal impact on surrounding land use.

The sluice windows will be opened and closed, in accordance with the details below by the nominated landowner volunteer. Council and the landowner volunteer acknowledge there are many variables during flood events and will be guided by the details below. This plan will not restrict Council or the landowner volunteer from taking emergency actions outside of those listed, taking into consideration safe work procedures.

Close sluice in floodgates

Flood Watch issued by the Bureau of Meteorology for the Wilsons and Richmond Rivers.

Very significant rainfall in Bungawalbyn catchment (no Bureau of Meteorology (BOM) rain gauge, need to monitor using BOM rain radar and radio reports).

Minor flood warning issued for Coraki or Bungawalbyn Junction.

Monitor water levels and catchment conditions. If likely that a minor flood warning will follow, close sluice windows.

Fully close sluice windows at the first available low, run-out tide during daylight hours.

Open sluice in floodgates

Fully reopen sluice windows after flooding, or the cancellation of flood warning when the lifting mechanism is visible, and it is safe to access the site and operate the infrastructure during daylight hours.

Contingencies

Flood warning occurs overnight.

Sluices need to be closed and it is a high or rising tide, or creek water levels are too high.

Landowner is away when Flood Warning is issued.

Sluices will remain open until safe (for operator and infrastructure) to close them.

Landowner volunteer will notify Council before leaving, and Council will manage the sluice in their absence.

- If the nominated landowner volunteer requires assistance with the floodgate, or any associated infrastructure, they are to contact Council.
- Council are to be notified by either phone or email within 24 hours if the sluice windows are opened or closed for any reason other than what is outlined above.
- If Council has not been notified of any action outside of what is outlined above, they will return the sluice windows to the agreed upon state and aperture (open or closed) for the current conditions.
- All notifications should be directed to Council Reception on 6623 3800 or council@rous.nsw.gov.au

Rous County Council contact details

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218-232 Molesworth Street, Lismore NSW 2480

(02) 6623 3800
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Authorisation

This plan has been endorsed by Council and the landowners within the immediate catchment whose land is influenced by the management of floodgates.

Landowners have signed a letter of endorsement stating they understand the management strategy for the floodgate, including the triggers for opening and lowering into the operational position.

The nominated landowner volunteer has agreed to operate the floodgate on behalf of Council, as outlined in this Active Floodgate Management Plan and in accordance with the Workplace Health and Safety advice and directions provided to them.

Disclaimer and copyright

Version control

Version	Description	By	Date
0.1	Draft developed before landowner consultation	Chrisy Clay	18/06/2019
0.2	Final draft incorporating landowner feedback	Chrisy Clay	6/09/2019
1.0	Final version – issued to landowners	Brenda Ford	

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Contents

1. Overview

Many coastal floodplains in New South Wales have been extensively modified by networks of constructed drains, altered water courses and floodgates. These are designed to mitigate the impacts of floods and large rainfall events.

Constructed drains reduce inundation after flooding and floodgates prevent flood waters and tidal brackish water from inundating low areas of the floodplain. This in many cases has converted prior wetlands and low-lying floodplain areas into dryland farming areas. While these developments have enhanced rural settlement and agricultural industries, they have also caused unintended adverse impacts to downstream water users, fisheries and the ecology of estuaries.

Rous County Council ('Council') is the Flood Mitigation Authority operating across the local government areas of Ballina, Lismore and Richmond Valley. Council is responsible for the construction, replacement and routine maintenance of flood mitigation infrastructure, including floodgates and some pipes, levees, rural drains and canals. Council's natural resource management function relates to the environmental consequence resulting from the operation of this infrastructure. Council is responsible for reducing the environmental impact of these floodgates and other infrastructure, while retaining their benefits for flood mitigation.

The flood mitigation directive that Council operates under in the *Local Government Act 1993* is *'Prevent and mitigate menace to the safety of life or property from floods and natural resource management issues arising therefrom'.*

Purpose of a Floodgate Management Plan

Council has an Active Floodgate Management Plan ('the Plan') for each of its floodgates that are actively managed. Active management is the opening of floodgates during non-flood periods when the floodgate is otherwise operating passively. Opening floodgates and allowing tidal exchange can reduce their environmental impact by improving water quality and enhancing aquatic habitat and fish passage. Opening a floodgate for tidal exchange can occur through modifying a floodgate with a sluice window or an automatic, tidally operated float system or the floodgate can be winched opened.

These Plans document and communicate:

- how active management can assist in reducing the environmental impact of the floodgate,
- a strategy for how that will be monitored and achieved,
- appropriate and consistent strategy for opening the floodgate and returning it to the operational position or state and by whom,
- safe operating procedures for volunteers and Council staff,
- how adverse effects on current land use will be identified and prevented, and
- additional management strategies for the drainage system that would further reduce the environmental impact of flood mitigation.

Each Plan is tailored for the system and its floodgates, considering their location, purpose and function.

Guiding principles for management

- Rous County Council is the Flood Mitigation Authority, and acts in consultation with stakeholders on the management of its infrastructure.
- The primary function of Council's infrastructure is for flood mitigation.
- The intention of active floodgate management is to reduce environmental impact without causing adverse effect on current land use.
- All landowners behind the floodgate whose property may be impacted will be invited to participate in reviewing and updating the Plan and will be sent a final version of the Plan for their records. Where property ownership changes, the new landowner will be involved at the time the Plan is reviewed unless their location and role is critical to the management strategy.
- Active floodgate management is a cooperative exercise between Council, as the Flood Mitigation Authority, and the surrounding landowners. Council appreciates landowners' continued support of this important activity.

Stakeholder involvement

This Active Floodgate Management Plan is a formal agreement between Rous County Council and landowners on how tidal exchange will occur on the identified drainage system. The Plan has been developed in consultation with landowners whose property may be impacted from the floodgate's operation.

Rous County Council seeks the input and support of other stakeholders for their Active Floodgate Management program and its delivery.

Organisation	Role
Rous County Council	Owns, develops and uses individual Active Floodgate Management Plans.
Relevant landowners	Endorses and uses individual Active Floodgate Management Plans.
Lismore City Council Ballina Shire Council Richmond Valley Council	Supports active floodgate management and provides input on general program where relevant.
NSW Department of Primary Industries	Supports active floodgate management and provides input on general program where relevant. Regulatory role under *Fisheries Management Act 1994*

Plan review frequency

The Plan will be formally reviewed every three years (from the date of adoption) and the effectiveness of the outlined strategy assessed.

Feedback on the Plan and active floodgate management matters

Feedback and comments should be referred to Council by telephone on (02) 6623 3800 or by email: council@rous.nsw.gov.au

2. Haughwood Canal

Asset number and description

A reference in this section to 'asset number' is to a unique reference that Council has assigned to the specified asset.

Asset number 1960 – Haughwood Canal floodgates

- Four floodgates
  - Two square 2100mm floodgates
  - Two square 2100mm floodgates, with sluice windows, operated with separate winches

Asset No.	Description	Number
1960-030-01	Aluminium floodgate (2100mm square) with sluice window	2
1940-031-02	Aluminium floodgate (2100mm square)	2
1960-610	Hand rail	1
1960-035	Lifting gear	1
1960-263	Canal	1
1960-130	Culvert (4 cell box with headwall)	1
6600-410	Bungawalbyn Creek western levee	1

Aerial photograph of asset location and images of asset

1: Haughwood Canal locality map.

2: Haughwood Canal floodgates with sluice windows open.

3: Winches on Haughwood Canal headwall used to open sluice windows below.

Drainage system characteristics

Location in estuary.	Mid-upper estuary.
Location in landscape.	Floodplain and former low-lying, freshwater backswamp.
Land elevation.	0.7m – 1.5m AHD
Land use.	Agriculture: cattle grazing and tea tree cropping.
Vegetation.	Grasses and pastures. Increasing native sedges and rushes in western half of system.
Salinity levels and estuary dilution capacity.	Low.
Tidal range.	Low.
Land elevation adjacent to drains.	Low, graduating from artificial levee along Bungawalbyn Creek.
Soil type.	Higher floodplain area on eastern half of system has some alluvial sediment, but entire drainage system contains peat soils. (NSW DPI, 2005) The former backswamp in western half of the drainage system, experienced peat fires in 2002.
Acid sulfate soils.	High risk, large areas of sulfuric sediments (actual sulfate soils) often close to the ground surface. Backswamp in western half of system contains peat acid sulfate soils. (NSW DPI, 2005)
Hydraulic conductivity.	Extreme. (NSW DPI, 2005)
Acid export.	High and chronic. Groundwater-driven export. (NSW DPI, 2005)
Water quality issues.	Chronic acidic discharge with low dilution capacity within Bungawalbyn Creek, which is a High Conservation Value water course. (Foster, 2001) Can discharge deoxygenated water (blackwater) after flooding.

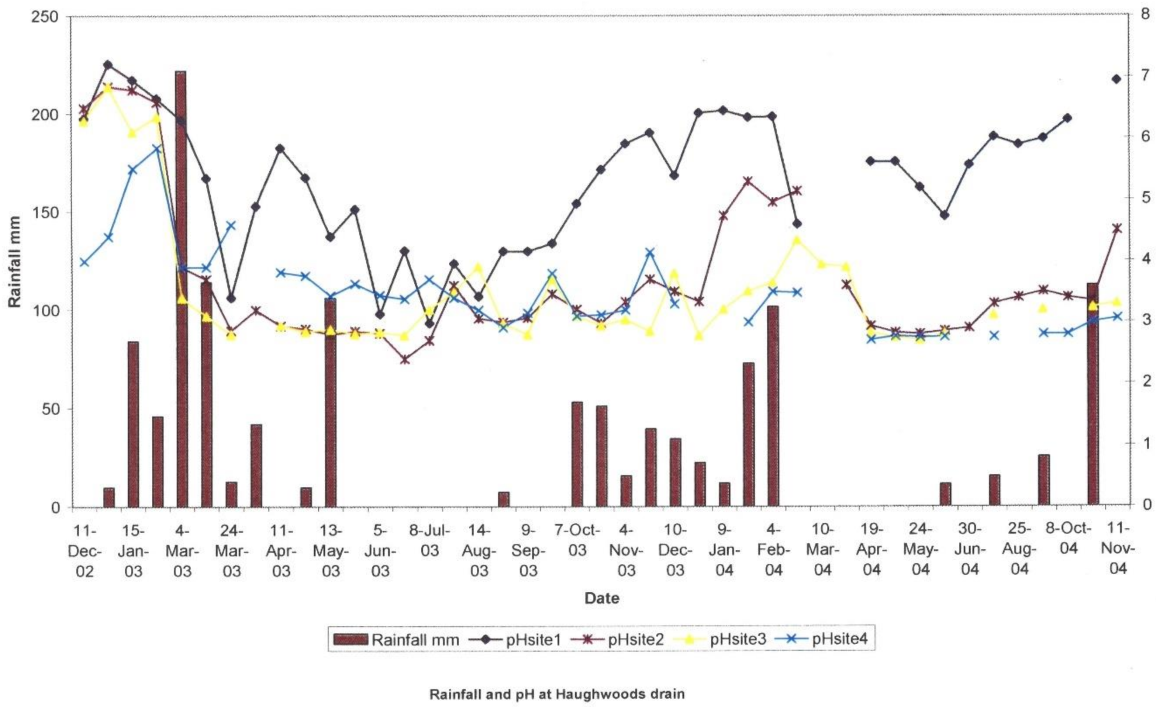
Water quality

Haughwood Canal is a source of acidity into Bungawalbyn Creek. This acidification is from the oxidation of acid sulfate soils within the drainage sub-catchment, particularly the former backswamp in the western half of the drainage system which is underlain by peat. (NSW DPI, 2005).

A water quality monitoring program at Haughwood Canal undertaken by NSW Agriculture during 2003 and 2004, captured conditions whilst the floodgates were actively managed. Monitoring showed the benefit of tidal flushing, with the pH of drain water near the floodgate 2 to 3 units higher than the pH of drain water in the former backswamp area (NSW DPI, 2005). The pH of drain water in the former backswamp area in 2003 and 2004 ranged from 2.7 and 4 (NSW DPI, 2005). Tidal exchange has diluted acidity within the drainage system before it enters Bungawalbyn Creek.

Acid discharge at Haughwood Canal is groundwater driven and occurs when the hydraulic gradient between groundwater and the drainage system is greatest (NSW DPI, 2005). Before active floodgate management and reshaping of the drain, acid discharge would occur until groundwater levels receded below the drain water level. The reshaping of the canal has reduced how much acidic groundwater can enter the drainage system.

The soils within the Haughwood Canal drainage catchment share very similar characteristics to nearby Boggy Creek. Marcasite, an iron sulfide mineral, has been detected within Boggy Creek's peat acid sulfate soils (Allery, 2003). Compared to the more commonly found pyrite, marcasite is much more reactive and acidifies rapidly upon oxidation. Iron and aluminium concentrations in peat acid sulfate soils dramatically increase at low pH's, meaning the oxidation of peat acid sulfate soils (like what exists in Haughwood drainage catchment) can release large amounts of both metals in toxic quantities.



4: Water quality within Haughwood Canal during 2003 and 2004. Site 1 is closest to the floodgates and Site 3 and 4 are located within the backswamp. (NSW DPI, 2005).

Before active floodgate management, large quantities of MBO also accumulated in the drainage system behind the floodgate (NSW DPI, 2005). If mobilised this MBO would have stripped dissolved oxygen from the water column and then discharged this into Bungawalbyn Creek.

Active floodgate management has improved water quality discharging from Haughwood Canal, by diluting the acidic discharge before it enters Bungawalbyn Creek and reducing the accumulation of MBO's.

Landowners have been willing to make further changes to how the drainage system operates and Haughwood Canal has had several significant works occur to further improve water quality.

In 2003, two groundwater containment weirs were installed in the western half of the drainage system, to reduce acidic groundwater entering the drain. Six years later the entire drainage system was reshaped so it was shallower and not as wide. At the same time the western half of the drainage system, which is located within the backswamp, was subdivided into smaller properties and agricultural activity decreased. Drain maintenance activities in the western half of the system have reduced as well.

As a result of these changes, the western half of the drainage system appears to be returning to a more natural water regime. Less groundwater is being drained, and surface water is slower to leave the area. In response, vegetation is changing from introduced pasture species to more native wetland vegetation. Although monitoring has not occurred, it is expected that these land management changes have reduced the amount of acidity leaving the system as well as reducing deoxygenation (blackwater) events after flooding.

5: Looking downstream along the eastern half of the drainage system in 2010, after the drain was reshaped to be not as wide or deep.

Aquatic habitat values

The former freshwater wetland that historically existed in the western half of Haughwood Canal would have had some aquatic habitat value. Little information has been documented or recorded on what the area was like before extensive drainage, however some landowners remember riding through a similar wetland nearby at Boggy Creek on horseback and being surrounded by high and thick reeds. (NSW DPI, 2005)

Haughwood Canal is an artificial man-made drainage system that shows no natural characteristics. The eastern half of the system crosses through higher floodplain/levee area before being intercepted by Haughwood Road. The road sits above ground level and separates the backswamp from the higher floodplain area. The invert of the road culvert is higher and is a barrier to tidal exchange in the western side of the drainage system. The drainage system provides little habitat and the water quality within the system is often unfavourable for aquatic life.

However, Haughwood Canal discharges into Bungawalbyn Creek, which has been previously identified as a High Conservation Value watercourse by the Northern Rivers Water Management Board. (Foster, 2001) Bungawalbyn Creek provides important aquatic habitat, particularly for fish, within the wider Richmond floodplain.

The active management of the Haughwood Canal floodgates is focused on reducing the system's impact upon Bungawalbyn Creek.

6: Brolga at Haughwood Canal, with the concrete headwall and main floodgate structure in the distance.

Whole of system management

Haughwood Canal has changed significantly over the past 15 years. Apart from active floodgate management, the entire drainage system has been reshaped so it is shallower and intercepts less groundwater. The Canal has also been fully fenced to exclude cattle.

The following table outlines what management changes have already been made and what could be explored in the future. A cooperative approach that balances the needs of current land use and environmental benefits is promoted by Council. Haughwood Canal has benefitted from the willingness of previous landowners to trial and adopt different management strategies to improve water quality and Council acknowledges their efforts.

Council provides this information for landowners and other organisations that are responsible for promoting and facilitating natural resource management on private freehold land. This information identifies a range of relevant strategies for improving water quality based on the characteristics of the system and are consistent with current best management practice.

On Haughwood Canal, Council has management responsibility for the floodgates and the headwall, the main canal up until Haughwood Road, as well as the Bungawalbyn Creek western levee. The western half of the drainage system from Haughwood Road upstream, and all other minor drains and other flood mitigation structures in the system are owned and managed by others.

Management strategy	Works	Undertaken	Location	Recommendation	Responsibility
Acidic groundwater containment.	Groundwater containment weirs installed in drainage system.	Yes, two groundwater containment weirs were installed in the western half of the drainage system by NSW Ag in 2003 (funding assistance by ASSPRO)	On private section of drainage system, near road culvert and 600 m upstream. The weir located furthest up the system was removed in 2008 when the drain was reshaped.	Review function of remaining weir with landowners and consider removing, as the drain has filled in, so sediment sits above the structure crest.	Private landowners. Local Government: • Rous County Council. State Government: • North Coast Local Land Services. • Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
	Stock exclusion to reduce sedimentation of system and possible exposure of sulfidic material along drain bank.	Yes, eastern half was fenced 10m away from the drain with a permanent wooden post structure by NSW Ag in 2003. (funding assistance by ASSPRO) Western half was fenced with electric fencing and metal pickets by NSW DPI in 2010. A cattle watering system was installed with troughs fed by a tank with water pumped from a well to assist with stock watering. (funding assistance by NRCMA)	Entire drainage system.	.	
	Reducing drainage density – removing drains or reshaping so shallow and wide to only drain surface water.	Yes. Western half of the drainage system was reshaped by RRCC in 2008. From 4m wide and 1.5m deep to 2.5m wide and 0.5deep. (funding assistance by NRCMA) The eastern half of the drainage system was reshaped by RRCC in 2009, from 10m wide to 8m wide. (funding assistance by NRCMA).	Entire drainage system.	Monitor effectiveness, function and maintenance of changes to the drainage system.	
Tidal flushing for dilution of acidification.	Actively manage floodgates on drain headwall.	Yes, in 2003 by NSW Ag, NSW Fisheries and RRCC (funding assistance by Environmental Trust). Sluice windows were installed on the system in 2006 by RRCC to replace the winch system used to open floodgates.	Main floodgate structure on Bungawalbyn Creek.	Continue with outlined management strategy.	Private landowners. Local Government: • Rous County Council.
Reduce impact of deoxygenation events.	Reduce drainage density – removing drains or reshaping so shallow and wide to only drain surface water.	Yes. Western half of the drainage system was reshaped by RRCC in 2008. From 4m wide and 1.5m deep to 2.5m wide and 0.5deep. (funding assistance by NRCMA) The eastern half of the drainage system was reshaped by RRCC in 2009, from 10m wide to 8m wide. (funding assistance by NRCMA).	Entire drainage system	Monitor effectiveness, function and maintenance of changes to the drainage system.	Private landowners. Local Government: • Richmond Valley Council. • Rous County Council. State Government: • North Coast Local Land Services.

Management strategy	Works	Undertaken	Location	Recommendation	Responsibility
	Return lowest lying land to a more natural water regime, i.e. shallow and permanent inundation.	Partially in western half of the drainage system in response to the drain being reshaped, and a decrease in agricultural activity.	Western half of drainage system.	Monitor effectiveness, function and maintenance of changes to the drainage system.	• Department of Primary Industries. • Department of Planning, Industry and Environment (previously Office of Environment and Heritage) • Marine Estate Management Authority.
Management Plan.	Collation of site information, identification of management options.	No.	Whole system.	Assess cost versus benefit. Explore possibility with landowners.	
Water quality monitoring.	Monitoring program to identify any water quality issues and confirm benefits of managing floodgate.	No, only spot samples and observations.	Main floodgates.	That a program be developed to determine success of Active Floodgate Management Plan. Identify resources required and assess cost versus benefit.	Local Government: • Rous County Council.

ASSPRO = Acid Sulfate Soil Program, a state government program addressing acid and acid sulfate soils by NSW Agriculture.
NSW Ag = NSW Agriculture, previous State Government department.
NSW DPI = NSW Department of Primary Industries.
NRCMA = previous Northern Rivers Catchment Management Authority.
RRCC = Richmond River County Council, former Flood Mitigation Authority on the Richmond.

3. Risks of actively managing floodgates

Work Health and Safety

- The sluice windows are fitted with winches and large forces can be involved in winch systems.
- The sluice windows must only be opened on a low or falling tide. This will reduce the risk of the wire rope breaking.
- The sluice windows are opened and closed by nominated landowner volunteers or Council operators, who must consult and follow the approved Safe Work Procedure and Floodgate Fact Sheet relevant for the activity and undertake their own risk assessment before operating the floodgate.
- Operating the sluice windows during and after heavy rain or flooding can require working in wet and slippery conditions. Safe access to the site should be assessed after events.
- The sluice windows are only to be operated during daylight hours.

Environmental / Agricultural

Flooding

There is a risk of flooding to land upstream of the floodgate and surrounding areas, if the sluice windows are not closed before a flood arrives and floodwater from Bungawalbyn Creek enters the drainage system.

Increased salt levels in drainage system

Salinity levels are low in Bungawalbyn Creek, even during droughts and periods of low flows. There is no risk posed by tidal water overtopping banks in low-lying areas or of lateral salt seepage into the banks.

4. Monitoring, evaluation and reporting

Council will explore whether water quality monitoring can occur at Haughwood Canal. However, if resources are not available for monitoring, scientific principles and visual observations support the assumption that implementing the outlined management strategy will improve water quality.

An evaluation of the success of the Plan will be made at the 3 yearly review, and a report provided by Council to landowners and relevant stakeholders.

5. Historical context

History of when and why asset was installed

Haughwood Canal and the associated headwall and floodgate structure were constructed in 1964 by Richmond River County Council. The construction was funded by the NSW Department of Public Works, with the then Minister approving the works at a cost of £15,000. Before 1964, drainage was limited to a few small field furrows which assisted in removing surface water from the backswamp. These drains connected to nearby Bora Creek. The drainage system constructed in 1964 significantly increased drainage of the backswamp.

The backswamp is fed by runoff from the large surrounding catchment and higher country between Haughwood Road and Benauds Road (see map in Appendix).

Private drainage history

In 2003, NSW Agriculture installed two groundwater containment weirs in the privately owned, western half of the drainage system.

7: One of the groundwater containment weirs that was installed in the private section of Haughwood drainage system in 2003.

In 2008 the private, western half of the drainage system was reshaped to be narrower and shallower. The drain previously averaged 4m wide and 1.5m deep and was reduced to 2.5m wide and 50cm deep. The drain was fenced to exclude stock at this time.

During the reshaping, the groundwater containment weir furthest up the drainage system was removed. The first weir near the road was left but is now completely covered with vegetation and the drain has filled in so sediment sits above the structure crest.

History of active floodgate management

NSW Department of Primary Industries commenced landowner extension in the area in 2000 and obtained funding to modify infrastructure on Haughwood Canal from the Acid Sulfate Soil Program and NSW Fisheries Environmental Trust Floodgate Program.

The floodgates already had a lifting winch installed, which landowners had used for many years to open the system for tidal flushing. The lifting gear was upgraded in 2003 to meet current work health and safety standards and allow landowners to operate the system.

In 2006, when the existing steel floodgates were upgraded to aluminium, two sluice windows were installed in the new floodgates.

The sluice windows have been kept open, except during floods and after heavy rainfall. This is the optimal strategy for tidal exchange through the existing floodgate structure and no improvement is suggested at this time for its future management.

Recent changes to drainage system

Haughwood Canal has changed significantly over the past 15 years. The western half of the drainage system appears to be returning to a more natural water regime where less groundwater is being drained, and surface water is slower to leave the area. In response, vegetation is changing from introduced pasture species to more native wetland vegetation.

NSW Agriculture undertook a vegetation survey of the backswamp area in 2003 and 2004 before and after the groundwater containment weirs were installed. The survey was undertaken to record all plant species present in the backswamp, identify dominant species and provide a baseline before changes to the drainage system and water levels occurred.

Both surveys found the backswamp was dominated by Carpet Grass (*Axonopus compressus*) (Green & Smolders, 2004). Carpet Grass is a very tolerant species that can thrive in areas that are often waterlogged, have low soil fertility and are shaded. It was once used as a pasture species but is now considered inferior to other species for cattle grazing. Importantly from a water quality perspective, Carpet Grass readily produces de-oxygenated water (blackwater) after flooding.

Within the surveys, the presence of Grey Sedge (*Lepironia articulate*) was noted (Green & Smolders, 2004). Grey Sedge is a dominant native species found in wetlands in the Bungawalbyn area. It is tolerant of acidic conditions and where it has little competition it can readily establish and dominate. Long term landowners in the area recall that historically most of the backswamp was dominated by Grey Sedge, but Carpet Grass was now dominant after repeated slashing and poisoning with herbicides (NSW DPI, 2005).

In 2019, much of the lowest lying backswamp area is now dominated by Grey Sedge. The Sedge is growing throughout the private drainage channel and is blocking flows. Another local species *Leptospermum brachyandrum*, a weeping tea tree, has also colonised the lowest lying areas.

The change in vegetation can be seen in the series of photographs below. These are taken from Haughwood Road, which intersects the drainage system and separates the eastern and western halves.

8: Looking west, and upstream from Haughwood Road in February 2002.

9: Looking west, and upstream from Haughwood Road in January 2004. It was noted the Spring and Summer were wetter than the years previous.

10: Looking west, and upstream from Haughwood Road in 2013, note the thick stands of Grey Sedge along the drain.

11: Looking west, and upstream from Haughwood Road in 2019, the drainage system is now dominated by Grey Sedge.

6. References

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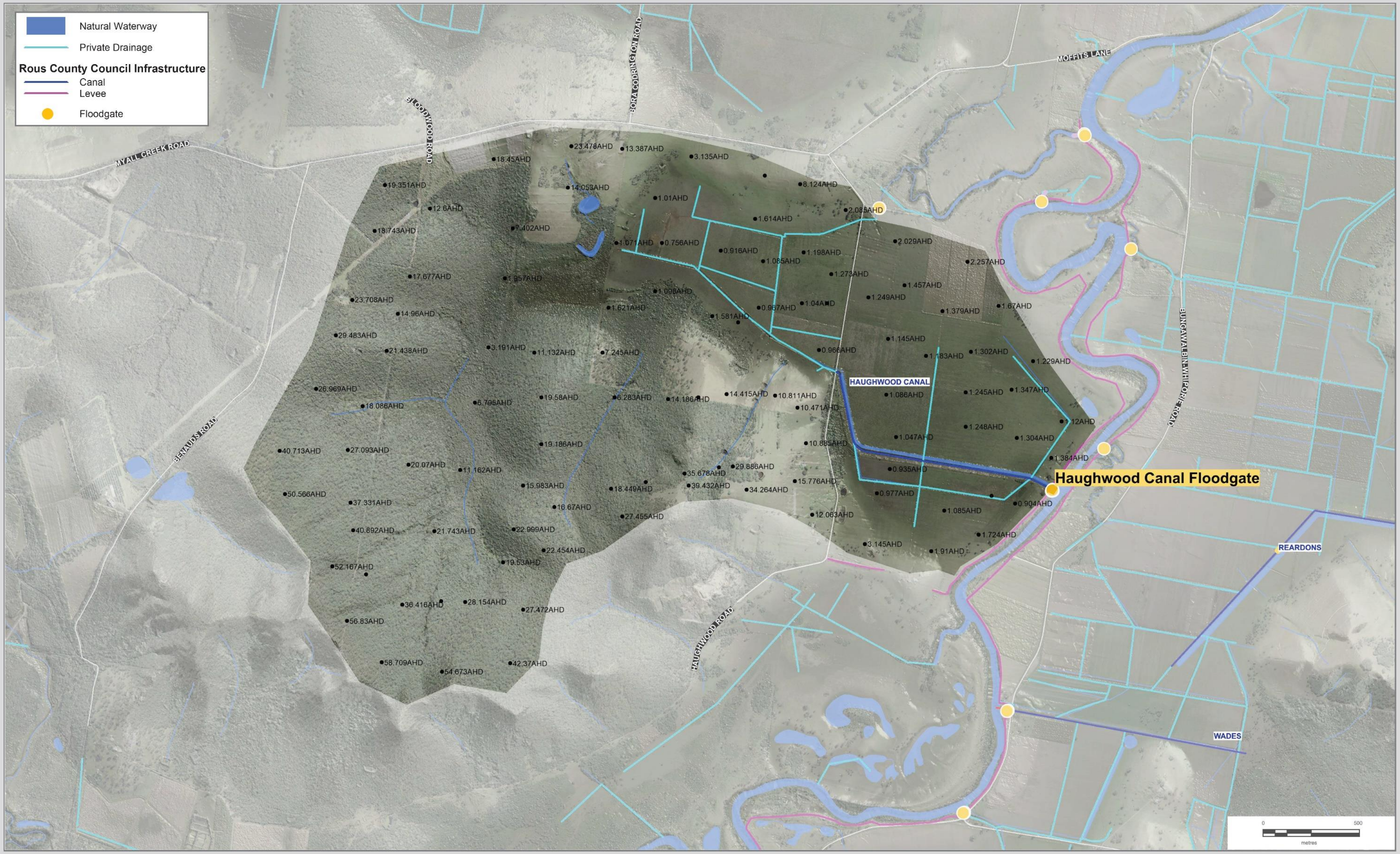
Foster, J. (2001) Assessment of the Bungawalbyn Region for High Conservation Value Status. Unpublished report by expert panel for the Far North Coast River Management Committee.

Green J. & Smolders A. (2004) Haughwood Drainage System: preliminary vegetation survey August 2003 and postwork vegetation survey March 2004. Unpublished report.

NSW Department of Primary Industries (2005) Haughwood Canal ASS remediation project. Unpublished information.

Appendix: Haughwood Canal drainage system



Haughwoods Canal Catchment

THE INFORMATION ON THIS MAP MAY NOT BE ACCURATE.

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