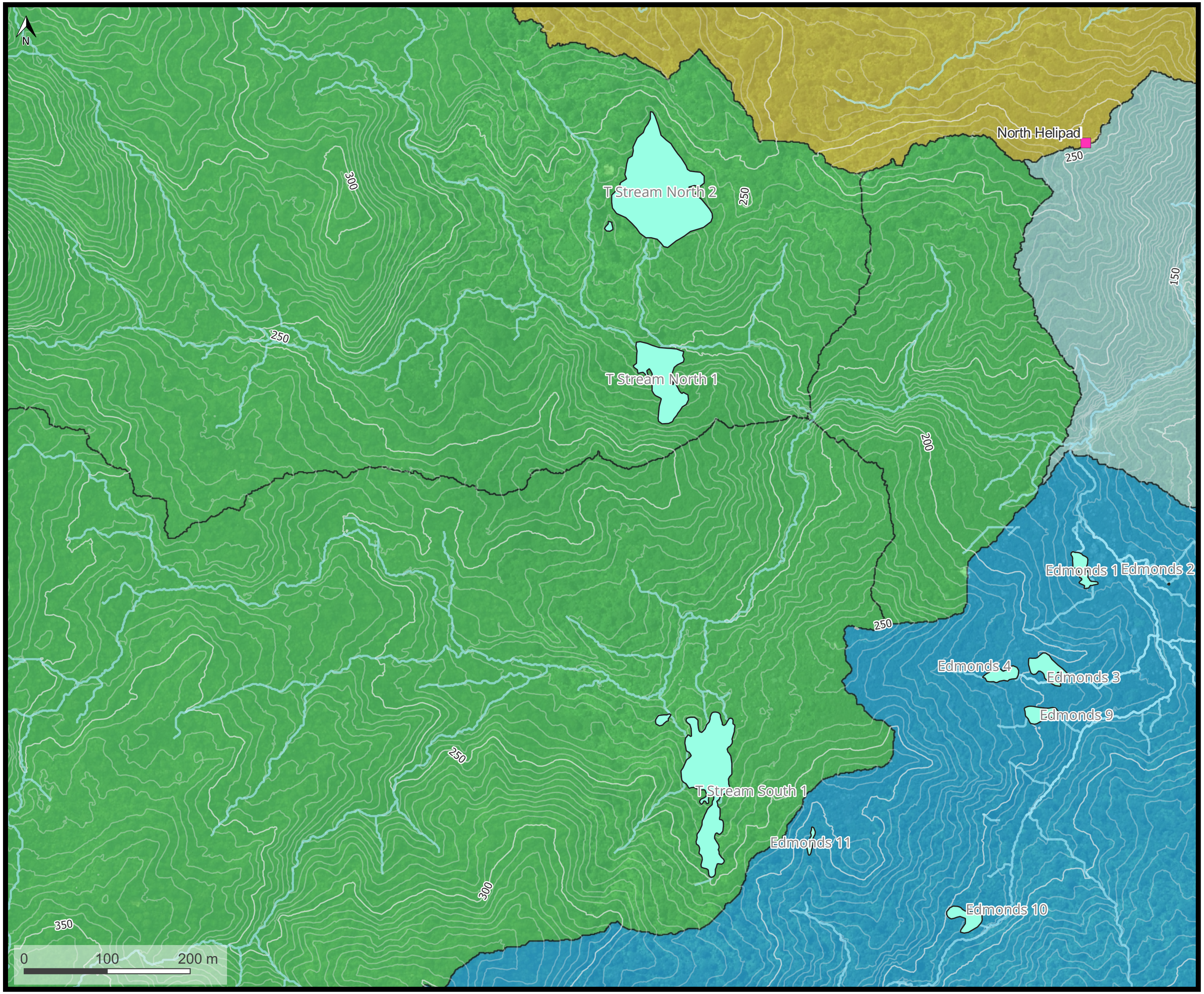
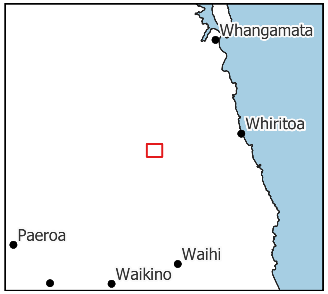


Map Title:
Teawaotemutu Stream Catchment

Project:
Wetland Delineation

Client:
Oceana Gold



Legend

- **Helipad**
- **Stream**
- **Contour (m)**
- **Wetland**
- **Wharekiraupong Stream**
- **Teawaotemutu Stream**
- **Adams Stream**
- **Edmonds Stream**

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire
04/10/2024

Layout Name
Catchments G:\Shared drives\Projects\Oceana Gold\WWLA0996_WKP Wetland Identification_Delineation\Technical\GIS\QGIS project files\OGL WKP Wetland Fieldwork.qgz

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Figure 21.

2.2.7 Adams Catchment

There were twelve wetlands identified in the Adams catchment, of which four were depressions with hydrology features and eight were groundwater wetlands.

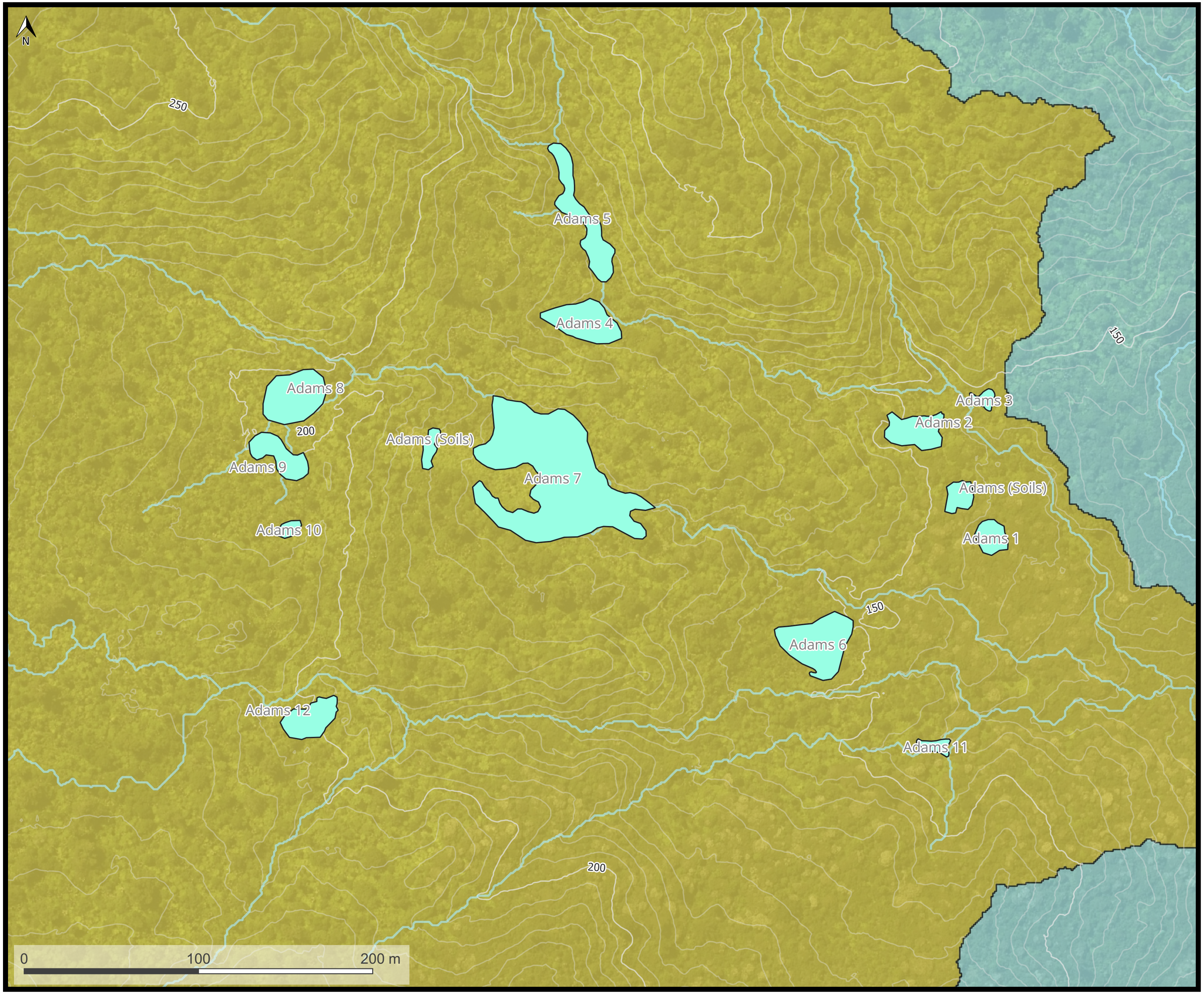
The depression with hydrology feature wetlands were located in steeper valleys along streams which were supporting the wetland. Some seepage could be observed at some sites, indicating that these were potentially also supported by groundwater in places. Dense vegetation covered these sites, limiting light and heat from reaching the surface.

Both the topsoils and subsoils in surface water-supported wetlands were observed to be very dark brown (**Figure 22 – Photo 1**), or black, but no peat was identified. This is likely due to the steep surrounding topography which creates a fast-flowing, flashy catchment. As a result, the movement of water into the wetland is preventing any peat from forming.

The groundwater wetlands presented slightly differently to any other wetlands observed in the project area. They were located in closed depressions in flatter areas of terrain. No hydrology features were observed nearby or feeding the wetlands. Vegetation over these areas was sparser. The closed depressions were like small ponds, and there was no indication that surface water run-off during rainfall was feeding into them due to the topography surrounding the areas.

The topsoils in the groundwater-supported wetlands were generally also dark brown or black, but in most cases a bright orange soil was observed (**Figure 22 – Photo 2**). The soils were coated with the slimy, iron-oxidising bacteria (**Figure 22 – Photo 3**). Along with the orange slime, an oily biofilm was also seen. These features were observed in other groundwater wetlands in the project area. Another feature observed in these wetlands was a 5-10 cm layer of peat (**Figure 22 – Photo 4**). This was not something observed in other wetland within the study area. Peat forming in these wetlands was unique to the project area as it is thought to be due to the flatter topography and lack of rapid surface water flows through the area allowing vegetation to accumulate and decay.

Figure 22. Adams catchment photos.



Map Title:
Adams Stream Catchment

Project:
Wetland Delineation

Client:
Oceana Gold

Legend

- **Stream**
- **Contour (m)**
- **Wetland**
- **Wharekirauponga Stream**
- **Adams Stream**

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire
04/10/2024

Layout Name
Catchments G:\Shared drives\Projects\Oceana Gold\WWLA0996_WKP Wetland Identification_Delineation\Technical\GIS\QGIS project files\OGL WKP Wetland Fieldwork.qgz

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Figure 23.

3. Water Quality Data

Water samples were collected from each of the wetlands visited to assess identifiable characteristics between surface and groundwater sourced wetlands. The full table of results is presented in **Appendix B**.

The water sample results are presented on a Piper Diagram in **Figure 24** below. The wetland sites have been categorised according to the field observations in **Appendix A** and based on the wetland types 1-4 as discussed in **Section 2.1**.

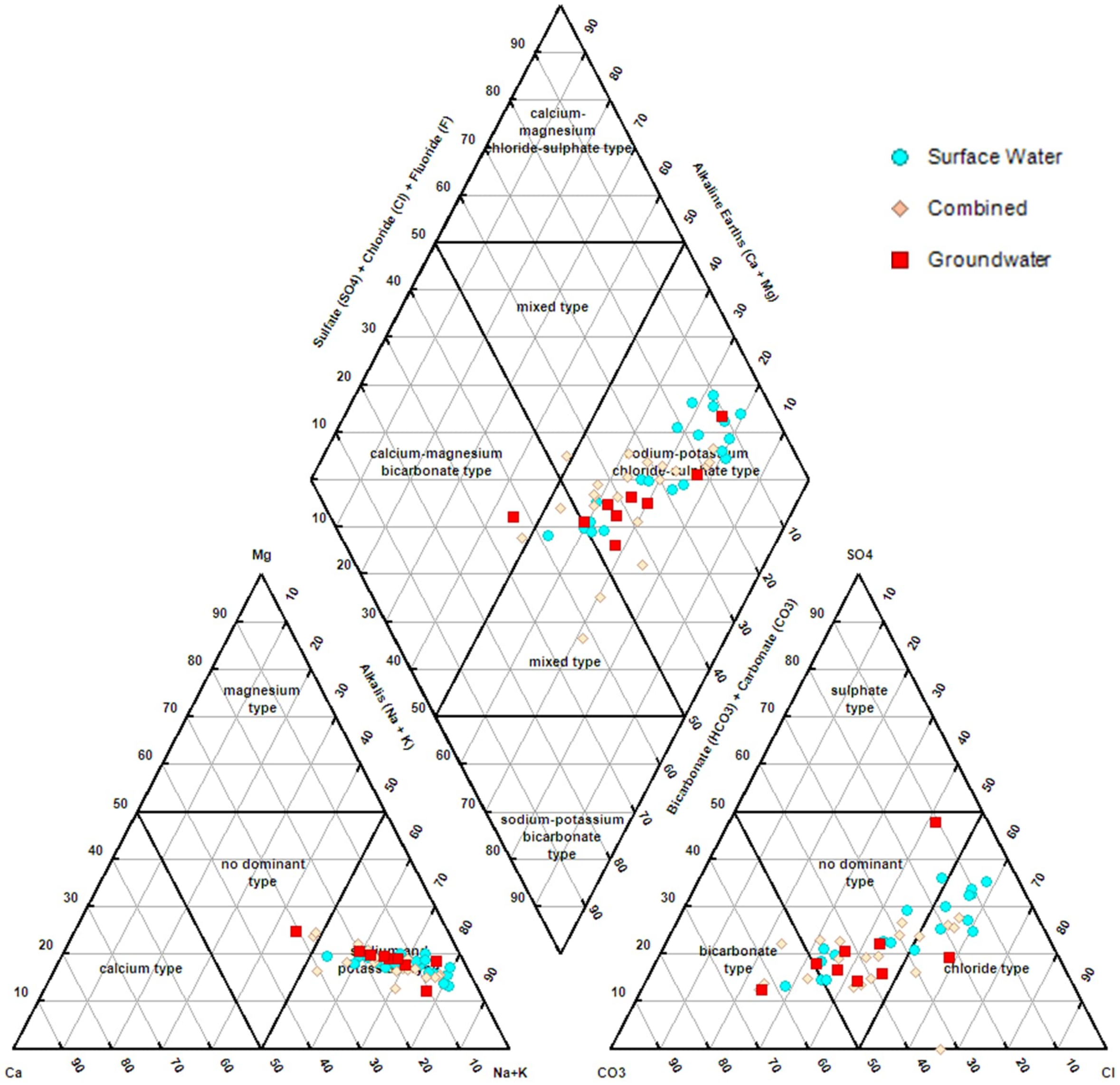


Figure 24. Piper Diagram plot of water sample results.

The Piper Diagram shows a trend between the wetland sites, with groundwater and combined sites appearing to be poorer in sodium and potassium, and richer in bicarbonate, whilst surface water and interflow sites appear to be richer in chloride and slightly richer in sulphate. Each of the samples were classified according to water signature, which showed surface water and interflow sites as being predominantly Na-Cl-SO_4, whilst groundwater and combined sites were predominantly Na-Cl-HCO_3. The water types are presented in **Table 3** whilst **Figure 25** shows the spatial variations.

The results correlate with a previous report written by GWS[5] which discusses water sampling that was undertaken in December 2020, March 2021, and May 2021. Whilst these water samples were taken from streams, rather than wetlands, they also concluded that surface water and groundwater sources show differing water chemistry. In their conclusion GWS indicates that surface water and groundwater have different water signatures, with surface water having a Na-HCO_3 water signature, whilst groundwater has a Ca-HCO_3 water signature.

Whilst the results give a good overview of water chemistry within each of the wetlands, sampling was undertaken during winter 2024 and therefore may not be fully representative of the actual water source in each wetland. This is due to rainfall that occurred during the fieldwork which may have diluted the water samples and those that indicate surface water only, may have a groundwater contribution during low flow conditions. Hence, it would strengthen the assessment to resample water from all of the wetlands and make observations of flows during the dry summer period.

[5] Waihi North Project, Assessment of Groundwater Effects – Wharekirauponga District. GWS, 14 June 2022.

Table 3. Water chemistry types for each wetland sample.

Wetland	Water Chemistry Type
Edmonds 1	Na-Cl-SO_4
Edmonds 3	Na-Cl-SO_4
Edmonds 4	Na-Cl-SO_4
Edmonds 5 (1)	Na-Cl-SO_4
Edmonds 5 (2)	Na-Cl-SO_4
Edmonds 6	Na-Cl-SO_4-HCO_3
Edmonds 7	Na-Cl-SO_4-HCO_3
Edmonds 9	Na-Cl-SO_4
Edmonds 10	Na-Cl-SO_4
Edmonds 11	Na-Cl-SO_4-HCO_3
Edmonds 12	Na-HCO_3-Cl
Edmonds 13	Na-Cl-SO_4
Edmonds 14	Na-HCO_3-Cl-SO_4
Edmonds 15	Na-Cl-HCO_3-SO_4
Edmonds 16	Na-Cl-HCO_3-SO_4
Edmonds 17	Na-Ca-Mg-HCO_3-Cl
Edmonds 18	Na-Ca-Mg-HCO_3-Cl
Edmonds 19	Na-Mg-HCO_3-Cl
Edmonds 20	Na-Ca-Mg-HCO_3-Cl-SO_4
Edmonds 21	Na-Mg-HCO_3-Cl
Edmonds 22	Na-HCO_3-Cl-SO_4
Edmonds 23 (1)	Na-Ca-HCO_3-Cl
Edmonds 23 (2)	Na-Ca-Cl-HCO_3
WKP 1	Na-Cl-HCO_3
WKP 2	Na-Mg-Ca-HCO_3-Cl

Wetland	Water Chemistry Type
Trib R 1	Na-Cl-HCO_3-SO_4
Trib R 2 (d/s)	Na-HCO_3-Cl
Trib R 2 (u/s)	Na-Cl-HCO_3
Otahu 1	Na-Cl-HCO_3-SO_4
T-Stream North 1	Na-Cl-SO_4
T-Stream North 2	Na-Cl-SO_4-HCO_3
T-Stream South 1	Na-Cl-HCO_3-SO_4
Waiharakeke 1	Na-Cl-HCO_3-SO_4
Waiharakeke 2 (1)	Na-HCO_3-Cl
Waiharakeke 2 (2)	Na-HCO_3-Cl
Waiharakeke 2 (3)	Na-Cl-HCO_3-SO_4
Waiharakeke 3	Na-Ca-HCO_3-Cl
Waiharakeke 4	Na-Ca-HCO_3-Cl
Adams 1	Na-Cl-HCO_3
Adams 2	Na-HCO_3-Cl-SO_4
Adams 3	Na-HCO_3-Cl
Adams 4	Na-HCO_3-Cl
Adams 5	Na-Cl-HCO_3-SO_4
Adams 6	Na-Cl-HCO_3-SO_4
Adams 7	Na-HCO_3-Cl
Adams 8	Na-HCO_3-Cl-SO_4
Adams 9	Na-SO4-Cl
Adams 10	Na-Mg-HCO_3-Cl
Adams 11	Na-Cl-SO_4
Adams 12	Na-Cl-SO_4-HCO_3

Map Title:

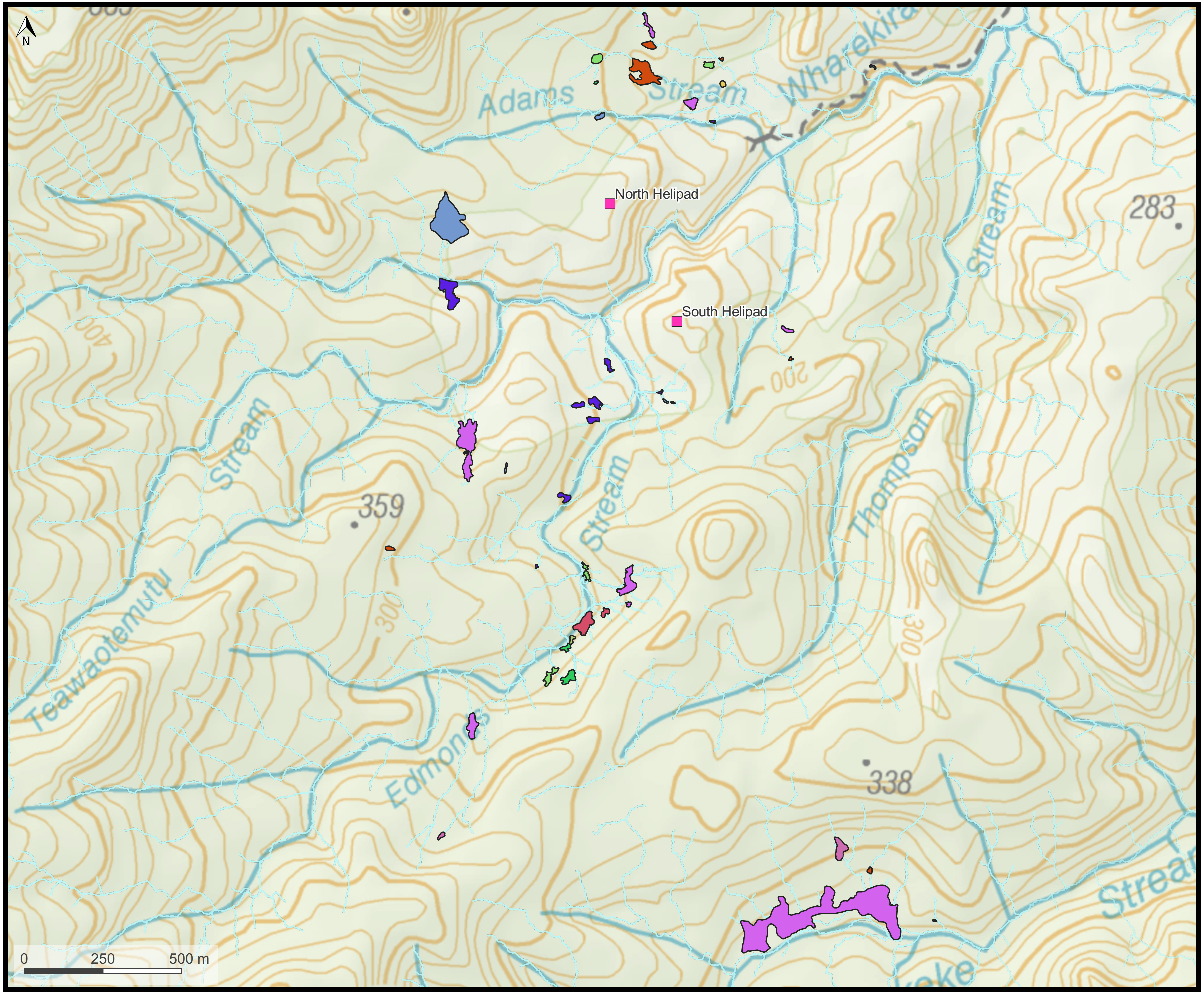
Water Signatures

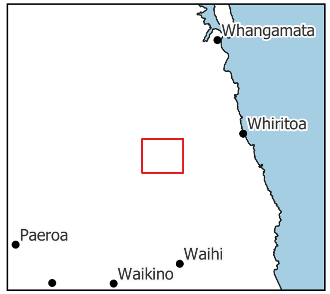
Project:

Wetland Delineation

Client:

Oceana Gold





Legend

- **Helipad**
- **Stream**
- **Na-Ca-HCO3-Cl**
- **Na-Ca-Mg-HCO3-Cl**
- **Na-Ca-Mg-HCO3-Cl-SO4**
- **Na-Cl-HCO3**
- **Na-Cl-HCO3-SO4**
- **Na-Cl-SO4**
- **Na-Cl-SO4-HCO3**
- **Na-HCO3-Cl**
- **Na-HCO3-Cl-SO4**
- **Na-Mg-Ca-HCO3-Cl**
- **Na-Mg-HCO3-Cl**

Data Provenance

Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire

23/09/2024

Layout Name

Water Signature G:\Shared drives\Projects\Oceana Gold\WWLA0996_WKP Wetland Identification_Delineation\Technical\GIS\QGIS project files\OGL WKP Wetland Fieldwork.qgz

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Figure 25.

4. Wetlands Potentially Affected by Dewatering

Table 4 identifies which wetlands are potentially at risk of dewatering based on a combination of factors. The analysis is premised on sites that reside within the predicted area of potential groundwater depressurisation (i.e. sites outside the predicted depressurisation zone are excluded). To identify the sites that may dewater and the significance of risk, the wetlands have been ranked from 0-4, with 0 being low probability and 4 being highest probability of a dewatering effect developing, based on the following:

- Groundwater supported (1-point), or combined (0.5 points) based on field observations;
- Located on geological boundaries where contact springs may emerge (1-point);
- Located within the modelled groundwater DTW < 1m (1-point); and,
- Predominantly HCO_3 water signatures (1-point).

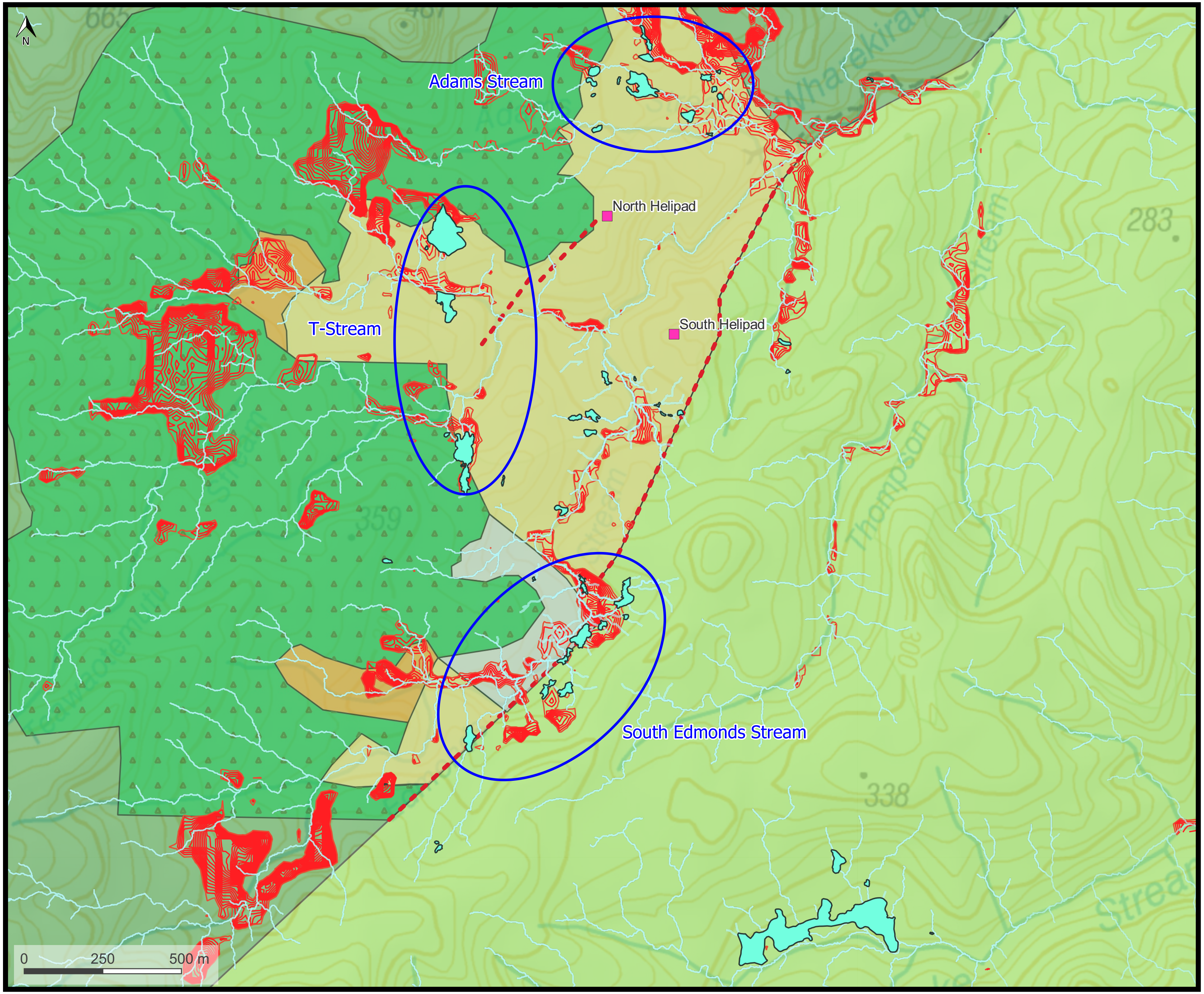
Using the above information gives three main areas where there is a potential risk of dewatering affecting wetlands: Adams Stream, T-Stream, and South portion of the Edmonds Stream (**Figure 26**). Whilst there are a couple of wetlands potentially at risk outside of these zones, this gives an indication where to focus future monitoring and mitigation methods.

Table 4. Wetlands potentially affected by dewatering.

Wetland	Wetland type based on field observations	Located near a geological boundary (Yes/No)	Located within a DTW < 1 m zone? (Yes/No)	Water signature	Wetland potentially affected by dewatering (0-4 based on criteria met)
Edmonds 1	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 2	Surface Water	No	No	N/A	0
Edmonds 3	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 4	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 5	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 6	Surface Water	No	No	Na-Cl-SO_4-HCO_3	0
Edmonds 7	Surface Water	No	No	Na-Cl-SO_4-HCO_3	0
Edmonds 8	Surface Water	Yes	No	Na-Cl-SO_4	1
Edmonds 9	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 10	Surface Water	No	Yes	Na-Cl-SO_4	1
Edmonds 11	Surface Water	No	No	Na-HCO_3-SO_4-Cl	0
Edmonds 12	Surface Water	No	No	Na-HCO_3-Cl	0
Edmonds 13	Surface Water	No	No	Na-Cl-SO_4	0
Edmonds 14	Combined	Yes	Yes	Na-Cl-HCO_3-SO_4	2.5
Edmonds 15	Combined	Yes	Yes	Na-Cl-HCO_3-SO_4	2.5
Edmonds 16	Combined	Yes	Yes	Na-Cl-HCO_3-SO_4	2.5
Edmonds 17	Groundwater	Yes	Yes	Na-Ca-Mg-HCO_3-Cl	4
Edmonds 18	Combined	Yes	Yes	Na-Ca-Mg-HCO_3-Cl	3.5
Edmonds 19	Combined	Yes	Yes	Na-Mg-HCO_3-Cl	3.5
Edmonds 20	Combined	Yes	Yes	Na-Ca-Mg-HCO_3-Cl-SO_4	2.5
Edmonds 21	Combined	Yes	Yes	Na-Mg-HCO_3-Cl	3.5
Edmonds 22	Combined	Yes	Yes	Na-HCO_3-Cl-SO_4	2.5
Edmonds 23	Combined	No	No	Na-Ca-Cl-HCO_3	1.5

Wetland	Wetland type based on field observations	Located near a geological boundary (Yes/No)	Located within a DTW < 1 m zone? (Yes/No)	Water signature	Wetland potentially affected by dewatering (0-4 based on criteria met)
Edmonds 24	Combined	Yes	Yes	N/A	2.5
Otahu 1	Surface Water	No	No	Na-Cl-HCO_3-SO_4	0
Otahu 2	Surface Water	Yes	No	N/A	1
WKP 1	Combined	No	No	Na-Cl-HCO_3	1.5
WKP 2	Surface Water	No	Yes	Na-Mg-Ca-HCO_3-Cl	2
Trib-R 1	Groundwater	No	Yes	Na-Cl-HCO_3-SO_4	2
Trib-R 2	Surface Water	No	No	Na-HCO_3-Cl	1
T-Stream North 1	Surface Water	No	Yes	Na-Cl-SO_4	1
T-Stream North 2	Combined	Yes	Yes	Na-Cl-SO_4-HCO_3	2.5
T-Stream South 1	Combined	Yes	Yes	Na-Cl-HCO_3-SO_4	2.5
Adams 1	Combined	No	Yes	Na-Cl-HCO_3	2.5
Adams 2	Groundwater	No	Yes	Na-HCO_3-Cl-SO_4	2
Adams 3	Groundwater	No	Yes	Na-HCO_3-Cl	3
Adams 4	Groundwater	No	Yes	Na-HCO_3-Cl	3
Adams 5	Groundwater	No	Yes	Na-Cl-HCO_3-SO_4	2
Adams 6	Groundwater	No	Yes	Na-Cl-HCO_3-SO_4	2
Adams 7	Combined	No	Yes	Na-HCO_3-Cl	2.5
Adams 8	Combined	Yes	Yes	Na-HCO_3-Cl-SO_4	2.5
Adams 9	Groundwater	Yes	Yes	Na-SO_4-Cl	3
Adams 10	Groundwater	Yes	No	Na-Mg-HCO_3-Cl	3
Adams 11	Groundwater	No	Yes	Na-Cl-SO_4	2
Adams 12	Combined	Yes	No	Na-Cl-SO_4-HCO_3	1.5
Waiharakeke 1	Surface Water	No	No	Na-Cl-HCO_3-SO_4	0
Waiharakeke 2	Surface Water	No	No	Na-HCO_3-Cl	1

Wetland	Wetland type based on field observations	Located near a geological boundary (Yes/No)	Located within a DTW < 1 m zone? (Yes/No)	Water signature	Wetland potentially affected by dewatering (0-4 based on criteria met)
Waiharakeke 3	Surface Water	No	No	Na-Ca-HCO_3-Cl	1
Waiharakeke 4	Surface Water	No	No	Na-Ca-HCO_3-Cl	1



Map Title:

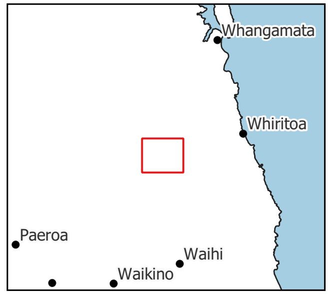
Wetlands at Potentially Higher Risk

Project:

Wetland Delineation

Client:

Oceana Gold



Legend

- Helipad
- Stream
- Veins

DTW_324

- 0 m
- 1 m
- Dacite-Andesite Pyroclastic Sediments
- Omahia Andesite Cover
- Rhyolite Flow
- Rhyolitic Pyroclastics
- Omahia Andesite
- Whiritoa Andesite
- Wetland

Data Provenance

Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire

20/09/2024

Layout Name

Wetlands at Risk G:\Shared drives\Projects\Oceana Gold\WWLA0996_WKP Wetland Identification_Delineation\Technical\GIS\QGIS project files\OGL WKP Wetland Fieldwork.qgz

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Figure 26.

5. Wetland Hydrological Assessment

5.1 Wetland Hydrology Criteria

To assess the impact of potential groundwater dewatering on wetlands and whether the wetlands can be solely supported by rainfall and/or surface runoff, analysis of the likelihood of inundation and soil saturation in accordance with the guidance criteria for wetland hydrology for New Zealand[6] was undertaken. This was performed using outputs from a Soil Moisture Water Balance Model (SMWBM) (refer to **Section 5.3** for further detail) were used.

To meet the wetland hydrology criteria[6], an area must be:

- Inundated for at least seven consecutive days during the growing season in most years (50 % probability of recurrence); or
- Saturated at, or near the surface, for at least 14 consecutive days during the growing season in most years (50 % probability recurrence). Soils can be considered saturated if the water table is within 15 cm of the surface for sands, and 30 cm for all other soils.

5.2 Growing Season

The Wetland Hydrology Tool[6] defines the growing season based on data from NIWA, which is premised on a methodology developed for the United States by the US Army Corps of Engineers, 2010. This tool states that the growing season for the Coromandel-Waihi area would be from July – June (almost continuous throughout the year). Applying this approach to New Zealand conditions, where the rainfall regime is dominated by and extremely reliable during winter (alone), means that most areas within this part of the North Island would be classified as wetlands because in most years they will be inundated for at least 7 consecutive days during winter. In the case of this catchment, using a continuous growing season would not accurately represent the conditions observed because there are many areas that are not wetland.

Therefore, for the purpose of this report, analysis has been carried out using the growing season:

- given in the MfE guidance for context only, and
- considered to be the warmer summer months from November – April (6 months).

5.3 Soil Moisture Water Balance Model (SMWBM)

A rainfall runoff model was used to simulate the long-term historic flow and soil moisture regime of the entire project area. As indicated previously, the rainfall runoff model used is known as the Soil Moisture Water Balance Model (SMWBM).

The SMWBM utilises daily rainfall and evaporation input data to calculate the soil conditions under natural rainfall conditions as illustrated in **Figure 27**. The model operates on a daily time step during dry days, and an hourly time step during days in which rainfall occurs. This enables peak flows to be assessed more accurately than a daily time step model.

[6] Ministry for the Environment (MfE), 2021. Wetland delineation hydrology toll for Aotearoa New Zealand. Wellington: Ministry for the Environment.

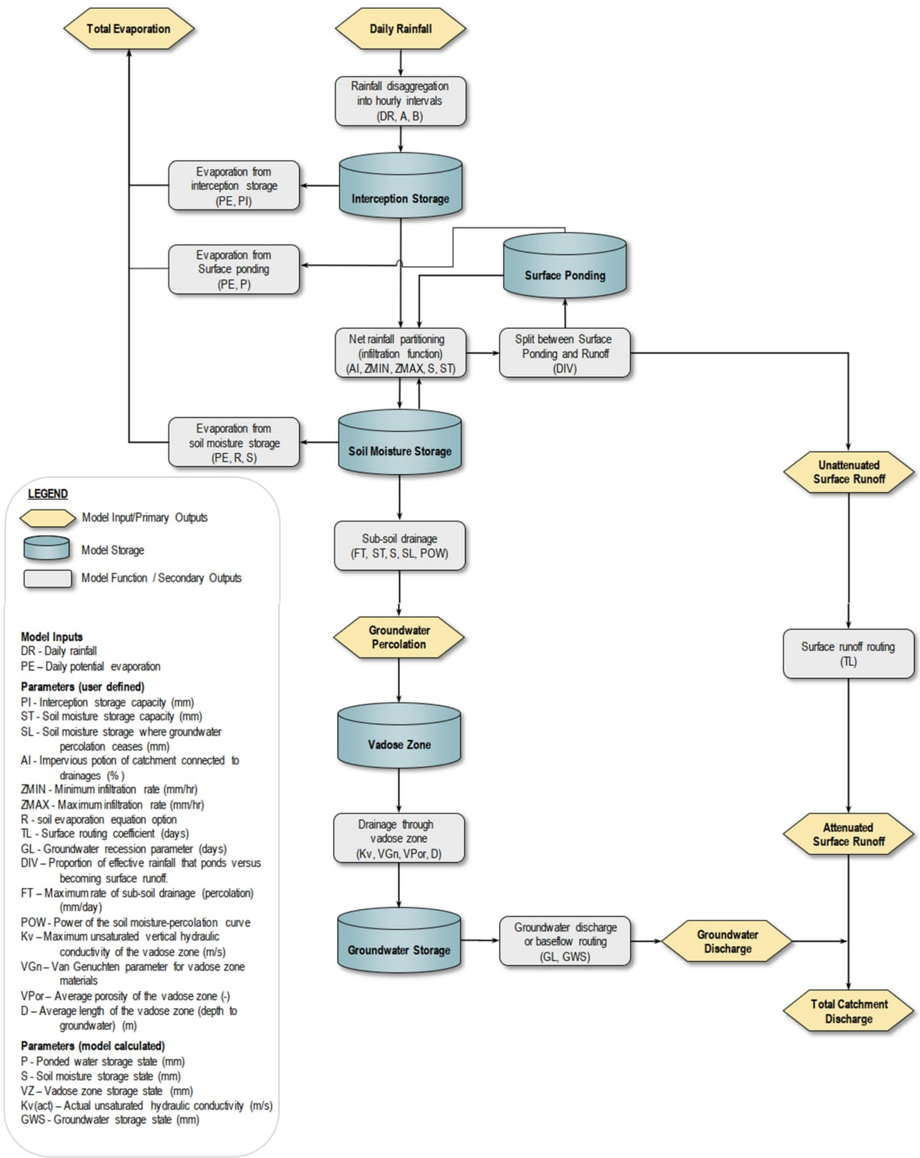


Figure 27. SMWBM flow diagram and parameters.

5.3.1 Rainfall and Evaporation

Daily rainfall was obtained from a derived Wharekirauponga dataset for the period January 1917 to March 2024. This is the same dataset used by GHD in their modelling[7].

Measured evaporation data from the Waihi climate logger data was used, along with data from NIWA's Cliflo station Paeroa Ews to fill in any missing dates. The monthly mean was calculated and used to extend the dataset back to 1917 to match the rainfall period.

Mean annual rainfall and evaporation is 2,740 and 905 mm, respectively. Mean monthly rainfall and evaporation are shown in **Figure 28,** which indicates that rainfall typically exceeds evaporation year-round.

[7] Wharekirauponga Hydrology Modelling Report, OceanaGold Ltd (17 August 2023).

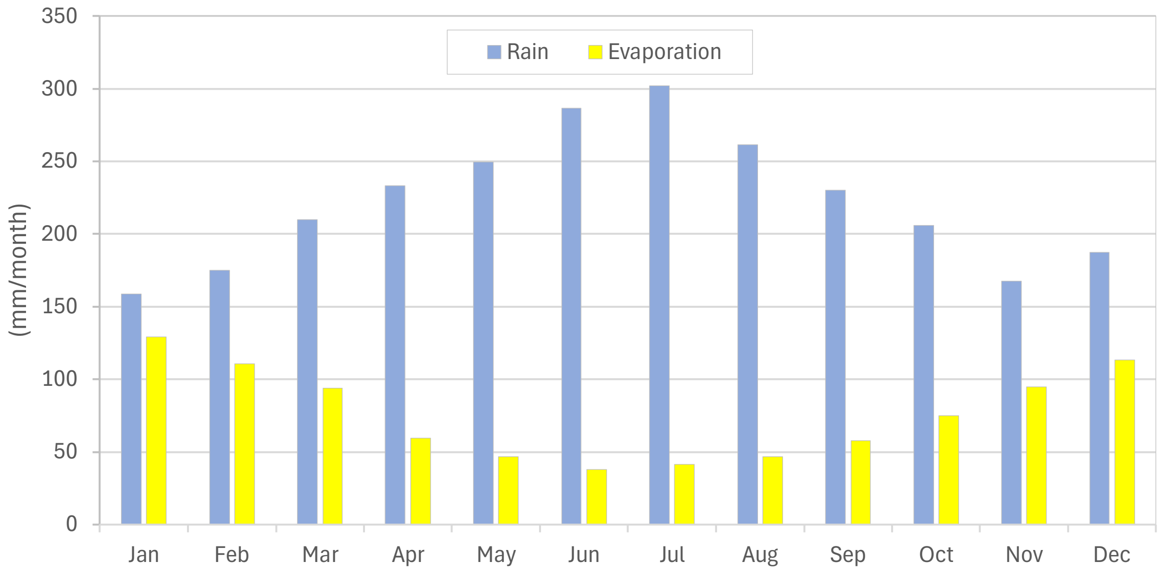


Figure 28. Mean monthly rainfall and evaporation for Wharekirauponga and Paeroa.

As the available evaporation data did not account for catchment characteristics such as dense forest and steep slopes, the SMWBM parameters were specified to account for the anticipated soil evaporation levels in the catchment. By reducing the value of the R parameter (soil evaporation equation) and increasing the value of PI (interception storage capacity), the soil evaporation to rainfall ratio decreased to an average of 10% (**Figure 29**). This is in line with the 10% expected for dense forested areas (Sturman & Spronken-Smith, 2001).

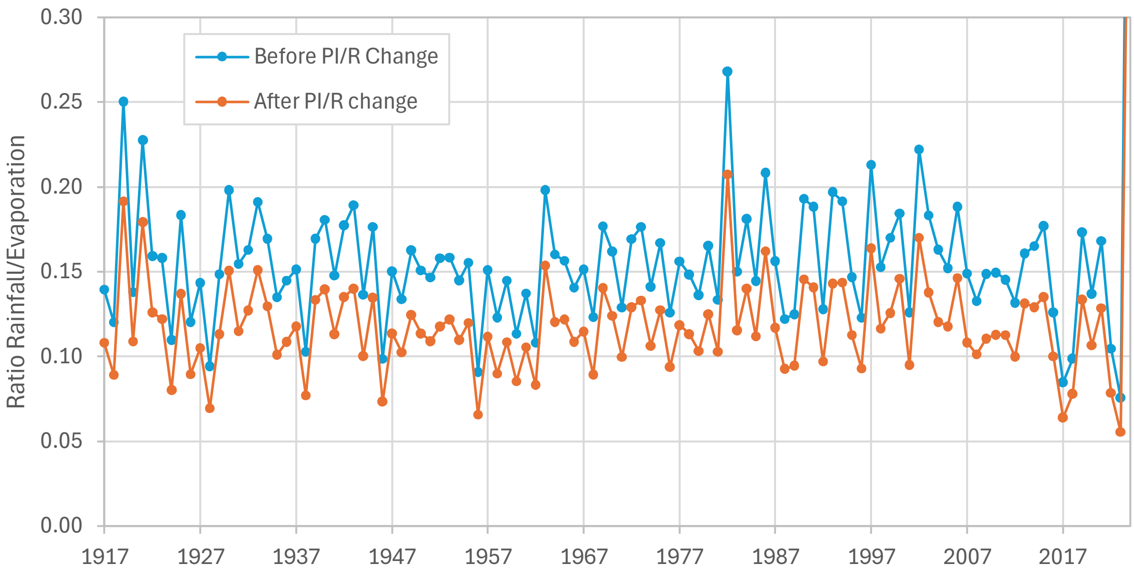


Figure 29. Changes to soil evaporation to reflect catchment characteristics.

5.3.2 Model Calibration

A rainfall runoff model was developed for the entire project area and configured with model parameters based on the catchment's physical characteristics (loamy soils, dense forest vegetation, steep slopes). This information was based upon field observations and the Landcare Research S-Maps. The Fundamental Soils

Layers (FSL) provided a starting point for the model parameters, and this was then updated according to field observations.

In the absence of a long-term automated gauging station within the project area, the model has been calibrated to spot gaugings undertaken in various streams in the area such as Edmonds Stream, on a fairly regular basis since 2018 (**Figure 30**). The model was scaled for each catchment to check the calibration.

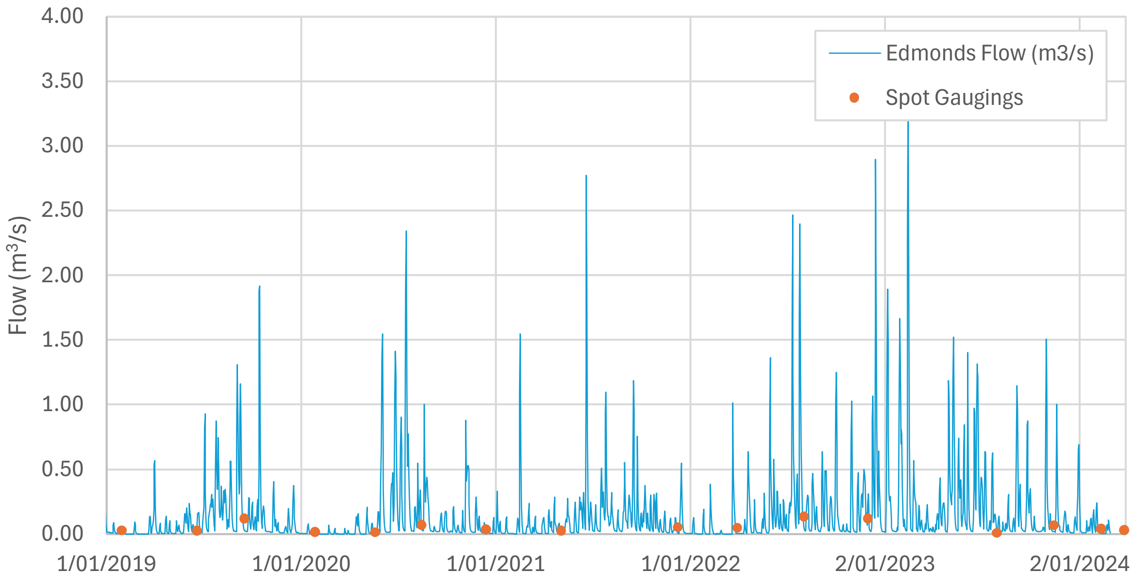


Figure 30. Simulated flow scaled for the Edmonds Stream.

5.4 Soil Saturation

As discussed in **Section 5.2**, to meet the wetland hydrology criteria[6], an area must be:

- Inundated for at least seven consecutive days during the growing season in most years (50 % probability of recurrence); or
- Saturated at, or near the surface, for at least 14 consecutive days during the growing season in most years (at least 50 % probability recurrence). Soils can be considered saturated if the water table is within 15 cm of the surface for sands, and 30 cm for all other soils.

Modelled soil moisture was used to determine the likelihood of the soils being inundated or saturated to meet the above criteria. In order to determine the depth of saturation, 80% of the maximum soil moisture storage capacity was used (80% of the ST value). Saturation occurs when the soil moisture is above the field capacity. The point of field capacity is reached after a storm when the readily drainable pore water is released from the soil, which we have assumed as the top 20% of the soil moisture capacity.

5.4.1 Base Model

As discussed in **Section 5.3.2**, the model was calibrated to the project area as a whole. However, analysis of the soil moisture conditions against the MfE wetland "growing season" criteria demonstrated that all land parcels within the catchment would be a wetland using this criterion. Analysis of the calibrated model using the 6-month growing season definition addressed the wider catchment issue but highlighted that a separate model set is needed for the wetlands to retain water in these areas during the growing season. A sub-model was developed for the wetland areas with soil physical properties reflective of greater of water retention. This sub-model took into account areas with flatter topography, depressions, and more clayey subsoils.

The discussion above is summarised in **Table 5**.

Table 5. Summary of wetland status using the two "growing season" criteria.

Wetland (Yes/No)	Calibrated Model	Wetland Specific Model	
	MfE (11.5 Months)	WWLA (6-months)	WWLA [1] (6-months)
Catchment as a whole	Yes	No	No
Wetland area	Yes	No	Yes
Comments	It is not appropriate that the entire catchment is classified as wetland, hence why we question the growing season criteria.	It is not appropriate that the wetland areas would be classified as non-wetland, hence signalling a need to modify the wetland area parameters.	Wetland area conforms to wetland over the 6-month growing season criteria (i.e. still wet in summer).
1. Model based on the changes to the parameters described below.			

The wetland areas sub-model included parameters adjustments from the calibrated model to reflect the following differences in the wetlands' physical properties:

- ***Slope*** - Generally flatter slopes with higher propensity for depressional areas subject to ponding during heavy rainfall, hence the parameter DIV that governs the partitioning of excess rainfall between surface runoff (0) and pooling (1) was increased from 0 to 0.98.
- ***Soil Type*** - Generally heavier more clayey hydric sub-soils hence the parameter FT that governs subsoil drainage was reduced by approximately 40% from 0.7 mm/day to 0.3 mm/day.
- ***Vegetation Cover*** – The vegetation was much denser in these sites and therefore the PI parameter was increased from 4 mm to 5 mm.
- ***Maximum Infiltration Rate*** – These sites were located in slightly flatter areas where rainfall runoff would decrease, increasing infiltration. The Z-Max parameter was increased from 1.7 mm/hour to 2 mm/hour.

Furthermore, some of the wetlands observed in the Adams Catchment showed slightly different characteristics, therefore the parameters were adjusted to reflect this in the Adam's sub-model

- ***Soil Moisture Storage Capacity*** – Peaty soils observed which have greater storage capacity, hence the parameter ST was increased from 160 mm to 170 mm.
- ***Maximum Infiltration Rate*** – These sites were located in slightly flatter areas where rainfall runoff would decrease, increasing infiltration. The Z-Max parameter was increased from 2 mm/hour to 2.5 mm/hour.
- ***Vegetation Cover*** – The vegetation was much less dense in these sites and therefore the PI parameter was decreased from 5 mm to 3 mm.

Figure 31 shows the comparison between the soil moisture conditions of the project area and the wetlands sub-model, whilst **Table 6** summarises the data from the soil moisture wetland criterion analysis.

Table 6. Summary of soil saturation analysis for base models.

	Project Area Model	Wetland Sub-Model	Adams Sub-Model
Number of events that meet criteria between 1917-2024	51	156	172
Annual probability recurrence (%)	38 %	87 %	92 %

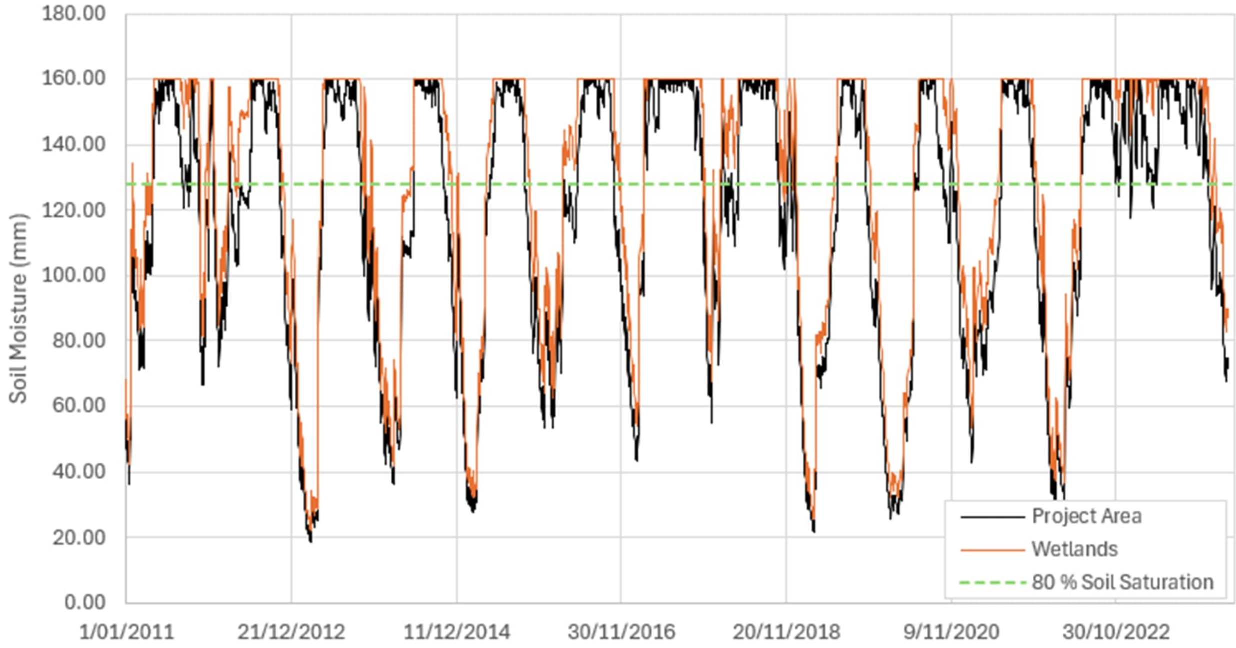


Figure 31. Simulated soil saturation comparison for the project area and the wetlands.

5.5 Simulated Dewatering Effects

To simulate the potential effects of dewatering on the catchment, and in particular, the wetlands, the power of the soil moisture percolation (drainage) curve (POW) value was decreased, which has the effect of increasing the drainage rate across the middle of the range of soil saturation levels promoting more rapid sub-soil drainage. The median drainage rate in the project area increased from 0.41 mm/day to 0.57 mm/day with POW changed from 2 to 0.5.

The objective of this simulation was to ascertain whether surface hydrological process governed by predominantly rainfall, would be adequate to maintain wetland status even with much higher sub-soil drainage.

The wetlands within the project area with simulated dewatering have an 83 % annual probability recurrence rate, with 141 events noted over the 1917-2024 period used for the model simulation. This means that the wetlands areas **are still considered** to be true wetlands based on the criteria.

The wetlands in the Adams catchment area with simulated dewatering have an 87 % annual probability recurrence rate, with 163 events noted over the 1917-2024 period used for the model simulation. This means that the Adam's wetlands **are still considered** to be true wetlands based on the criteria.

Figure 32 shows the comparison between the soil moisture conditions of the wetlands prior to and with drainage conditions simulated, whilst **Table 7** summarises the data from the soil moisture wetland criterion analysis.

Table 7. Summary of soil saturation analysis for drainage models.

	Project Area Model	Wetland Sub-Model	Adams Sub-Model
Number of events that meet criteria between 1917-2024	40	141	163
Annual probability recurrence (%)	33 %	83 %	87 %

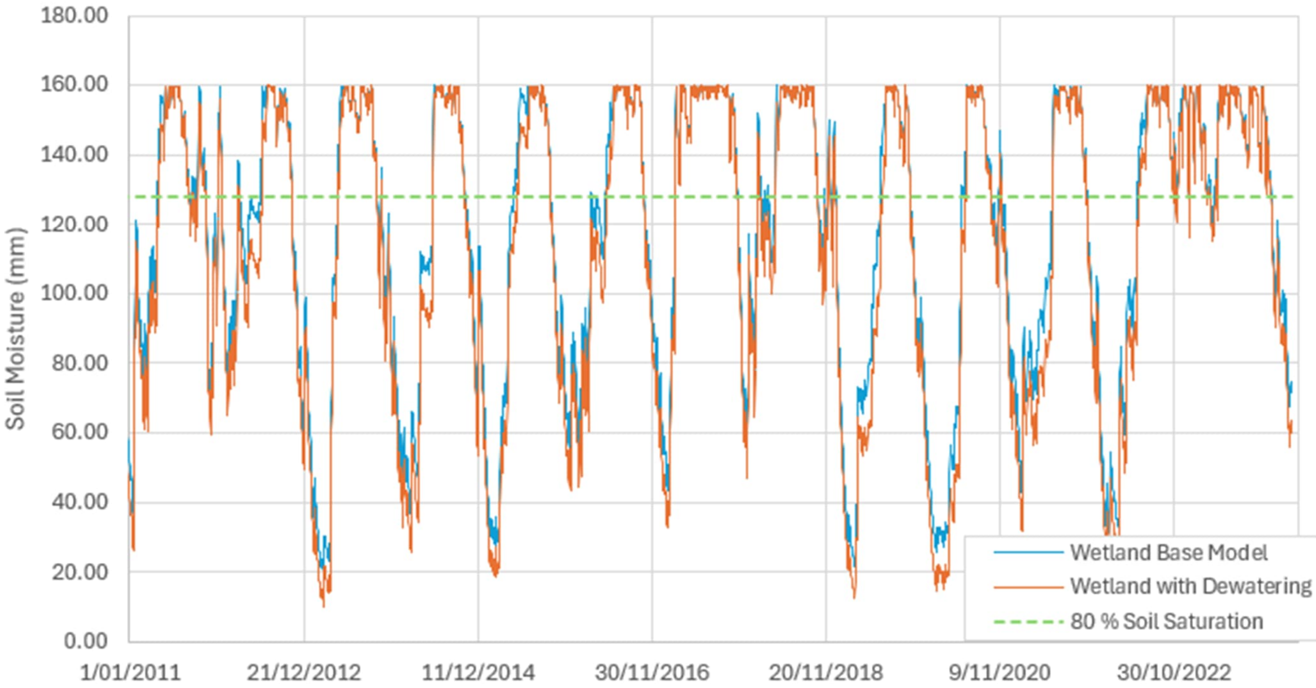


Figure 32. Simulated soil saturation of the base model and dewatering in the wetlands.

Simulating dewatering in the wetlands shows that the average depth of sub-soil drainage increased from 0.21 mm/day to 0.27 mm/day. This change suggests that the wetland may experience very slight reduction in moisture conditions. For example, if there was no rainfall for 30 days (which does not occur in reality), the moisture content of the wetland would be approximately 1.8 mm drier under the dewatering scenario, which is approximately 1% of the soil moisture content. The practical implication of this is expected to be an imperceivable change.

The relative change between the SMWBM results with and without the effects of drainage are shown on **Figure 33** where higher percolation rates (loss to groundwater beneath the wetland) can be observed.

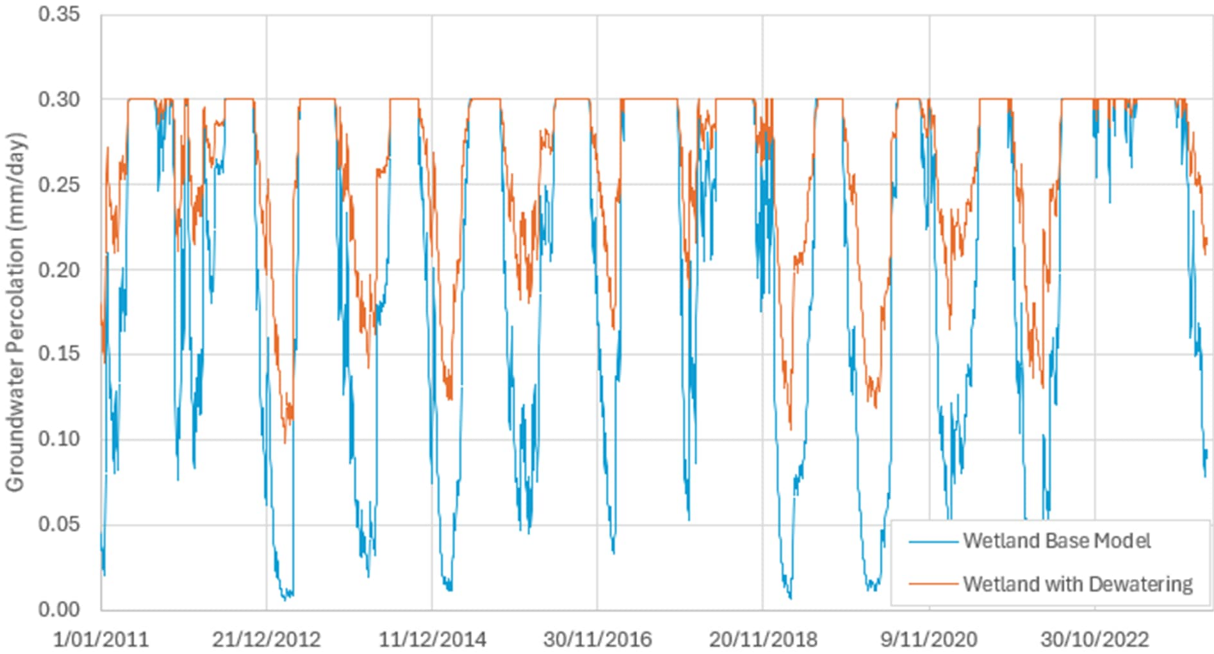


Figure 33. Simulated groundwater percolation of the base model and dewatering in the wetlands.

5.6 Rainfall Residual Mass

A residual rainfall mass plot, which depicts the departure of monthly rainfall from the mean, is shown in **Figure 34**. The analysis performed in this study was based on the departure from monthly average rainfall rather than annual average rainfall (i.e. January departure was calculated from the long-term January average). This approach exacerbates unusual seasonal events and dampens periods where rainfall is close to normal for that time of year. The 6-month rolling average of each monthly departure was calculated. Values plotted above the mean or zero-line are wetter than normal six-month periods, and vice versa.

Drought periods are indicated by orange ovals, whilst wetter than average periods are indicated by red ovals.

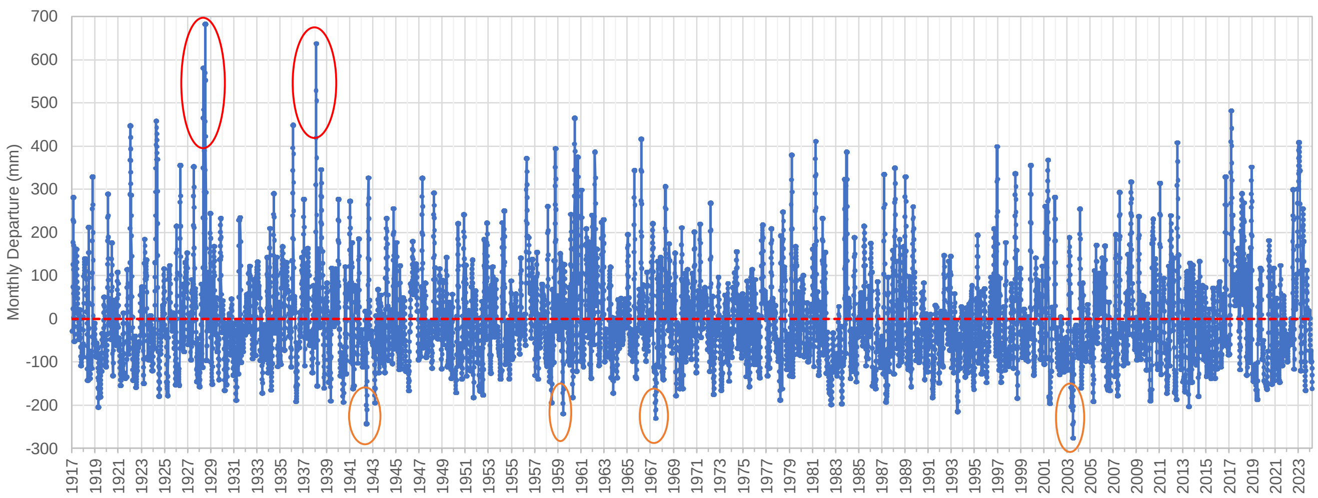


Figure 34. Rainfall 6-month rolling average departure from mean monthly.

5.6.1 Dry and Drought Periods

To evaluate the potential worst-case scenario of dewatering combined with drought conditions, the 2003-2004 dryer than average period was assessed against the model outputs (**Table 8**). The simulated soil saturation comparison is shown in **Figure 35**.

Table 8. Summary of worse-case scenario statistics for 2003-2004.

	Wetlands Sub-Model	Wetlands Dewatering Sub-Model
Days saturated from January 2023 – December 2024	114	101
Maximum consecutive days saturated	35	34
Number of events that meet the wetland criteria	3	3

Overall, there is a decrease in the number of days that saturation over 80 % occurs. Along with this there is a slight decrease in the number of consecutive days that saturation occurs. However, this does not change the outcome when assessing the period against the wetland criteria despite there being a 12 % decrease in total saturated days.

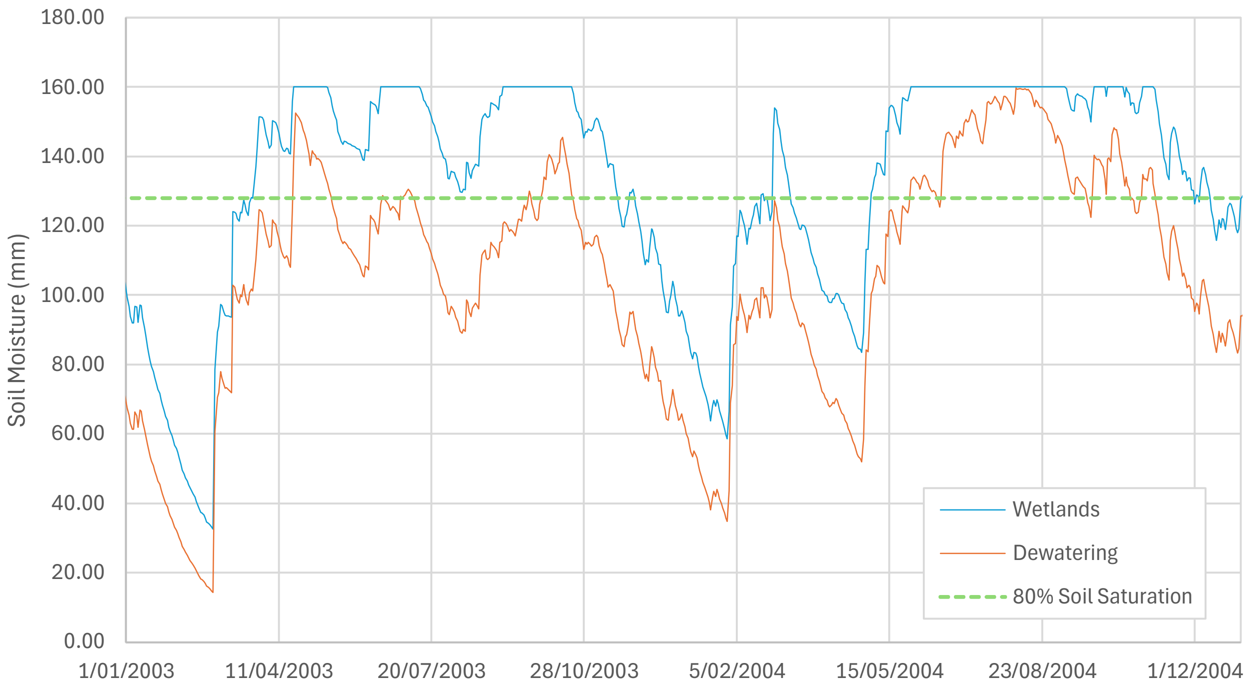


Figure 35. Simulated soil saturation comparison for the wetlands and dewatering during the 2003-2004 drought period.

A longer drought period, 2007-2008, recognised by NIWA[8], was also assessed against the model outputs (**Table 9**). The simulated soil saturation comparison is shown in **Figure 36**.

Table 9. Summary of worse-case scenario statistics for 2007-2008.

	Wetlands Sub-Model	Wetlands Dewatering Sub-Model
Days saturated from January 2023 – December 2024	82	76
Maximum consecutive days saturated	22	18
Number of events that meet the wetland criteria	4	2

[8] https://niwa.co.nz/hazards/droughts

Overall, there is a decrease in the number of days that saturation over 80 % occurs. Along with this there is a slight decrease in the number of consecutive days that saturation occurs. Furthermore, in this case, the number of events to meet the wetland criteria also decreases. However, even with this reduction, the wetlands would still meet the wetland criteria.

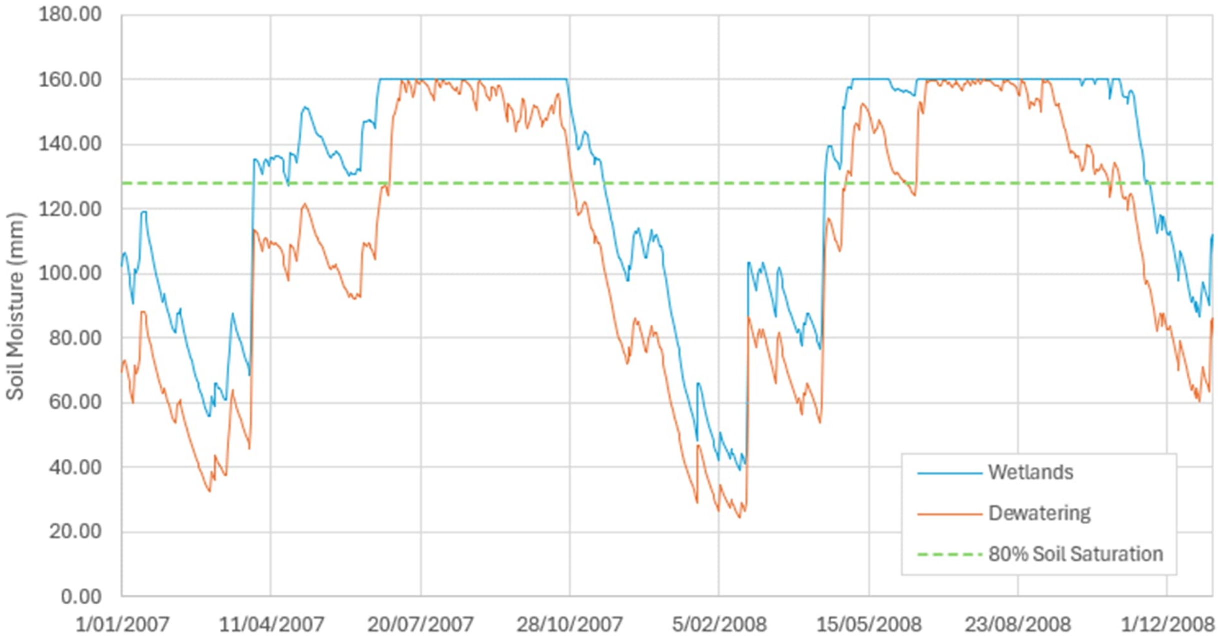


Figure 36. Simulated soil saturation comparison for the wetlands and dewatering during the 2007-2008 drought period.

5.7 SMWBM Conclusions

The results from the SMWBM show that if dewatering of the shallow sub-soil was to occur, there is potential for a reduction in the number of consecutive days where soil saturation levels at the surface are at or above 80 % saturation. Whilst there is a slight reduction overall, the wetland criteria is still met for the 1917 – 2024 period modelled, with the annual recurrence reducing from 87 % to 83 %.

Furthermore, the results from the long-term analysis show that even if dewatering were to occur at the same time as an extremely dry period or extended drought, the wetlands would remain saturated enough to still be considered wetlands under the wetland criteria.

The SMWBM is conservative in the outputs in the sense that it does not take into account inputs from other sources of water. For combined surface water and groundwater wetlands, there is an additional source of water (surface water) supporting the wetland. This suggests that those wetlands are even more likely to remain saturated enough to meet the criteria throughout seasonal variations and potential dewatering.

As a result, it can be concluded, based on the modelling, that the wetlands can be supported by rainfall alone and given the geomorphological position of the wetlands identified being typically in depressions with marked banks, with some form of hydrological input, no change to the wetland extent is anticipated.

6. Discussion

6.1 Summary

Fifty wetland sites have been identified in seven different catchments within the project area ranging in size from 7.3 (Edmonds 2) to 10,527.7 m^2 (T-Stream North 2), with a median size of 455.5 m^2. This excludes Waiharakeke 2 which is much larger than the other observed wetlands at 36,327.1 m^2. Those wetlands have been delineated and characterised to understand to what extent the surface water hydrology and the shallow groundwater system interacts.

Soil Moisture Water Balance Modelling (SMWBM) has been undertaken to simulate the hydrological function of existing wetland conditions and what might occur if a drainage effect were to be induced through a lowering of the shallow groundwater system in response to lowering the levels of the deep groundwater system to enable mining. The results of that modelling show that all the wetlands in the Wharekirauponga Catchment can be supported by climate alone. That is because the wetlands are typically located in depressions with marked banks and often have some form of additional hydrological input. As the SMWBM modelling does not consider this hydrological input, the results are conservative.

Due to the geomorphological position of the wetlands and observed characteristics, the wetland extents are not anticipated to change, even if a lowering of shallow groundwater levels were to occur. The soil saturation is expected to remain high enough for the wetlands to still be considered wetlands under the wetland criteria.

There is potential that the number of consecutive days that the soils will be saturated will reduce during a year, however, the model results show that even if dewatering were to occur at the same time as drought conditions (worst case scenario), the wetlands would still meet the criteria of being a functional wetland.

Of the fifty sites assessed, eight wetlands have been identified as having a higher susceptibility of being affected (relative to the others) if a linkage between the deep and shallow groundwater systems develops due to dewatering. Those locations have been identified due to their position relative to the catchment geology, the modelled depth to groundwater, the water chemical signature, and the field-based observations. Those sites are as follows:

- Edmonds 17
- Edmonds 18
- Edmonds 20
- Edmonds 22
- Adams 3
- Adams 4
- Adams 9
- Adams 10.

Given there may be shallow groundwater inputs into those wetlands, and that those inputs could potentially reduce if the groundwater levels were to lower because of deep dewatering, monitoring of the wetland hydrology is recommended. Assessing how wetland conditions might change as a function of seasonal variation is important both in terms of the observations made and the ability to use that information to calibrate the water balance modelling undertaken in this assessment. That will provide further confidence in the modelling and ensure that any hydrological change observed in the wetlands is not falsely attributed to dewatering when in fact it might be a natural deviation from previous conditions because of other changes such as prolonged periods without rain.

6.2 Conclusions

This assessment has concluded that the potential effects on the inland wetlands in the Wharekirauponga Catchment due to the proposed mine dewatering are less than minor.

No measurable change in the extents of the wetlands is expected beyond that which occurs naturally due to seasonal variation.

There is the potential for the proportions of surface water and groundwater entering the wetlands to change if a lowering of shallow groundwater levels did, in fact, occur. Such a change could result in a shift in the wetland water chemistry more towards being surface water dominated (Na-Cl-SO_4) rather than groundwater dominated (Na-Cl-HCO_3). Such a change in water chemistry would require an assessment of the effects on the ecology of the wetland to be undertaken.

6.3 Monitoring Recommendations

In order to gain a better understanding of the normal, seasonal fluctuations in the water levels of each wetland, it is suggested to install monitoring piezometers with sensors at each of the eight wetlands sites identified above, as per the USACE Guidelines.

As shown in **Figure 37** below, a standpipe piezometer would be installed within the wetland extent, and another outside the wetland extent. This would allow for the analysis of the inferred groundwater linkage between the Wetland Water Level (WWL), and the Groundwater Level (GWL).

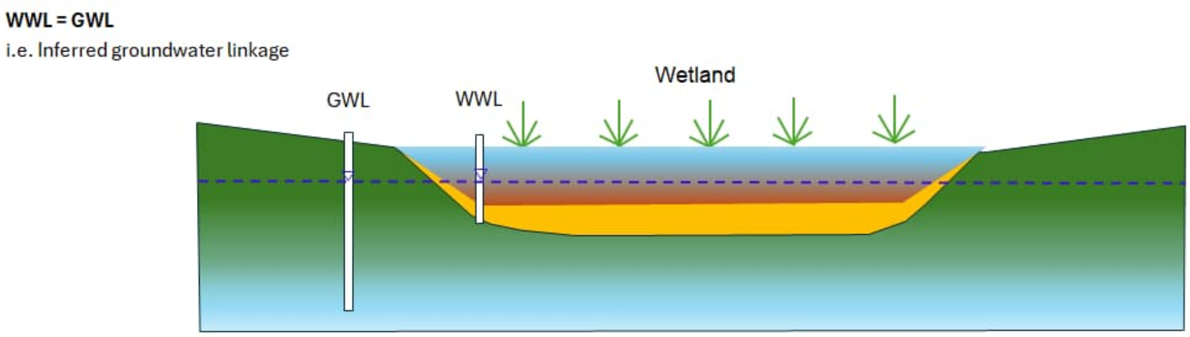
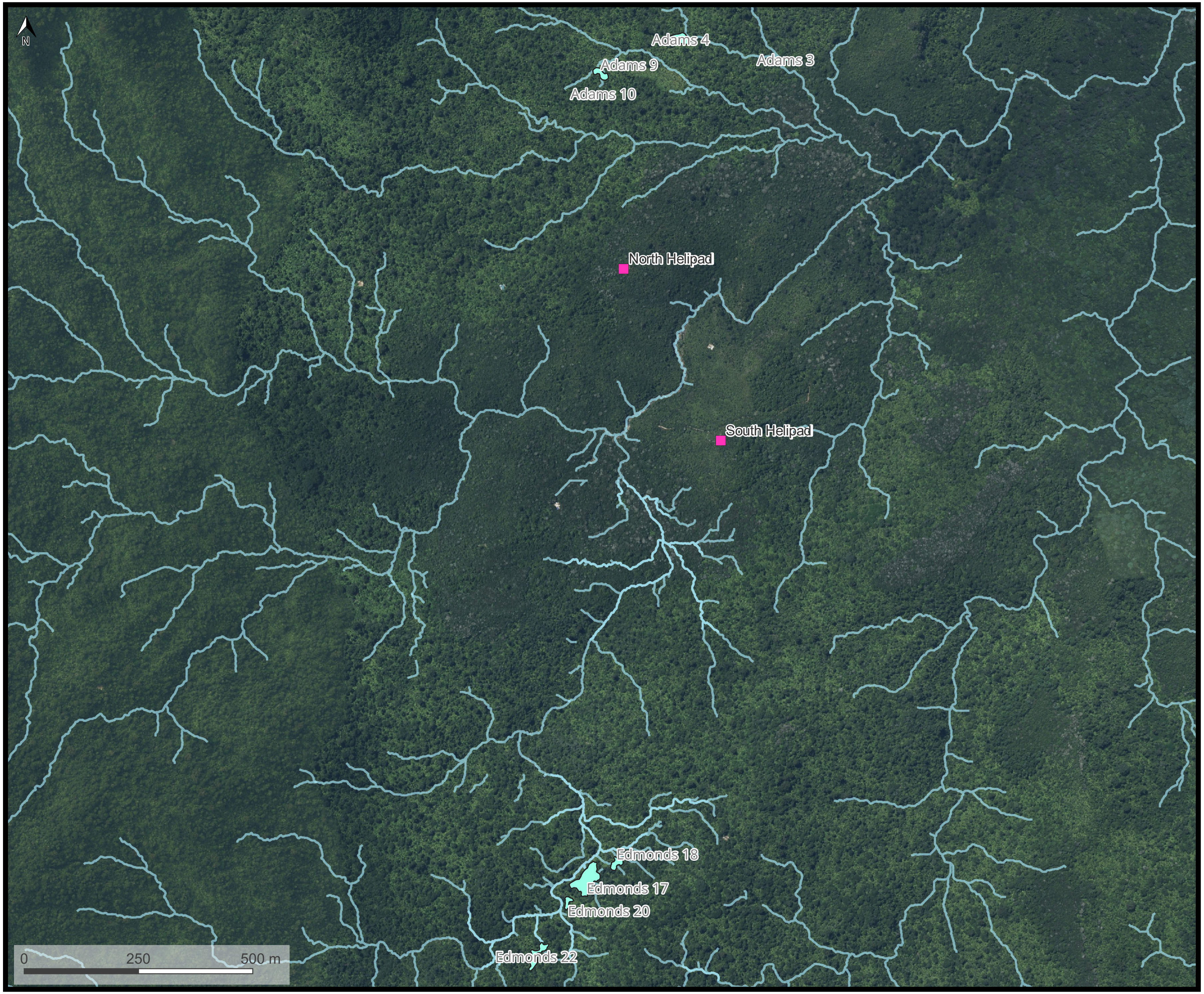


Figure 37. Wetland Piezometer Installation.

The aim of this monitoring would be to collect several years of baseline data prior to the commencement of stoping where wetland water levels and groundwater levels outside of the wetland are continuously measured. In addition, a control wetland would be established in the adjacent Waiharakeke Catchment that is predicted to be outside of the area of potential effect due to dewatering.

The baseline water level data will be used to recalibrate the SMWBM with a focus on simulated water levels and to perform statistical analysis of a longer duration dataset that can be used to derive trigger levels that would indicate a change in conditions beyond what has been observed or predicted to occur in the future from the SMWBM.

In addition to water level monitoring, we recommend that the chemistry of the wetland water is analysed to assess to what extent the relative proportions of surface water and groundwater entering the wetland changes seasonally.



Map Title:
Wetlands Potentially at Risk

Project:
Wetland Delineation

Client:
Oceana Gold

Legend

- Helipad
- Stream
- Wetland

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire
15/11/2024

Layout Name
Wetlands at risk G:\Shared drives\Projects\Oceana Gold\WWLA0996_WKP Wetland Identification_Delineation\Technical\GIS\QGIS project files\OGL WKP Wetland Fieldwork.qgz

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Figure 38.

Appendix A. Wetland Observations

A.1 Overview

This appendix presents WWLA's observations for each of the wetlands based on the Hydric Soils and Hydrology Tools Assessment as set out in the Wetland Delineation Protocols by the Ministry for the Environment (MfE). A total of 50 wetlands have been identified in the project area (**Figure A1**), with a further two sites recognised as potential wetlands based on soils and hydrology.

This appendix is structured in the manner provided in **Table A1**.

Table A1. Appendix structure.

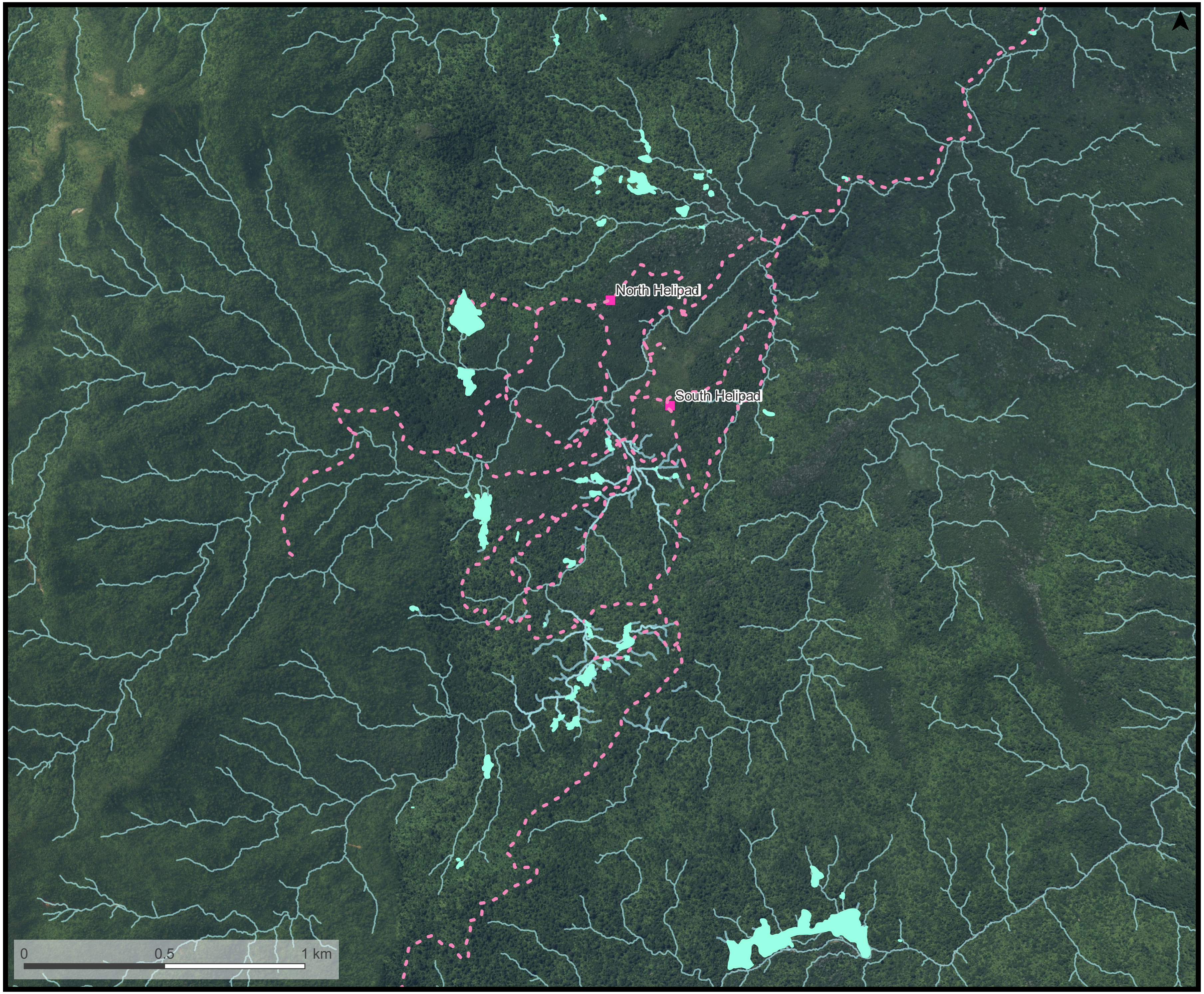
Section	Heading
A1	Overview
A2	Weather Conditions
A3	Methodology
A4	Overview of Wetland Hydrology Tool
A5	Wetland Assessment Data and Results

A.2 Weather Conditions

Five rounds of Hydrology Assessment fieldwork were conducted between February and August 2024. The weather and ground conditions during each round of fieldwork are summarised in **Table A5**.

Table A2. Summary of weather and ground conditions during hydrology assessment fieldwork.

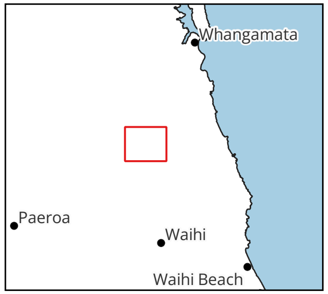
Round	Date	Weather & Ground Conditions
1	14 to 16 February 2024	Clear, dry, and hot with temperatures between 25 - 30°C and high humidity. The ground conditions were typical for the area, if not slightly dry due to an extended hot period.
2	29 February to 1 March 2024	Remained clear and dry during the visit. Temperatures remained about 25°C and ground conditions were stable (not slippery).
3	3 July 2024	The weather remained dry, however there was some rain in the week leading up to the visit. Ground conditions were reasonable.
3	7 to 9 August 2024	Mainly good, dry and sunny, however there was some rain in the afternoon on the 8 August and overnight. Temperatures ranged from 2°C at night to 15°C during the day. Ground conditions were poor to adequate, being very slippery in places.
4	20 to 23 August 2024	Some rain prior to and during the fourth and final round of fieldwork. This was mainly light, passing showers which cleared up by Tuesday evening. The remainder of the week was cloudy and dry. Ground conditions were reasonable throughout, but the rainfall had caused some areas to become saturated and slippery. Temperatures ranges from 5°C at night to 16°C during the day.



Map Title:
Wetlands

Project:
Wetland Delineation

Client:
OceanaGold Limited



Legend

- **Helipads**
- **Stream**
- **Trail**
- **Wetland**

Data Provenance
Aerial imagery and land parcels from Land Information New Zealand

Drawn by: Jaide Derbyshire
25/09/2024

Layout Name
Wetlands

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Figure A1.

A.3 Overview of the Wetland Assessment Tools

The Wetland Delineation Protocols by the Ministry for the Environment (MfE) sets out the method for delineating wetlands across New Zealand.

The tools are based on the US Army Corps of Engineers Wetlands Delineation manual for the USA originally developed in 1987 and refined through the 1990's. Since 1991, this document has been a mandatory requirement for permitting activities that potentially impact on wetlands (amongst other things) under Section 404 of the USA Clean Water Act (CWA). The use of this document is a legislative requirement of the National Policy Statement for Freshwater Management 2022 update.

This method of wetland delineation involves identifying hydrophytic vegetation followed by an assessment of hydric soils and hydrology. Typically, the hydric soils and hydrology tests are only undertaken if the results of the vegetations tests are uncertain, however, in the case of this assessment, it was important to understand the hydrology features supporting the wetlands. Therefore, both aspects were completed. As the work undertaken by WWLA is based on hydric soils and hydrology, the following sections focus on this.

A.3.1 Hydric Soil Tool Assessment

The procedure for hydric soil testing involves examining various soil characteristics indicative of hydric soils including the following:

- ***Field observations and soil colour***: This provided valuable information about soil characteristics that can indicate wetland conditions, including the presence of gleyed colours (grey or bluish-grey), and presence of mottling (speckled, low chroma colours).
- ***Soil morphology***: Morphological features seen in the soil profile can provide details about potentially hydric conditions such as mottling, oxidised root channels, accumulation of organic matter, and presence of iron or manganese concretions can indicate perennial or prolonged wet conditions in the growing season.
- ***Soil structure and texture****:* Proportions of sand, silt, and clay influence water-holding capacity, drainage, and aeration potential. Hydric soils are often characterised by finer textures such as silty or clayey soils with poor drainage.
- ***Soil moisture***: Hydric soils typically exhibit saturated or ponded conditions for a significant portion of the year, resulting in anaerobic conditions that do not require oxygen for growth.
- ***Soil chemistry***: Chemical indicators such as iron and manganese reduction, accumulation of organic matter, and low redox potential, can suggest hydric soil conditions.

Soil colour is one of the key defining feature for identification of hydric soils because the presence of water within the soil profile will affect the colour of soils, depending on the duration of anaerobic conditions. Soils that are subject to prolonged anaerobic conditions with the matrix iron reduced tend to have matrix with low chroma colours. The low chroma colours are typical of hydric soils (**Figure A2**). Note that dark topsoil colour values of 3 or less are not good indicators of hydric soils as many topsoils have colours in this range.

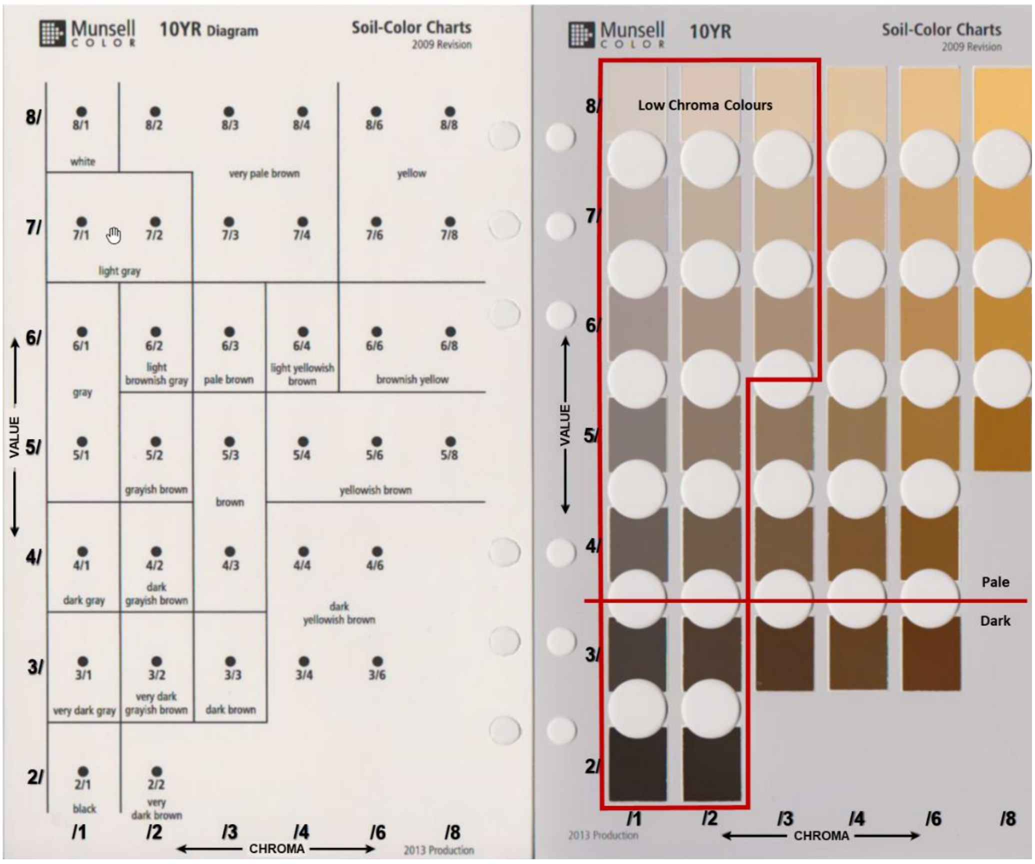

Figure A2. 10YR hue page from the Munsell colour chart.

A simple indicator for hydric soils is provided in Landcare Research (2018), which is reproduced in **Figure A3.**

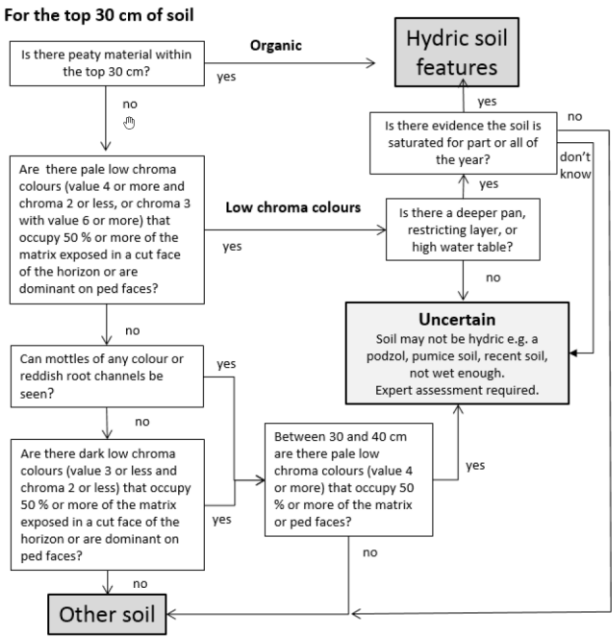

Figure A3. Simple key to identifying hydric soils.

A.3.2 Hydrology Tool Assessment

Hydrology indicators are one-off observations that identify the presence or absence of a wetland in areas where hydrophytic vegetation and hydric soils are present or uncertain. Wetland delineation using the hydrology tool should be undertaken during periods of 'normal rainfall'. Hydrology indicators can be highly transient; therefore, a follow-up visit may be required during normal and wetter periods of the growing season.

There are four indicator groups identified in the guidelines:

- Observation of flooding or groundwater;
- Evidence of flooding or ponding;
- Soil saturation; and
- Landscape, vegetation and soil observations (which may overlap with the vegetation and hydric soil tools).

Group 1 are primary indicators and Groups 2 to 4 have a mix of primary and secondary indicators. The presence of one primary indicator, or two secondary indicators, confirms the presence of a wetland. The full suite of 26 hydrology indicators is summarised in **Table A3**.

Table A3. Summary of wetlands hydrology indicators.

Indicator	Primary	2ndary	Observation Description ("observed in the area of interest during the growing season")
Group 1: Observation of flooding or groundwater			
1A: Surface water	✓		Surface water can be observed in the form of either flooding or ponding.
1B: Groundwater	✓		A high water table is observed within 30 centimeters of the soil surface as determined by soil pit, auger hole or shallow monitoring well.
1C: Soil saturation	✓		Soil saturation is observed in the top 30 centimeters of the soil profile. Indicated by 'water glistening on the surfaces and broken interior faces of the soil samples removed from a pit or auger hole'. Pg 19.
Group 2: Evidence of flooding or ponding			
2A: Water marks	✓		Water marks (discoloration or staining) are seen on trees, rocks, fences or other fixed objects. Lichen may also be absent below the flooding level.
2B: Sediment deposits	✓		Thin layers or coatings of fine mineral material (e.g., silt or clay) or organic matter (e.g., pollen) are seen on trees, rocks or other fixed objects.
2C: Drift deposits	✓		Debris (e.g., branches, leaves, plastic fragments) are seen deposited on the ground surface or entangled in vegetation or other fixed objects.
2D: Agal mat or crust	✓		An algal mat or crust is seen on or near the soil surface after the water has drained away.
2E: Iron deposits	✓		A thin orange or yellow crust or gel or oxidised iron is seen on or near the soil surface or as a sheen on standing water.
2F: Surface soil cracks	✓		Surface soil cracks are seen where mineral or organic sediment dry and shrink to form a network of cracks or polygons.
2G: Inundation visible on aerial imagery	✓		Inundation is seen on one or more recent aerial or satellite images.
2H: Sparsely vegetated concave surface	✓		A lack of vegetation (less than 5 per cent coverage) is seen on concave land surfaces resulting from prolonged ponding.
2I: Salt crust	✓		Hard or brittle deposits of salts are seen on the ground surface, usually in depressions, seeps or lake fringes, after evaporation of saline surface water.

Indicator	Primary	2ndary	Observation Description ("observed in the area of interest during the growing season")
2J: Aquatic invertebrates	✓		Numerous live or dead aquatic invertebrates, including diapausing eggs, remains of aquatic invertebrates, such as aquatic snails or crustaceans, are seen on the soil surface or plants or other emergent objects.
2K: Water-stained leaves	✓	✓	Water-stained grey or black leaves are visible due to long periods of saturation during the growing season
2L: Drainage patterns		✓	Areas that have recently experienced overland water flow may show soil erosion, low vegetation bent in the direction of water flow, or absence of leaf litter or small woody debris.
Group 3: Evidence of current or recent soil saturation			
3A: Hydrogen sulphide odour	✓		Hydrogen sulphide odour, similar to rotten eggs, is detected from the top 30 centimeters of the soil profile. Hydrogen sulphide is produced in soils only when saturation has been prolonged.
3B: Oxidised rhizospheres along living roots	✓		A soil horizon with greater than or equal to 2 per cent iron-oxide (orange coating) can be seen on the surfaces of living roots or soil pores immediately surrounding the roots within the top 30 centimeters of the soil profile.
3C: Reduced iron	✓		A soil layer containing reduced iron in the top 30 centimeters of the soil profile can be seen where the soil changes colour upon air exposure.
3D: Recent iron reduction in tilled soils	✓		A soil layer containing greater than or equal to 2 per cent redox concentrations (mottles) is visible in pore linings of masses in a soil that has been tilled less than two years ago within the tillage zone or the top 30 centimeters of the soil profile, whichever one is shallower.
3E: Dry-season water table		✓	A water-table depth between 30 centimeters and 60 centimeters of the soil profile can be seen during the normal dry season or a drier-than-normal period of the year.
3F: Saturation visible on aerial imagery		✓	Visual assessment of one or more aerial or satellite images can identify sites where soil saturation corresponds to depressions, drainage patterns, crop management, field verified hydric soils or other evidence of a seasonally high water table during the growing season
Group 4: Evidence from other site conditions or data			
4A: Stunted or stressed plants	✓		It can be seen that most plants in cultivated or planted wetland areas are smaller, less vigorous or appear more stressed compared with neighbouring non-wetland areas
4B: Geomorphic position		✓	The possible wetland may be seen in a localised depression, swale, drainage system, concave position in a floodplain, at the toe of a slope, on extensive flatland, the low-elevation fringe of a pond or waterbody, or groundwater discharge zone.
4C: Shallow aquitard		✓	A semi-permeable–impermeable layer is confirmed within 60 centimeters of the soil surface, which decreases movement of groundwater and causes a perched water table within 30 centimeters of the soil surface. This semi-permeable–impermeable layer can be composed of clay or non-porous rock.
4D: Facultative-neutral test		✓	Plant test – normally done by ecologists.
4E: Frost-heave hummocks		✓	Frost-heave hummocks are produced as water-logged soils undergo freeze–thaw processes. Exclude livestock pugging hummocks.

A.4 Methodology

As indicated above, the objectives of the fieldwork was firstly to confirm the presence or absence of a natural inland wetland and delineate the wetland extent (if any) and secondly, to ascertain the wetlands mode of water maintenance. To achieve these objectives, the field investigation methodology planned for each site is summarised in **Table A4**.

Table A4. Summary of wetland inspection field methodology.

Objective	Testing	Description

Presence / Absence	Soil excavation and description	• Hand excavation of a 400 x 400 mm hole to a depth of 400 mm, followed by hand auger of a 60 mm core to a depth of 1,000 mm. Note - this was not possible at the majority of sites due the ground conditions and dense roots. Therefore, a smaller and shallower hole may have been excavated.
		• Describe the soil in accordance with the NZ Geotechnical Society guidelines for soil and rock description, and the requirements for hydric soil identification provided in Section 5 of the Hydric Soils Identification Guide, which included:
		  • Munsell Soil Colour Book 2009;
		  • New Zealand Hydric Soils – Field Identification Guide Sheet; and

	Recording the hydrological indicators of the site.	• Utilising the data form provided to perform the Wetland Hydrology Tool assessment (refer to details in previous section).
Extent	Hydrological judgement	Judgments were made on the basis of: • Visual observation of water at or near the surface; • Observed change in ground surface elevation compared to surrounding land; • Recording of the elevations of the site with a Garmin inReach/GPS; and • Soil descriptions.
Mode of Water Maintenance	Water flow observations and water testing	• Observations were made of any surface water inputs directly to the potential wetland areas and/or proximity to nearby surface water (or lack therefore); • Water samples were taken from the headwaters of the stream(s) feeding the wetland or from central ponding if there was no inflowing stream present. • Water samples were dispatched to laboratory for major anion and cation analysis along with some nutrients, metals and pH.

All of the above were recorded throughout using QField, a mobile application for QGIS. This allowed for accurate mapping of wetland extents, soil pits, water features and various other observations.

A.5 Wetland Assessment Data and Results

In this section we structure our assessment for each area by providing an overview figure, with tabulated data as follows:

- conclusion;
- geomorphology of the landform;
- observations of water;
- soil descriptions; and
- key findings.

The wetland (hydric soils) extent shown in the figures is an overall judgement of all the factors observed and data obtained from the site, hence in some instances there will be non-wetland soil tests within the wetland area demarcated.

A.5.1 Edmonds 1

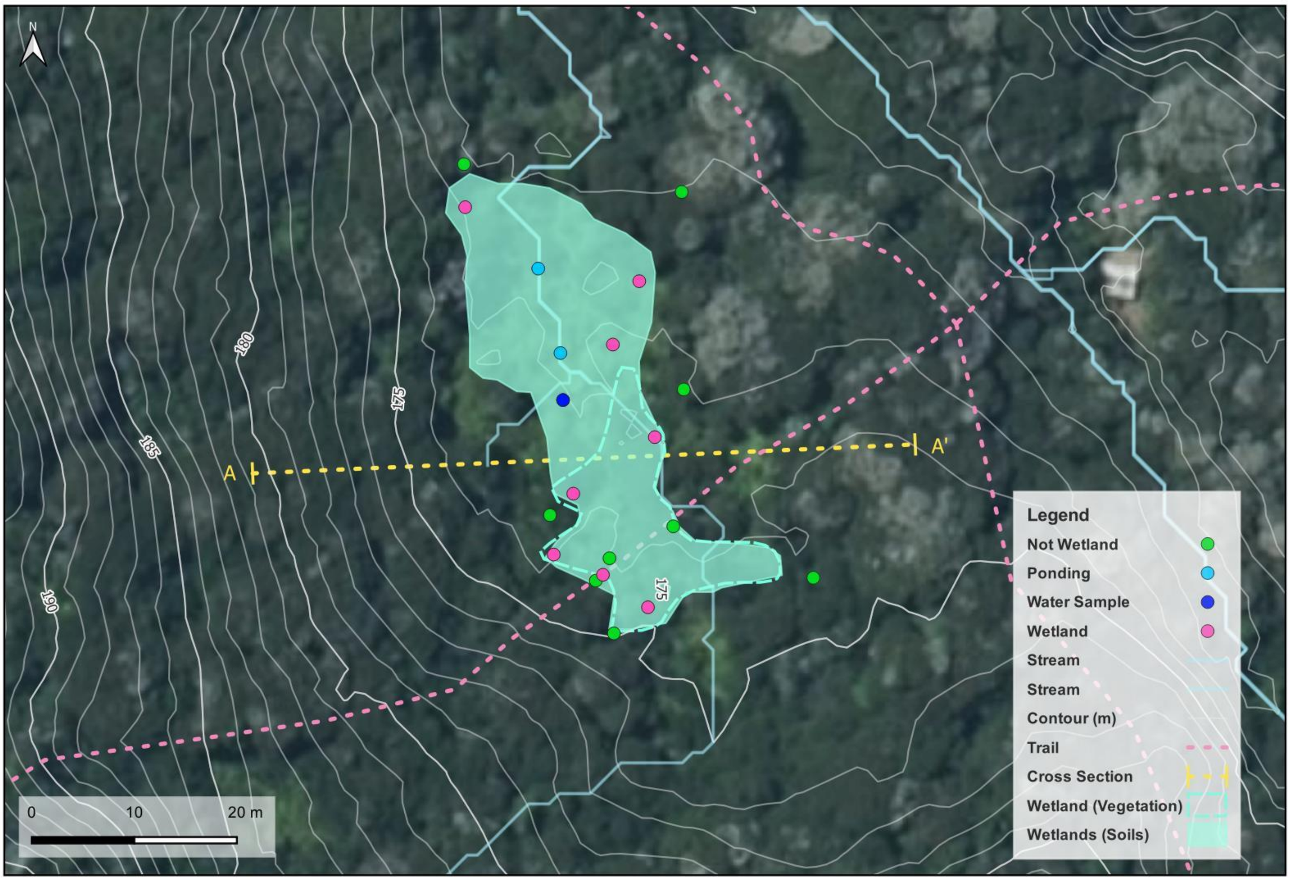

Figure A4. Edmonds 1 overview.

Table A5. Data summary for Edmonds 1.

Topic	Comments
Summary	Edmonds 1 (**Figure A4**), was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The wetland was located in fairly flat area with steep land to the west. The walking trail ran directly through the site.
Water Observations	A small surface water stream was identified on LiDAR, but this was not evident in the field. The wetland had no clear source of water, no stream or flowing water and no evidence of groundwater, such as seepage or upwelling. The wetland is likely to be fed by surface water runoff or stormwater during and shortly after rainfall events. There was some ponding identified further north of the initial boundary, and the soils confirmed wetland characteristics. This extended the initial boundary given by the ecologists.
Soils	Surface ponding was underlain by a very dark brown soil (Topsoil 2/2, subsoil 2/2), indicative of a high organic content and considered hydric soils according to the Munsell colour chart. These areas were very fluid and were not possible to dig/auger to the full 1 m depth. The wetland soils without surface water ponding were still highly saturated (**Figure A5 – Photo 1**). These areas had very dark brown saturated surface soils around 5 cm thick (topsoil 2/2) and were mostly clay with silt throughout. There were lots of organic matter in the topsoil, indicating hydric soils. The subsoil, also dark brown/black (3/1), was likely a silty clay; majority clay with some silt. Grey soils (6/1), which are extremely poorly drained were seen below the water table in places. The subsoil was sticky and had a hydrogen sulphide odour, which is indicative of reducing conditions and another indicator of hydric soil conditions. The water table was evident at, or just below, the surface at these sites.

	Non wetland areas, on the extremities of this wetland were clearly very dry (unsaturated) and were characterised by soils which were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8), which are not indicative of hydric soils (**Figure A5 – Photo 2**). There was a small 2 cm layer of organic matter at the surface, followed by around 5 cm of topsoil. The soil was likely a clay loam; majority clay with some silt. There was no saturation and no water table present. There was some grey and orange mottling observed in sites with close proximity to the wetland boundary, but this is likely the result of leaching, and not indicative of wetland soils.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 1 was surface water-fed from surface runoff during rainfall. **Figure A6** shows this as a schematic.

Figure A5. Edmonds 1 photos.

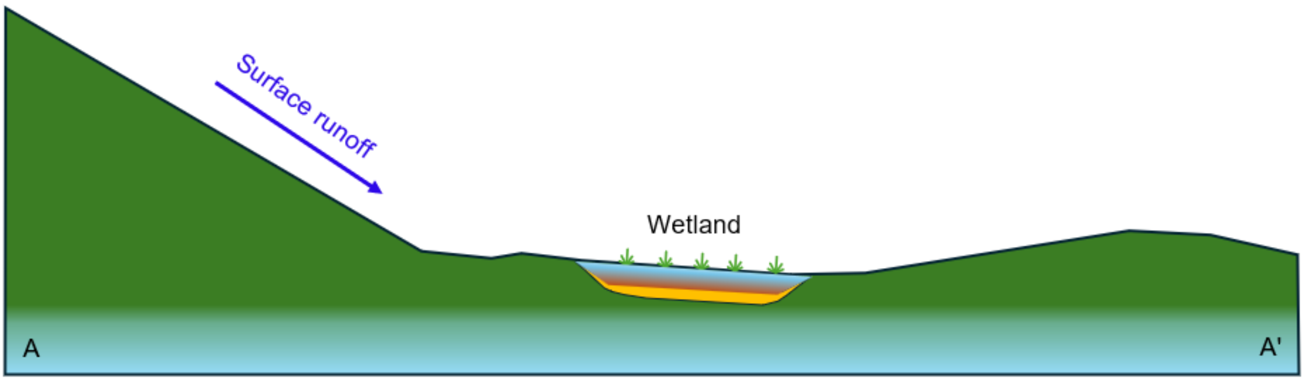

Figure A6. Hydrology schematic for Edmonds 1.

A.5.2 Edmonds 2

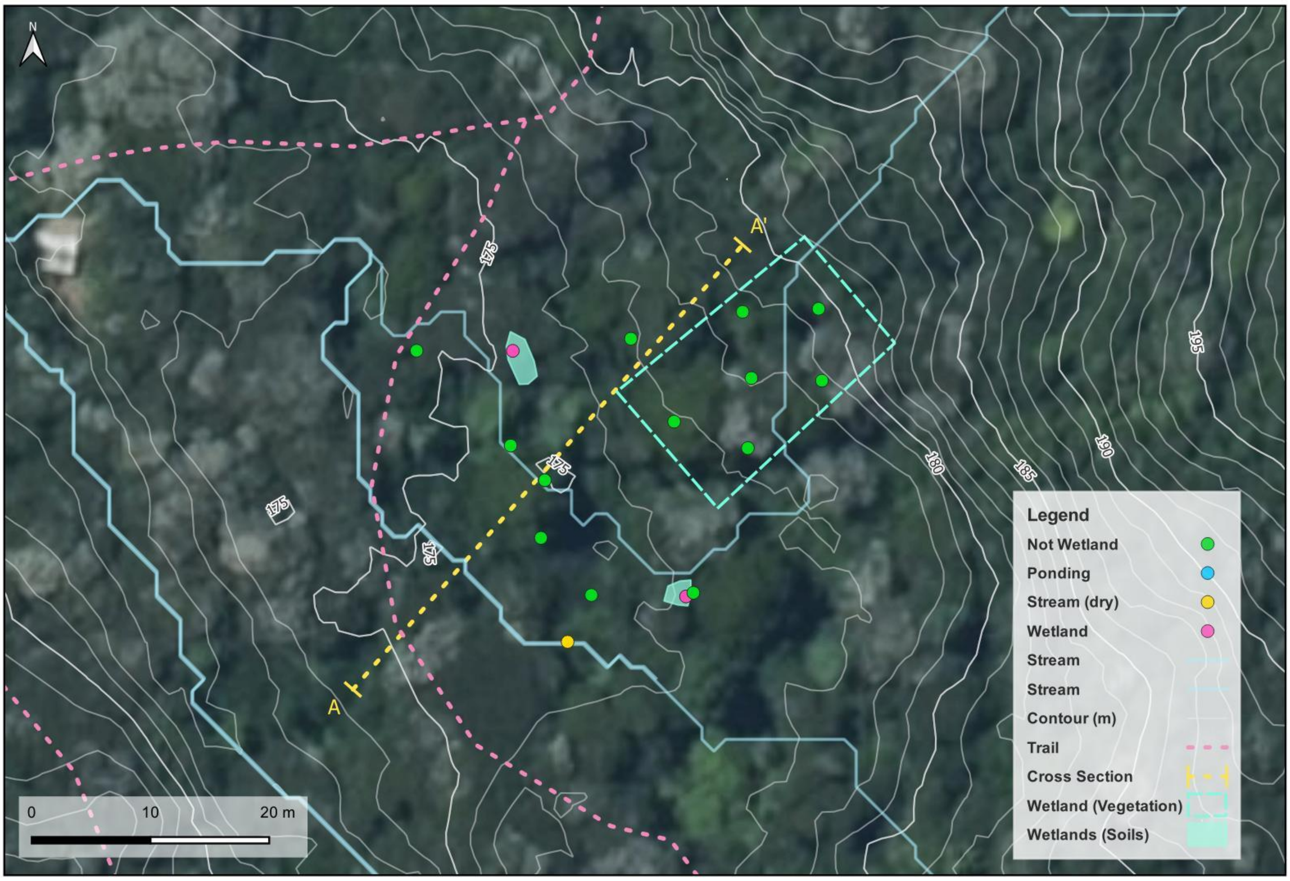

Figure A7. Edmonds 2 overview.

Table A6. Data summary for Edmonds 2.

Topic	Comments
Summary	Edmonds 2 (**Figure A7**) was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The wetland area identified by Bioresearches, was a fairly flat area with steep slopes to the north and east.
Water Observations	The LiDAR imagery indicates a stream running through the area, but this was not observed in the field. The majority of the initial area provided was moist but did not show evidence of wetland soils, however two small depressions (about 1 m deep) were identified. These areas were approximately 6.5 m^2 and 3 m^2 and had visible ponding and/or hydric soils. A water sample could not be taken as there was not enough water. It appeared that the depressions are supported by rainfall and runoff as no seepage or upwelling was observed.
Soils	One of the locations with wetland soils was in a small 6.5 m^2 depressional area around 1 m lower than surrounding topography (**Figure A8 – Photo 1**). Surface ponding is underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger for a full 1 m profile. The second, smaller depression without surface water ponding was still highly saturated. This area had very dark brown saturated surface soils (topsoil 2/2) and was mostly clay with some silt throughout. The subsoil was also dark brown/black (3/1) and was likely a silty clay. The subsoil was sticky and had a hydrogen sulphide odour. Non wetland areas, were very clearly dry (unsaturated) and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Soil was likely a clay loam; majority clay with some silt with no saturation and no water table present (**Figure A8 – Photos 2 and 3**).

Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 2 was surface water-fed from surface runoff during rainfall. **Figure A9** shows this in a schematic.



Figure A8. Edmonds 2 photos.

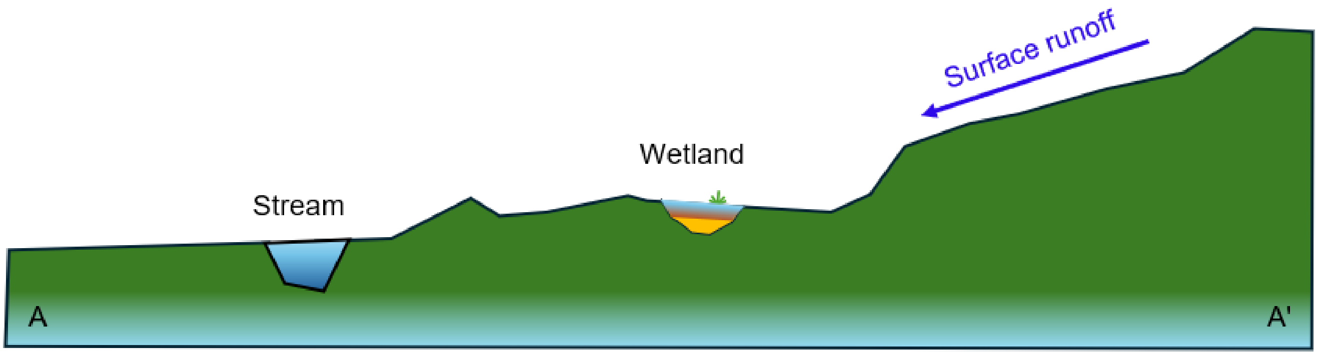

Figure A9. Hydrology schematic for Edmonds 2.

A.5.3 Edmonds 3

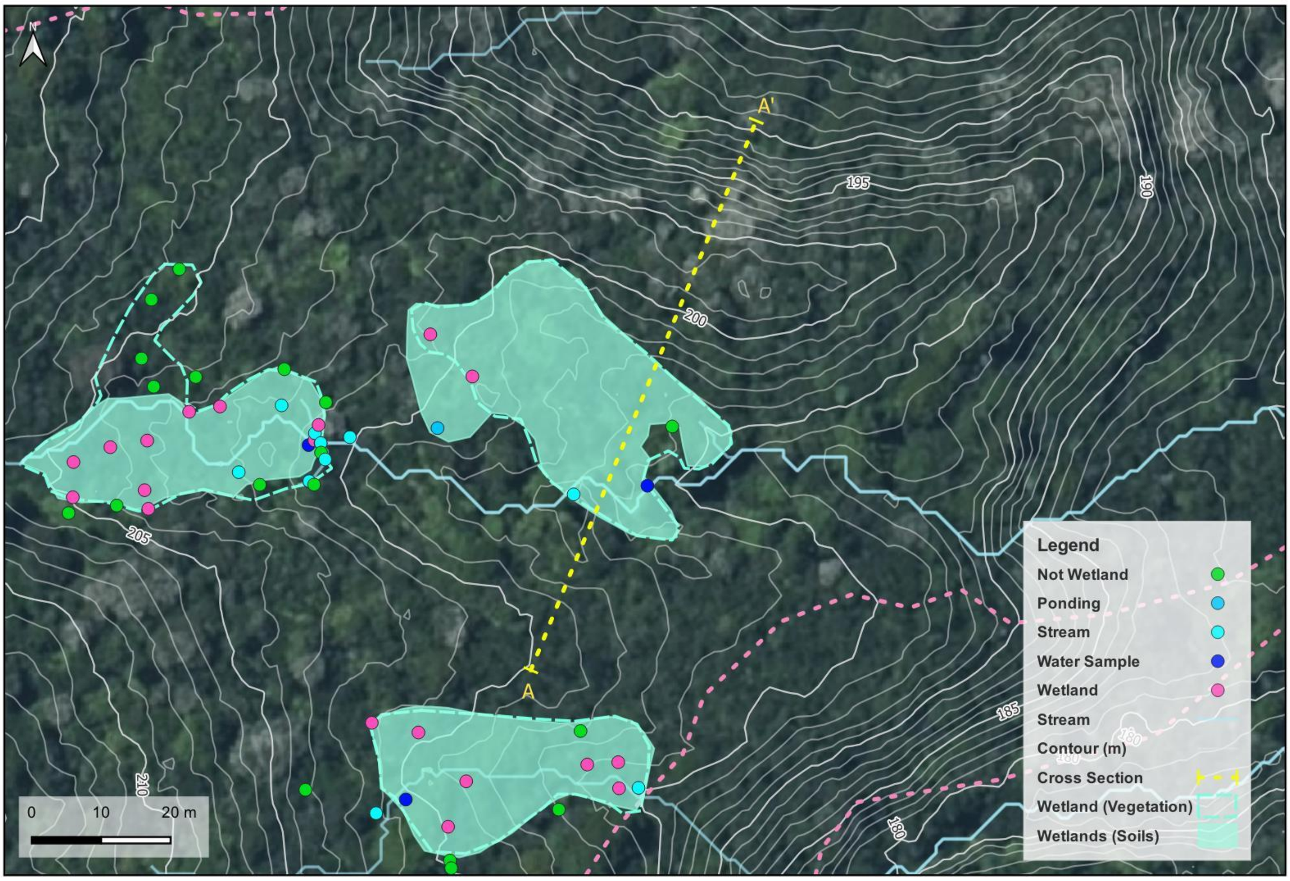

Figure A10. Edmonds 3 overview.

Table A7. Data summary for Edmonds 3.

Topic	Comments
Summary	Edmonds 3 (**Figure A10**) was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The wetland was located in a fairly flat area surrounded by steeper banks, particularly to the north.
Water Observations	A stream runs through the area which creates a sperate wetland approximately 30m upstream, before feeding into Edmonds 3. The stream had a good amount of flow and was about 30 cm deep in some places which created ponding in the flatter areas where it fanned out.
Soils	Surface ponding as underlain by a very dark brown soil (Topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger (**Figure A11 – Photo 1**). Some areas that were not covered by surface ponding were still wet underfoot with rich dark brown saturated surface soils (topsoil 2/2). The subsoil was a dark- to mid- slightly greyish colour (5/1) and was likely a silty clay; majority clay with some silt. The soil was very sticky, and the water table was observed at around 12 cm below ground (**Figure A11 – Photo 2**). Non wetland areas, (bottom), were unsaturated but remain sticky, likely due to recent rainfall, and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Lots of organic matter was observed, along with worms and grubs. Soil was likely a silty clay; majority clay with some silt. No redox conditions were observed (**Figure A11 – Photo 3**).
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 3 was surface water-fed from the stream that ran through the site and surface runoff during rainfall. This is shown on **Figure A12** as a schematic.

Figure A11. Edmonds 3 photos.

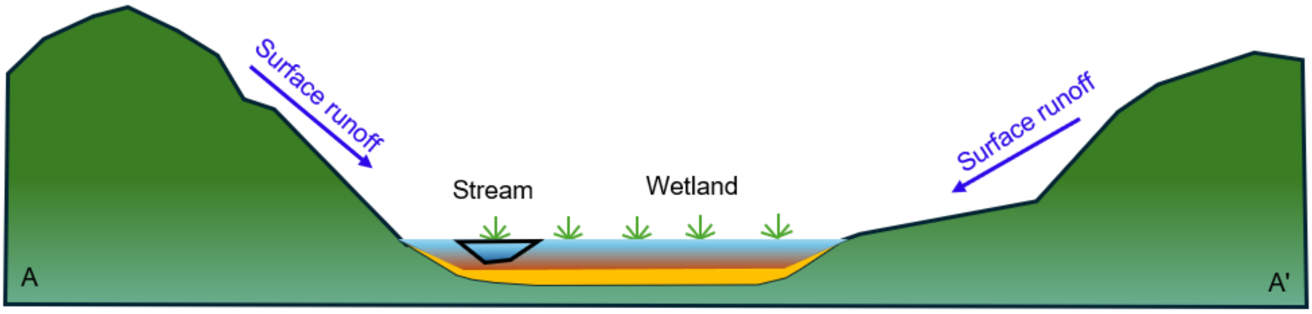

Figure A12. Hydrology schematic for Edmonds 3.

A.5.4 Edmonds 4

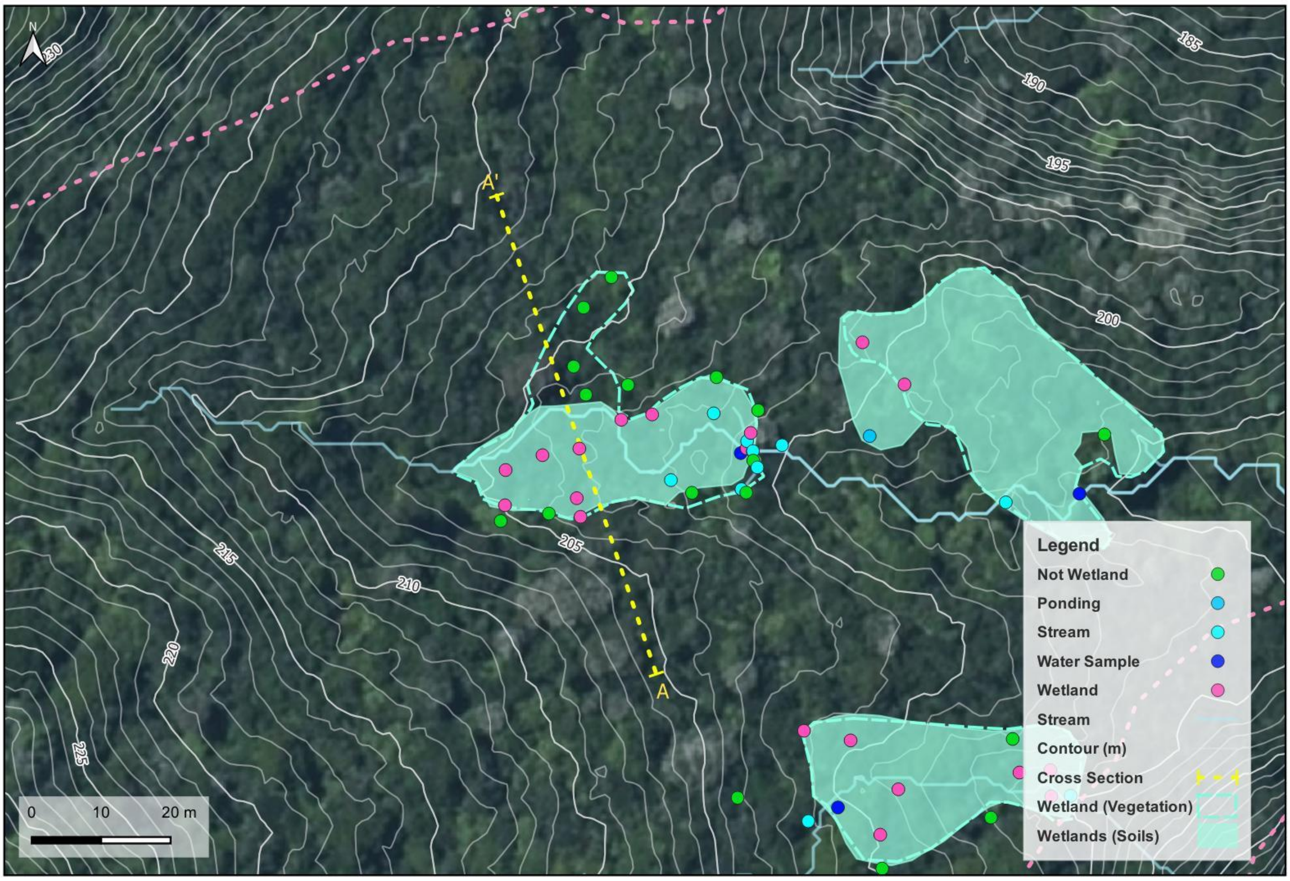

Figure A13. Edmonds 4 overview.

Table A8. Data summary for Edmonds 4.

Topic	Comments
Summary	Edmonds 4 (**Figure A13**) was identified by Bioresearches as a potential wetland pending confirmation. The previous assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology and Vegetation	The wetland is located in a fairly flat area in the centre of a small valley. The area was covered by dense wetland vegetation.
Water Observations	Surface water was evident throughout the area despite an extended period of hot, dry weather during the first visit. A primary stream was running through the site from west to east with two tributaries identified in the east which appears to form as a result of surface ponding. The two tributaries join the main stem on the eastern border of the wetland area. The original area delineated by Bioresearches extended further north but the Hydric Soil and Hydrology Tool Assessments did not show wetland indicators. This reduced the size of the wetland area.
Soils	Surface ponding across the site was underlain by a very dark brown soil (topsoil 2/2, subsoil 3/2). These areas were very fluid and were not possible to dig/auger to the full 1 m depth (**Figure A14 – Photo 1**). When auguring was attempted, the auger sank to about 1.2 m deep without resistance. Some areas that were not covered by surface ponding were still wet underfoot with rich, dark brown, saturated surface soils (topsoil 2/2). These sites were also difficult to auger due to the high fluidity in the subsoil. The subsoil was likely a clay loam; majority clay with some sand and silt causing a gritty texture. Non wetland areas were very clearly dry (unsaturated) and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Soil was likely a clay loam; majority clay with some sand and silt (**Figure A14 – Photo 2**).

Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 4 was surface water-fed from the stream that ran through the site and surface runoff during rainfall. This is shown in **Figure A15** as a schematic.

Figure A14. Wetland 4 photos.

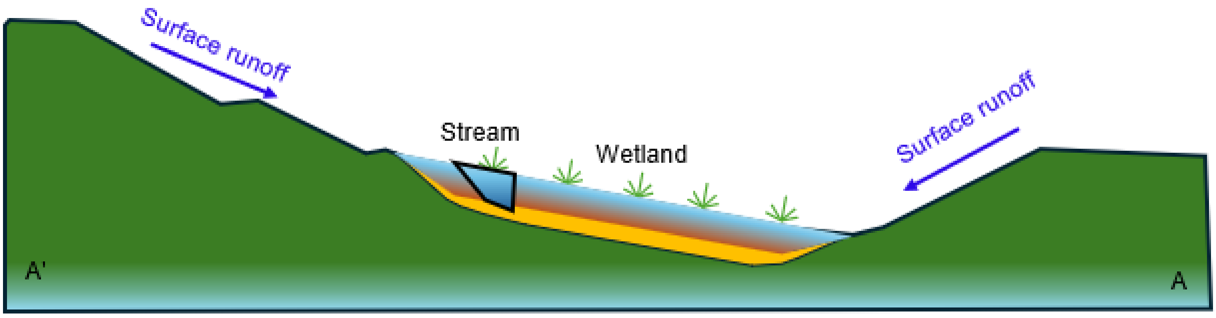

Figure A15. Hydrology schematic for Edmonds 4.

A.5.5 Edmonds 5

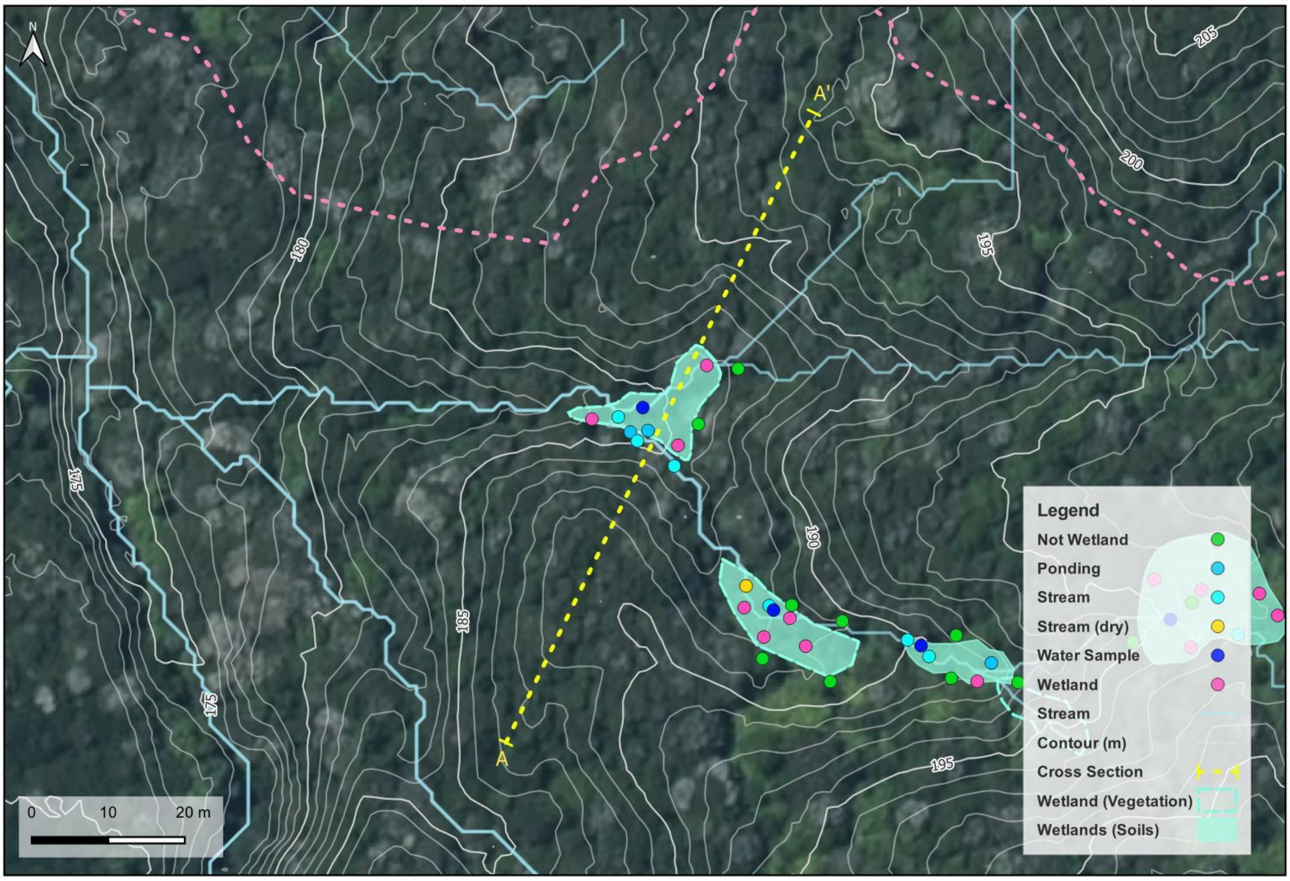

Figure A16. Edmonds 5 overview.

Table A9. Data summary for Edmonds 5.

Topic	Comments
Summary	Edmonds 5 (**Figure A16**) was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The wetland topography was fairly flat, and gently sloped downwards to the west. Some small banks surrounded the wetland.
Water Observations	Two tributaries flowed through the wetland and converged along the western boundary. The stream running through the site fanned out to create ponding. Three further wetlands are located upstream along the stream.
Soils	Surface ponding in the wetland was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger for a 1 m profile. Wetland areas, without surface water ponding were still highly saturated with a shallow water table. These areas had very dark brown saturated surface soils around 5 cm thick (topsoil 2/2) (**Figure A17 – Photo 1**). The soils were mostly clay with some silt throughout. The subsoil also dark brown/black (3/1) is likely a silty clay; majority clay with some silt. Grey soils (6/1) were seen in soils below the water table in places (**Figure A17 – Photo 2**). The subsoil was sticky and had a hydrogen sulphide odour. Non wetland areas were very clearly unsaturated and were dark brown with a lighter, mid-brown subsoil colour (topsoil 3/3, subsoil 6/8). The soil was likely a silty clay; majority clay with some silt. The subsoil was plastic and slightly moist, but this was likely due to recent rainfall. No water table was present.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 5 was surface water-fed from the stream than ran through the site and surface runoff during rainfall. This is shown in **Figure A18** as a schematic.

Figure A17. Edmonds 5 photos.

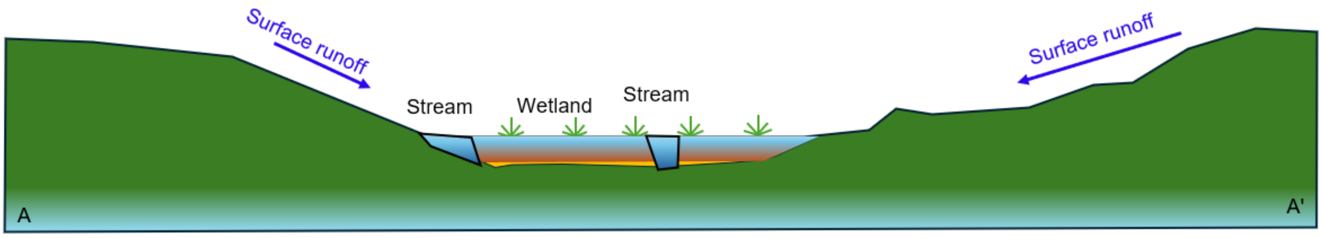

Figure A18. Hydrology schematic for Edmonds 5.

A.5.6 Edmonds 6

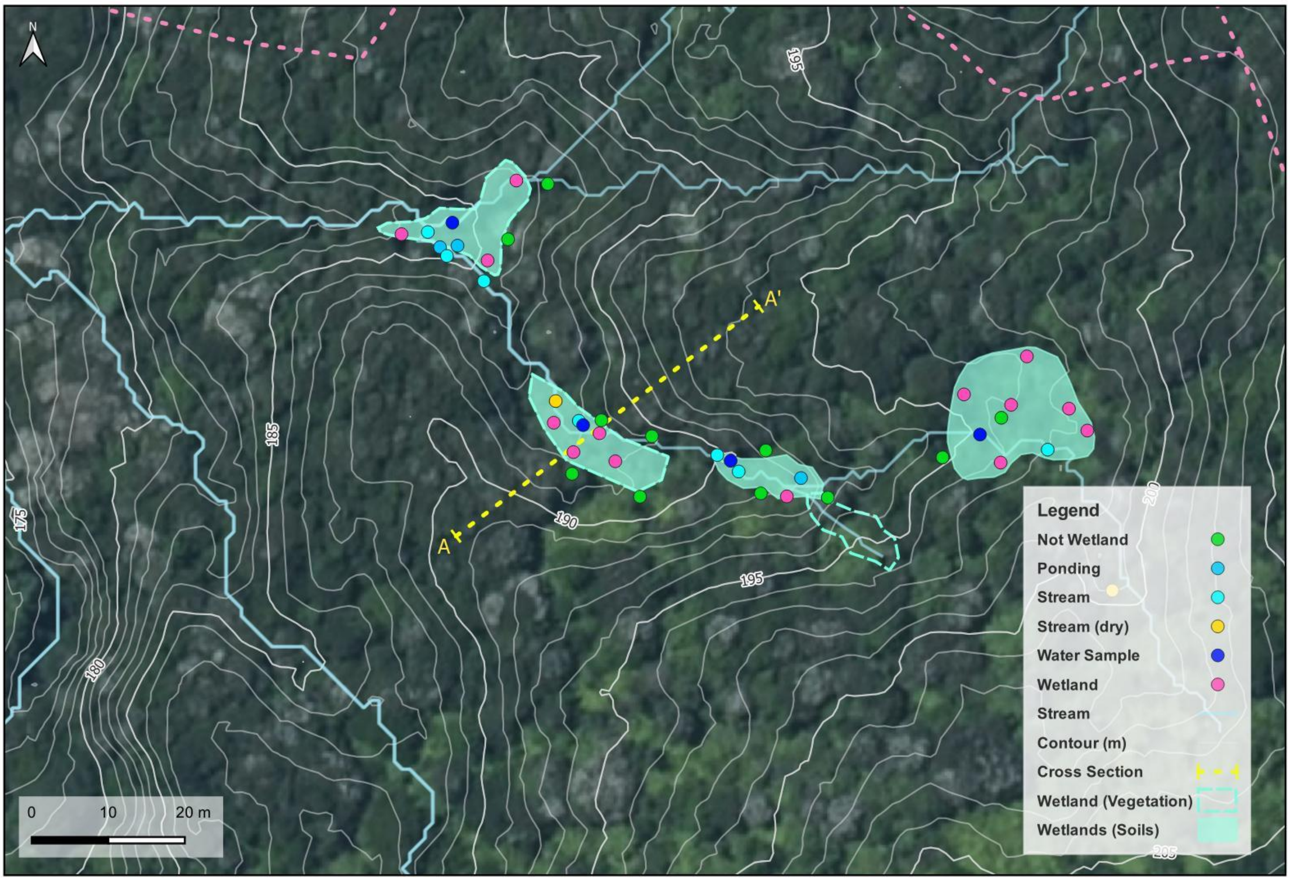

Figure A19. Edmonds 6 overview.

Table A10. Data summary for Edmonds 6.

Topic	Comments
Summary	Edmonds 6 (**Figure A19**) was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The topography was fairly flat with some small banks that surrounded the wetland.
Water Observations	The wetland followed a stream that flowed centrally through and fanned out to create ponding. One wetland is located downstream along the stream, whilst two more wetlands are located upstream along the stream. A white foam was observed in some of the surface water ponding areas.
Soils	Surface ponding (**Figure A20 – Photo 1**), was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger for a 1 m profile. Areas without surface water ponding (**Figure A20 – Photo 2)**, were still highly saturated with a shallow water table. These areas had very dark brown saturated surface soils around 5 cm thick (topsoil 2/2). The topsoil was mostly clay with some silt throughout and were quite plastic. The subsoil was likely a silty clay; majority clay with some silt. These were saturated and sticky. Non wetland areas were very clearly unsaturated and were dark brown with a lighter, mid-brown subsoil colour (topsoil 3/3, subsoil 6/8). The soil was likely a silty clay; majority clay with some silt. The subsoil was plastic and slightly moist, but this was likely due to recent rainfall. No water table was present.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 6 was surface water-fed from the stream that runs through the site and surface runoff during rainfall. This is shown in **Figure A21** as a schematic.

Figure A20. Edmonds 6 photos.

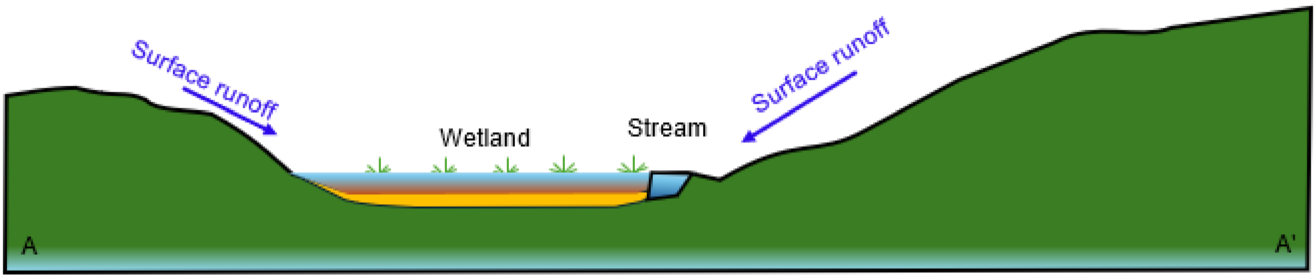

Figure A21. Hydrology schematic for Edmonds 6.

A.5.7 Edmonds 7

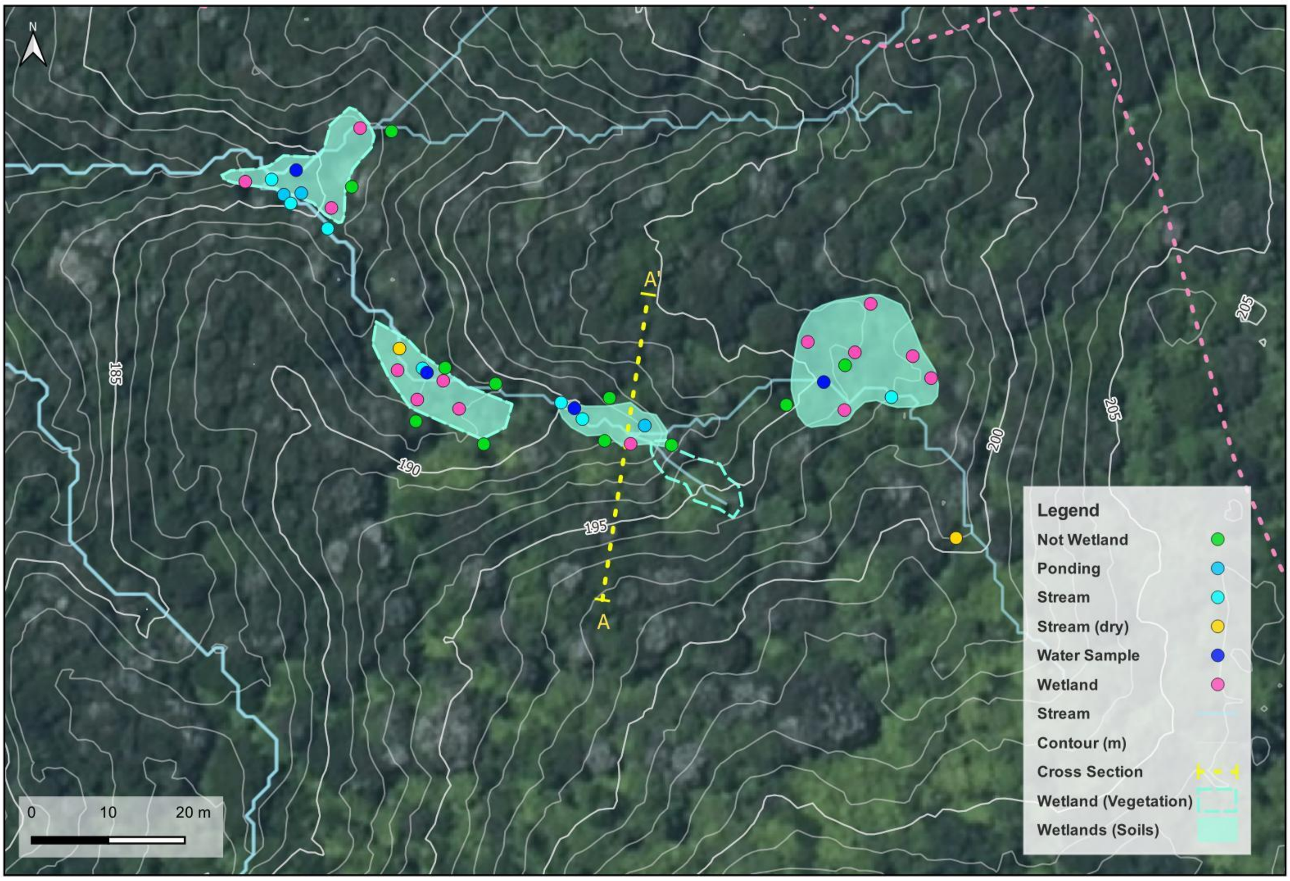

Figure A22. Edmonds 7 overview.

Table A11. Data summary for Edmonds 7.

Topic	Comments
Summary	Edmonds 7 (**Figure A22**) was identified by Bioresearches as a wetland based on the hydrophytic vegetation tests. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The wetland was located in a small dip in topography. The wetland itself was fairly flat with some small banks that surrounded it.
Water Observations	The wetland follows the stream that runs through the area. Two wetlands are located downstream along the stream, whilst another wetland is located upstream along the stream. A smaller tributary joins the stream and creates a very small area of surface ponding. Based on the hydric soils and hydrology tool assessment, the boundary of the wetland was adjusted to reflect observations.
Soils	Surface ponding was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger for a full 1 m profile. Areas without surface water ponding, were still highly saturated with a shallow water table (**Figure A23 – Photo 1**). These areas have very dark brown saturated surface soils around 2 cm thick (topsoil 2/2). The soils were mostly clay with some silt throughout. The subsoil was likely a silty clay; majority clay with some silt. These were saturated and sticky. Soils above the water table were gleyed and had orange mottling. Grey soils (6/1) were seen in soils below the water table which was identified at around 16 cm below ground. Non wetland areas were very clearly unsaturated and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8) (**Figure A23 – Photo 2**). The soil was likely a silty clay; majority clay with some silt. The subsoil was plastic and slightly moist, but this was likely due to recent rainfall. No water table was present at these sites.

Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 7 was surface water-fed from the stream that ran through the site and surface runoff during rainfall. This is shown on **Figure A24** as a schematic.

Figure A23. Edmonds 7 photos.

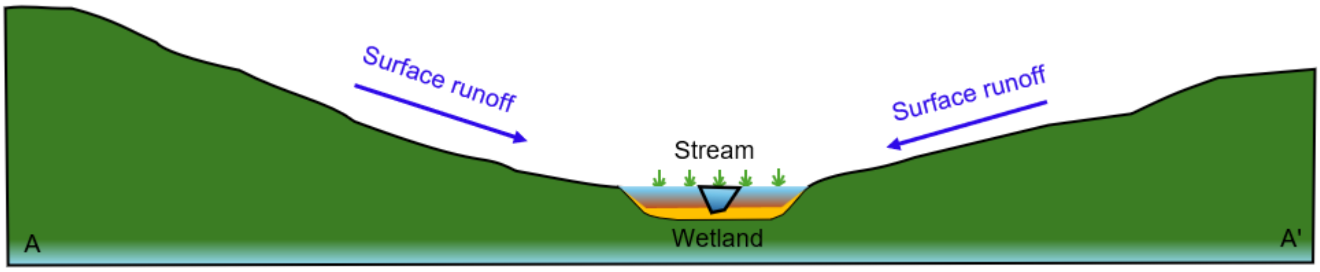

Figure A24. Hydrology schematic for Edmonds 7.

A.5.8 Edmonds 8

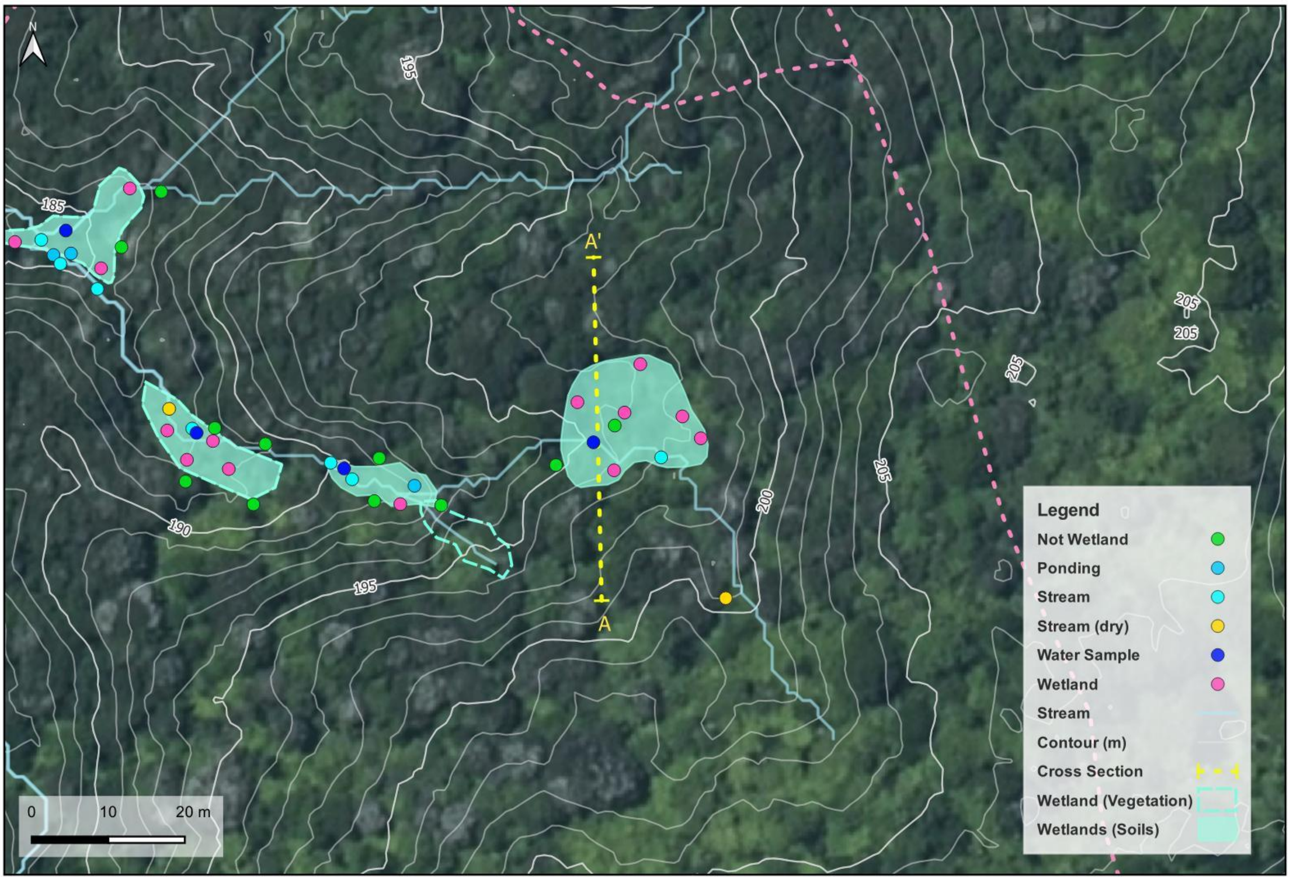

Figure A25. Edmonds 8 overview.

Table A12. Data summary for Edmonds 8.

Topic	Comments
Summary	Edmonds 8 (**Figure A25**) was identified by Bioresearches as a potential wetland pending confirmation. The previous assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology and Vegetation	The wetland was fairly flat and gently sloped to the west. The area was covered by dense wetland vegetation.
Water Observations	Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit. There was a small stream that ran along the south border of the site. Three wetlands are located downstream along the stream.
Soils	Surface ponding was underlain by a very dark brown soil (Topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger to the full 1 m depth. Some areas that were not covered by surface ponding (**Figure A26 – Photo 1**) were still wet underfoot with rich dark brown saturated surface soils (topsoil 2/2). These sites were often difficult to auger due to the high fluidity in the subsoil. Subsoil was likely a silty clay; majority clay with some silt. Other wetland sites showed redox conditions with orange/grey mottles and high saturation (Subsoil 7/1 with orange mottles, particularly along the roots). The soils held shape well due to clay content and saturation and were very sticky (**Figure A26 – Photo 2**). Non wetland areas were very clearly unsaturated and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Soil was likely a silty clay; majority clay with some silt. Did not hold shape, no saturation.

Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 8 was surface water-fed from the stream that ran through the site and surface runoff during rainfall. This is shown on **Figure A27** as a schematic.

Figure A26. Edmonds 8 photos.

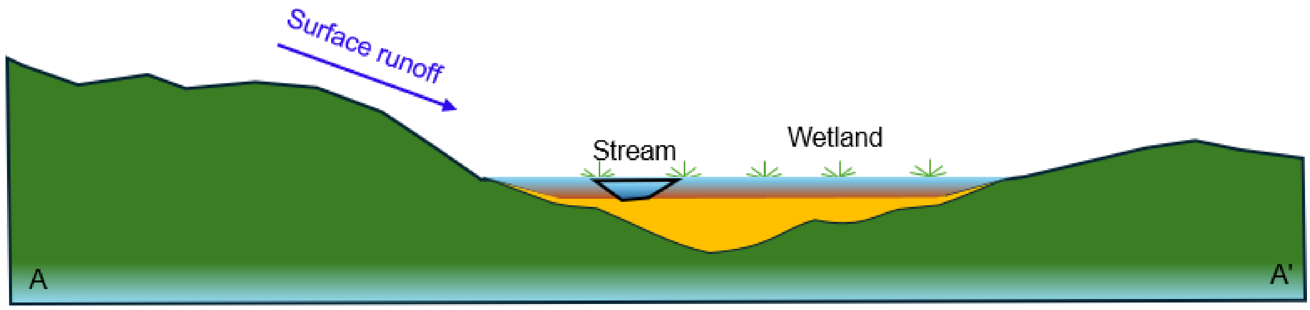

Figure A27. Hydrology schematic for Edmonds 8.

A.5.9 Edmonds 9

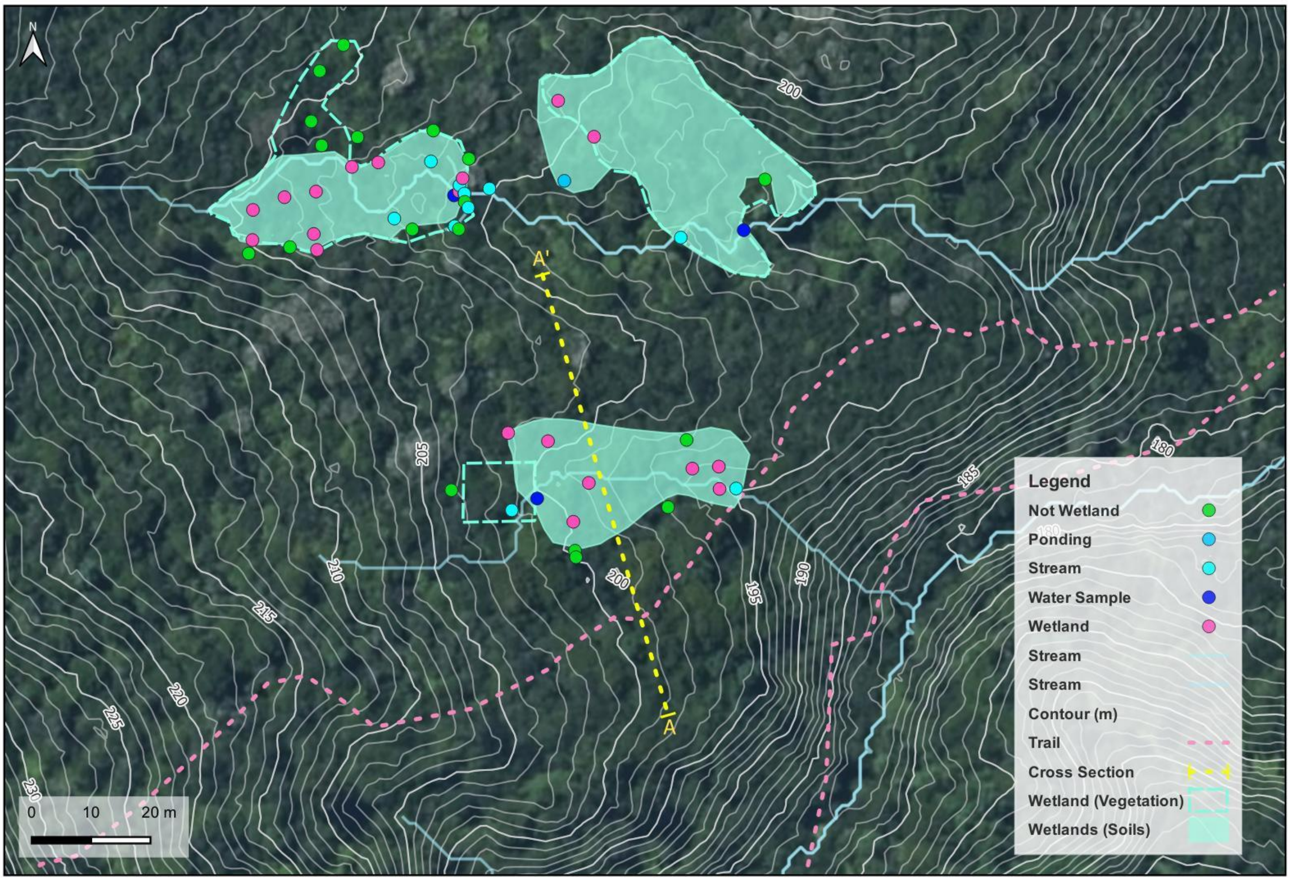

Figure A28. Edmonds 9 overview.

Table A13. Data summary for Edmonds 9.

Topic	Comments
Summary	Edmonds 9 (**Figure A28**) was identified by Bioresearches as a potential wetland pending confirmation. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology	The site was located on a fairly flat area at the base of a slope. There was a steep slope to the east which dropped down on to a walking track.
Water Observations	Two or three very small streams ran down through the site (**Figure A29 – Photo 1**). Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit.
Soils	Surface ponding was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger to the full 1 m depth (**Figure A29 – Photo 2**). The area without surface ponding was generally wet underfoot with rich dark brown saturated surface soils (topsoil 2/2). Subsoil was likely a silty clay; majority clay with some silt (**Figure A29 – Photo 3**). Wetland soils above the water table showed clear redox conditions with grey/orange mottling (subsoil 7/1 with orange mottles, particularly along the roots). Where the water table was very shallow (<20cm) soils were very sticky. Soils with a deeper water table were generally more plastic. Soils below the water table were grey (6/1) (**Figure A29 – Photo 4**). Non wetland areas were very clearly dry and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Soil was likely a silty clay; majority clay with some gravel. Some sites could not be dug deeper than ~30 cm due to the high amount of roots present. These soils do not hold their shape.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 9 was surface water-fed from the stream that ran through the area and from surface runoff during rainfall. This is shown in **Figure A30** as a schematic.

Figure A29. Edmonds 9 photos.

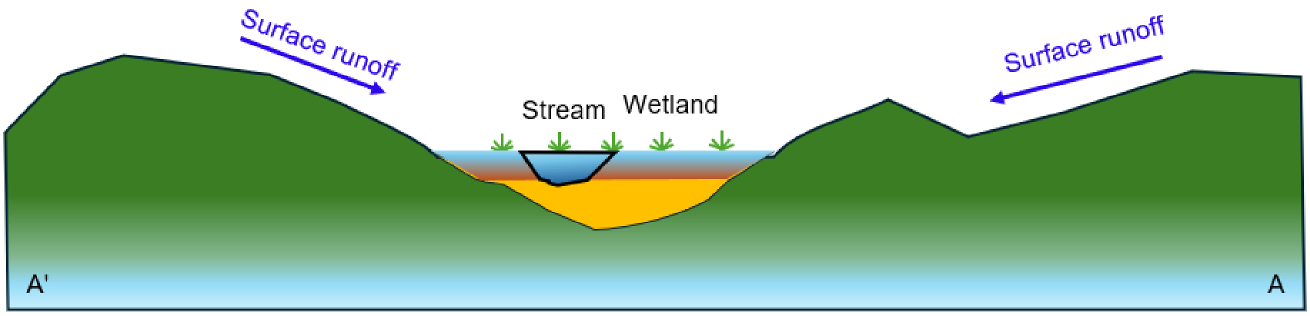

Figure A30. Hydrology schematic for Edmonds 9.

A.5.10 Edmonds 10

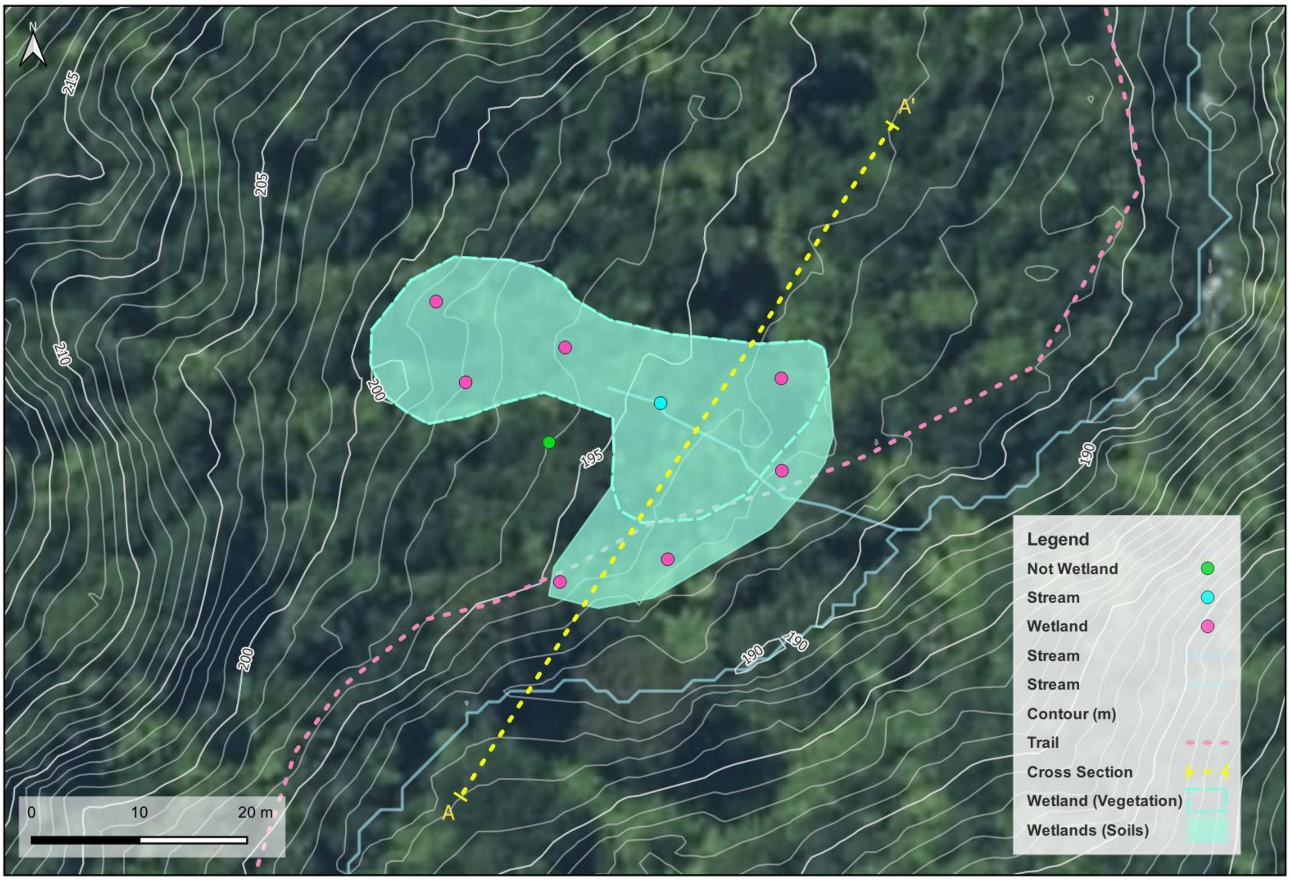

Figure A31. Edmonds 10 overview.

Table A14. Data summary for Edmonds 10.

Topic	Comments
Summary	Edmonds 10 (**Figure A31**) was identified as wetland by Bioresearches. This assessment has confirmed the feature is a surface water supported wetland based on the soils and hydrology.
Geomorphology and Vegetation	The wetland was located on an unmarked trail which ran directly through the site. The wetland did not continue down to Edmonds Stream and the two were separated by a steep drop in topography. The wetland was at a higher elevation then Edmonds Stream. The area was covered by dense wetland vegetation.
Water Observations	There was a small stream that ran directly through the site. Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit.
Soils	Surface ponding (**Figure A32 – Photo 1**) was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger to the full 1 m depth. Some areas that were not covered by surface ponding were still wet underfoot with rich dark brown saturated surface soils (topsoil 2/2). These sites were also difficult to auger due to the high fluidity in the subsoil. The subsoil was likely a silty clay; majority clay with some silt. Other wetland sites showed redox conditions with gleyed soil and orange mottles and high saturation (subsoil 7/1 with orange mottles, particularly along the roots) (**Figure A32 – Photo 2**). Soils held shape well due to clay content and saturation but were very sticky. The water table was identified at around 5 cm below surface level (**Figure A32 – Photo 3**). Non wetland areas were very clearly dry and were dark brown with a lighter, mid-brown colour (topsoil 3/2, subsoil 6/8). Soil was likely a silty clay; majority clay with some silt. The soils did not hold their shape and had no saturation.

Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 10 was surface water-fed from the stream that ran through the area and from surface runoff during rainfall. This is shown in **Figure A33** as a schematic.

Figure A32. Edmonds 10 photos.

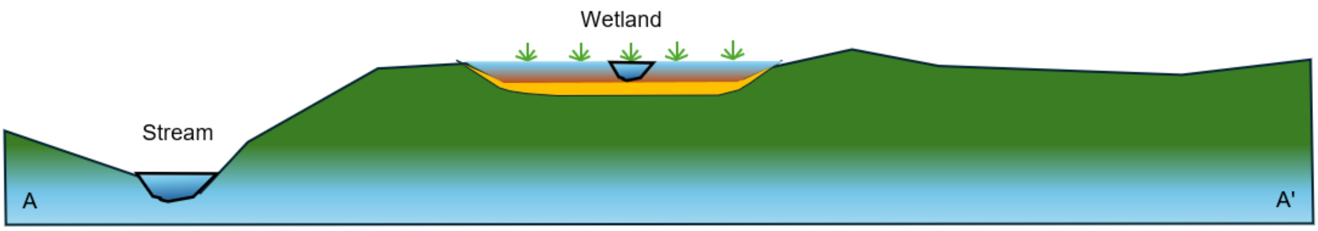

Figure A33. Hydrology schematic for Edmonds 10.

A.5.11 Edmonds 11

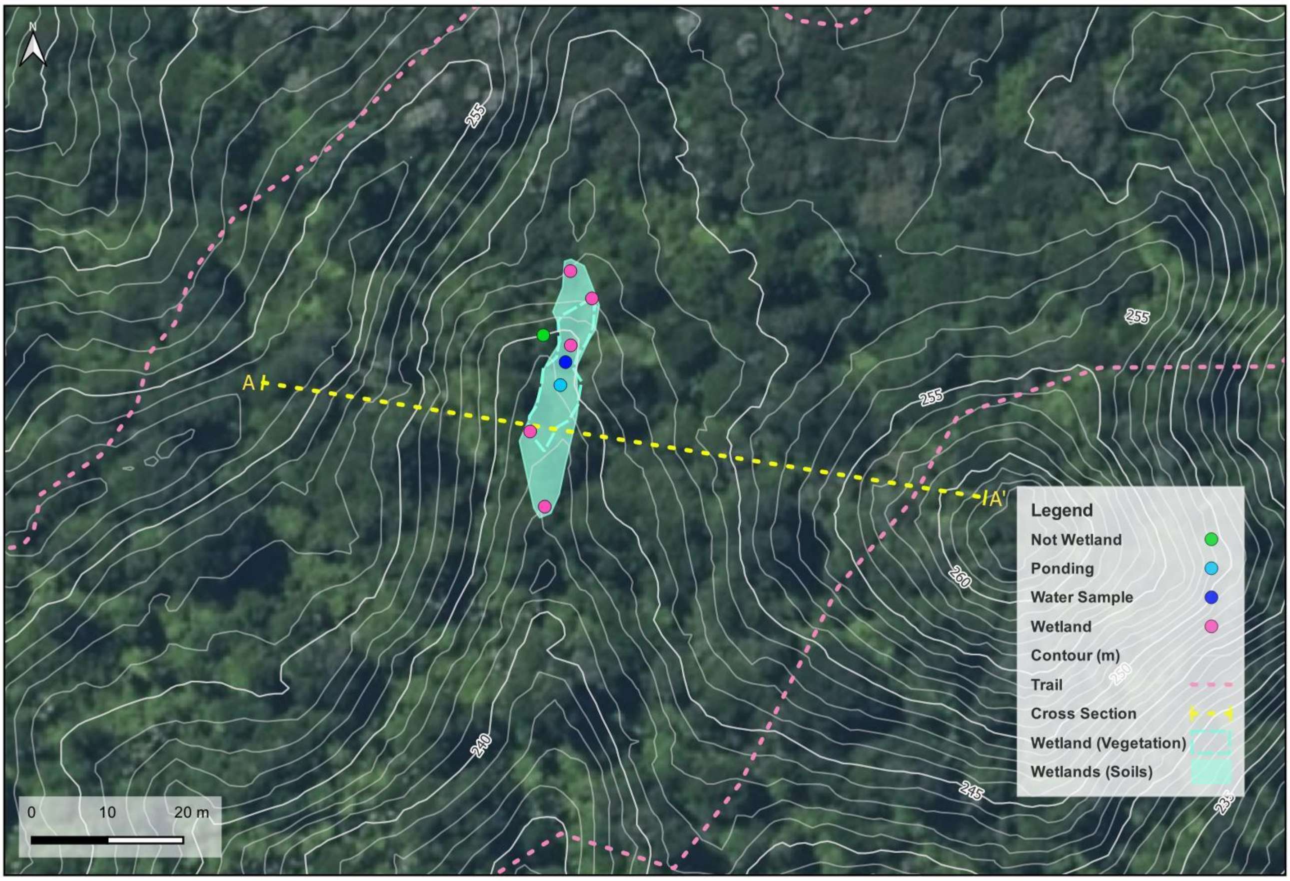

Figure A34. Edmonds 11 overview.

Table A15. Data summary for Edmonds 11.

Topic	Comments
Summary	Edmonds 11 (**Figure A34**) was identified as wetland by Bioresearches. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology and Vegetation	The site was bound by the steep topography to the east and west and was located in a small valley within which surface water had collected. Dense vegetation was present, **Figure A35** (right).
Water Observations	Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit. During the first visit the vegetation made access for sampling and auguring difficult. However, a water sample was obtained in the re-visit.
Soils	The wetland areas were a very dark brown, or very dark grey with high fluidity and surface water (topsoil 2/2 or 3/1, subsoil 2/2) (**Figure A35 – Photo 1**). These areas were very fluid and not possible to auger to get a full 1 m depth profile. Soils were mostly clay with some sand. Wetland areas without surface water ponding were underlain by a gleyed sub-soil which ranged from plastic to sticky (**Figure A35 – Photo 2**). Non wetland soils were unsaturated and crumbly with a dark, yellowish-brown colour (topsoil 3/4, subsoil 4/4). Soils were mostly clay with some silt and sand. These soils were slightly plastic in places and held their shape (**Figure A35 – Photo 3**).
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 11 was surface water-fed from surface runoff during rainfall. This is shown on **Figure A36** as a schematic.

Figure A35. Edmonds 11 photos.

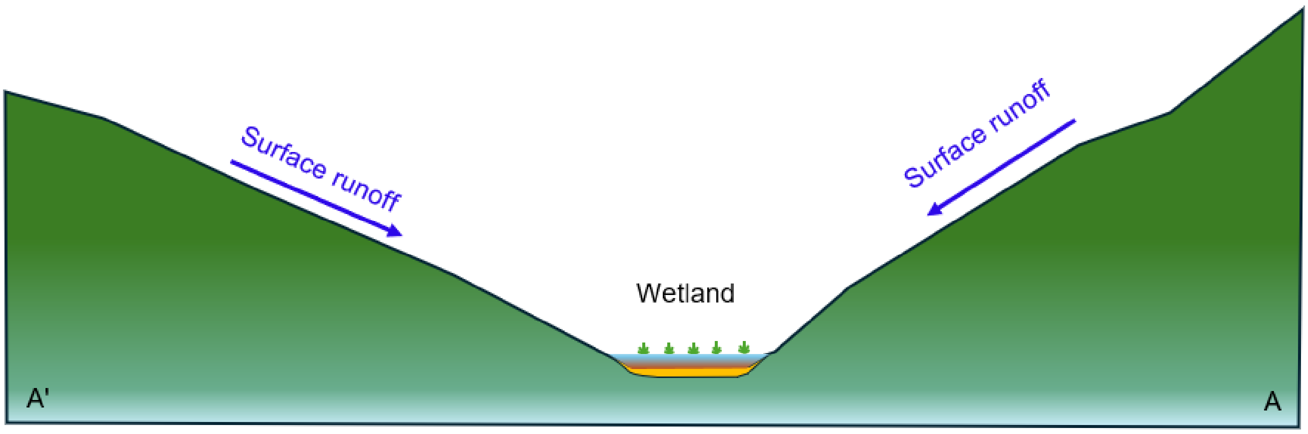

Figure A36. Hydrology schematic for Edmonds 11.

A.5.12 Edmonds 12

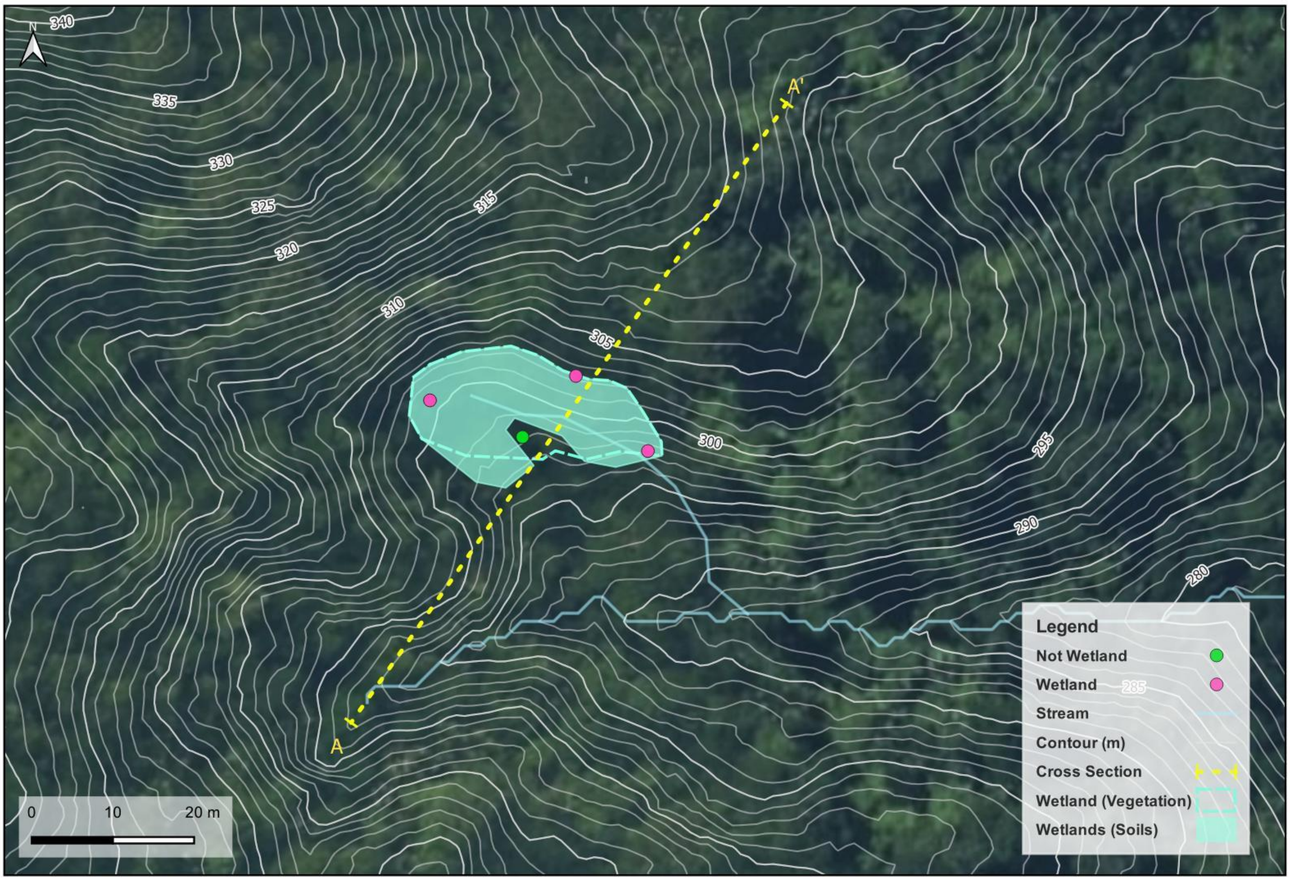

Figure A37. Edmonds 12 overview.

Table A16. Data summary for Edmonds 12.

Topic	Comments
Summary	Edmonds 12, (**Figure A37**) was identified as wetland by Bioresearches. This assessment has confirmed the feature was a surface water supported wetland based on the soils and hydrology.
Geomorphology and Vegetation.	The wetland was particularly steep and consisted of two valleys that ran from west to east, although the contours did not show this. The wetland was located along the dips in the two valleys with the slight mound between the two not showing wetland characteristics (**Figure A38 – Photo 1**). The area was covered in large boulders and dense vegetation which made digging very difficult (**Figure A38 – Photo 2**).
Water Observations	At the bottom of the two valleys there were two small streams. Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit.
Soils	Surface ponding was underlain by a very dark brown soil (topsoil 2/2, subsoil 2/2). These areas were very fluid and were not possible to dig/auger to show a full 1 m depth profile (**Figure A38 – Photo 3**). The area without surface ponding was generally wet underfoot with rich, dark brown saturated surface soils (topsoil 2/2). The subsoil was likely a silty clay; majority clay with some sand and gravel. Grey soils with orange mottling is noted in the subsoil. Non wetland areas were very clearly dry and were dark brown with a lighter, mid-brown colour (topsoil 3/3, subsoil 6/8). Soil was likely a silty clay; majority clay with some gravel. They did not hold their shape.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 12 was surface water-fed from surface runoff during rainfall. This is shown in **Figure A39** as a schematic.

Figure A38. Edmonds 12 photos.

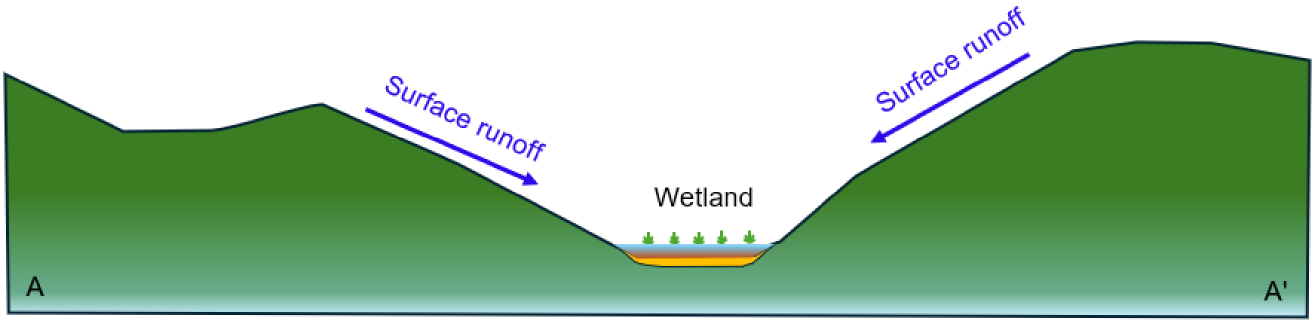

Figure A39. Hydrology schematic for Edmonds 12.

A.5.13 Edmonds 13

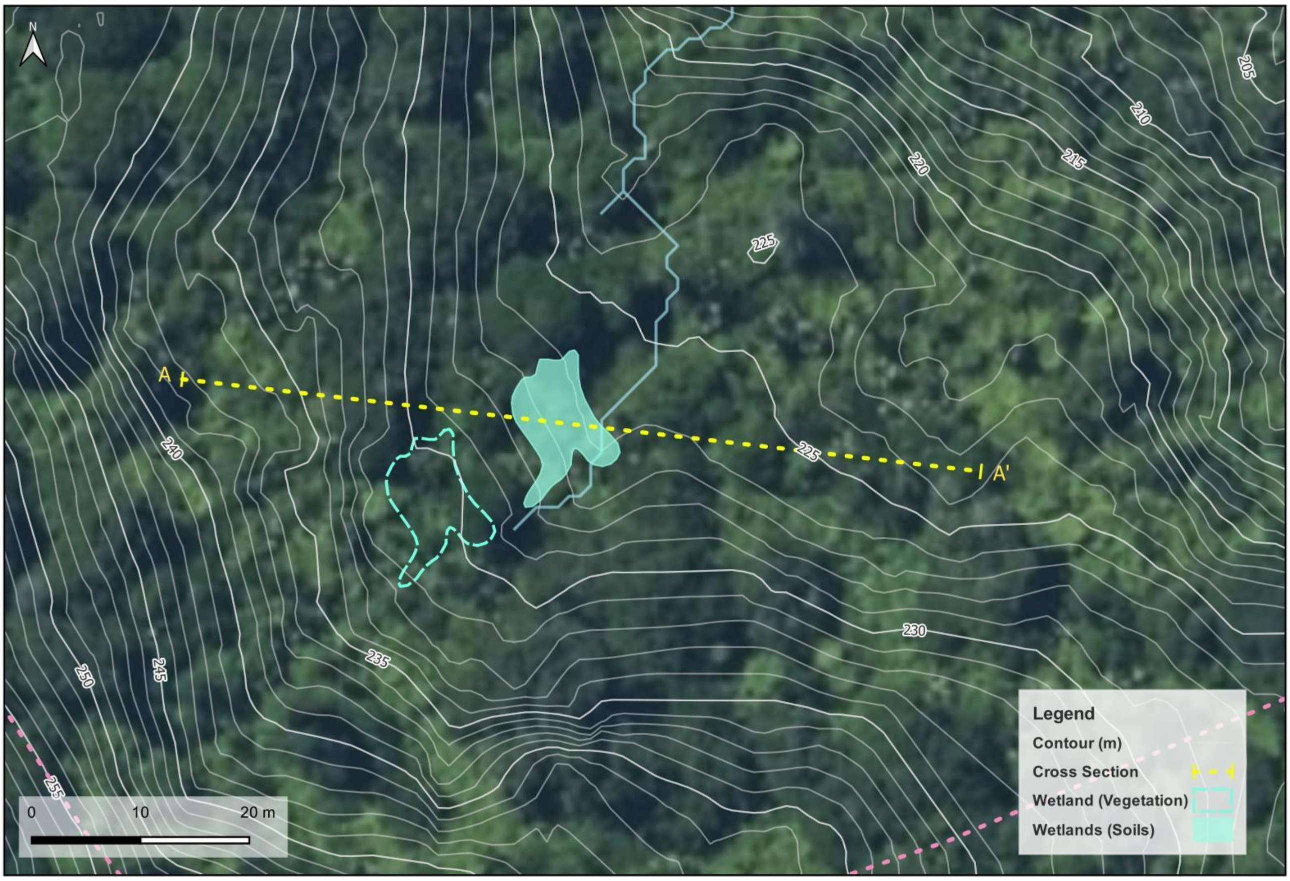

Figure A40. Edmonds 13 overview.

Table A17. Data summary for Edmonds 13.

Topic	Comments
Summary	Wetland 13 (**Figure A40**), was identified as wetland by Bioresearches. This assessment has confirmed the feature was a combination supported wetland based on the soils and hydrology.
Geomorphology	The site was bound by steep topography (**Figure A41 – Photo 1**) to the south and south-west. Very steep banks contained the wetland within a small dip in the topography. Ponding was observed within the wetland (**Figure A41 – Photo 2**).
Water Observations	There was a steep drop to the stream forming along the eastern edge of the site. Seepage was observed coming from the banks into the wetland and forming the stream.
Soils	Due to the terrain and vegetation, it was not possible to dig complete test pits at this location. Surface ponding was underlain by dark to mid brown topsoils that are highly saturated.
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 13 was surface water-fed from surface runoff during rainfall and potential interflow. This is shown in **Figure A42** as a schematic.

Figure A41. Edmonds 13 photos.

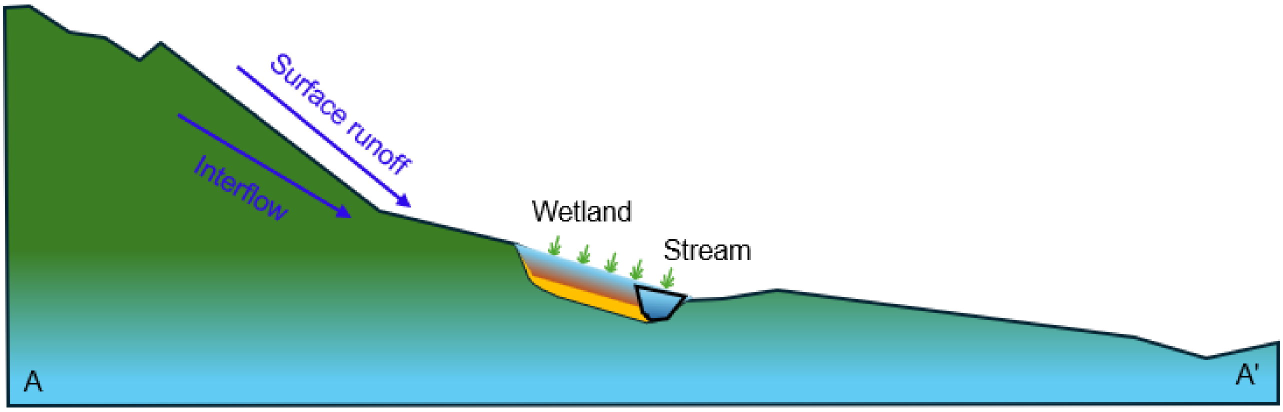

Figure A42. Hydrology schematic for Edmonds 13.

A.5.14 Edmonds 14

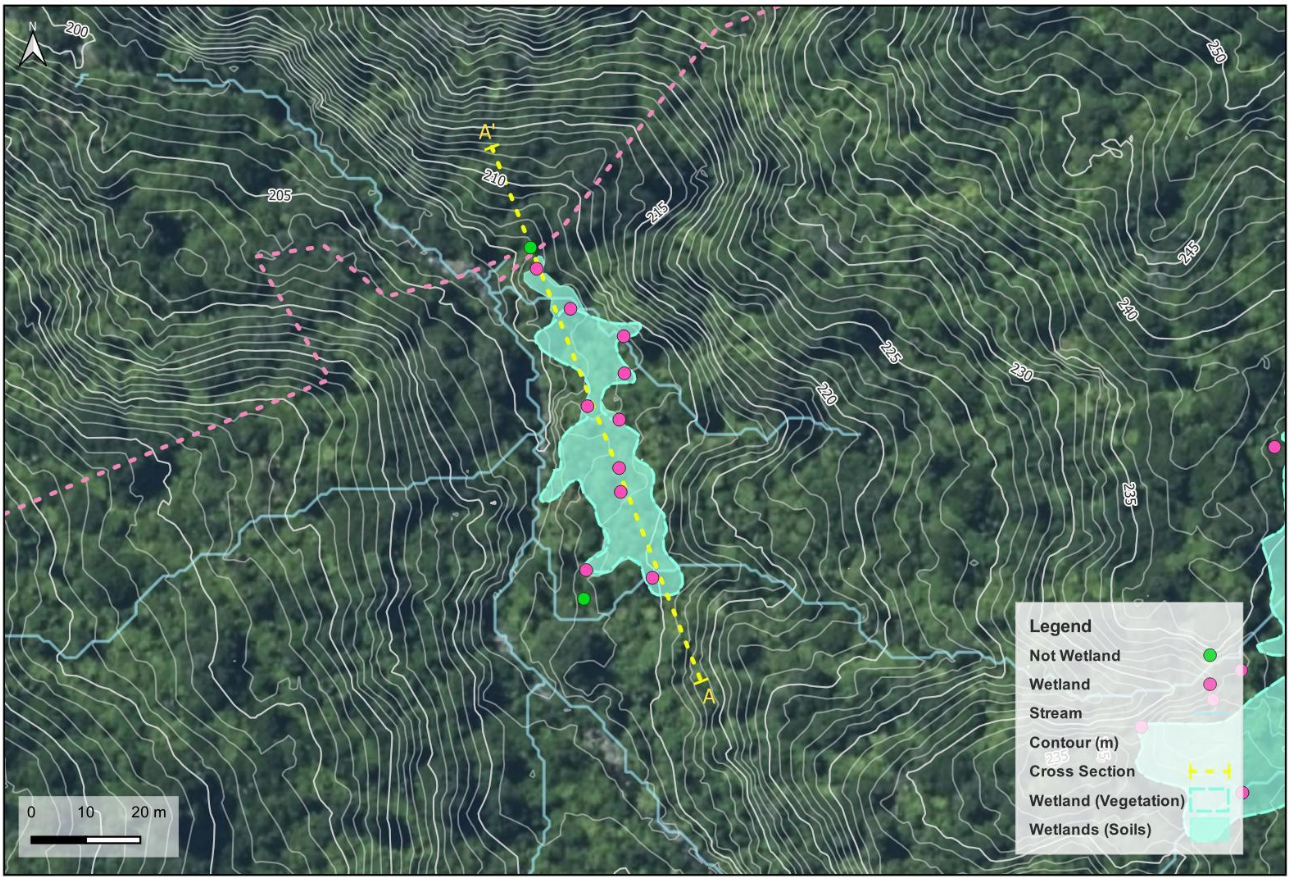

Figure A43. Edmonds 14 overview.

Table A18. Data summary for Edmonds 14.

Topic	Comments
Summary	Edmonds 14 (**Figure A43**), was identified as a wetland by Bioresearches. This assessment has confirmed the feature was a combination support wetland based on the soils and hydrology.
Geomorphology and Vegetation	The wetland was located within a valley with steep topography to the east and west. The site was covered by dense wetland vegetation.
Water Observations	A stream ran south to north along the western border of the site. Along with this, a small spring ran through the site in the northeast. A second small stream was identified along the southern edge of the site. Surface water was noted throughout the area despite the extended period of hot, dry weather during the first visit. A groundwater spring formed ponding which contained orange iron-oxidising bacteria (**Figure A44 – Photo 1**).
Soils	Some of the wetland areas were a very dark brown, or very dark grey with high fluidity and surface water (topsoil 2/2 or 3/1, subsoil 2/2). It was difficult to auger these sites, when attempted, some pockets of redox clay were found (clay 7/1 with orange) (**Figure A44 – Photo 2**) . Some of the surface water was underlain by a bright orange-brown soil (6/8) during the first, which was likely orange iron-oxidising bacteria. Non wetland areas were clearly unsaturated and were a dark, yellow-brown colour (topsoil 3/4, subsoil 4/4). The soils were very crumbly and gravelly with some larger rocks up to 10 cm, and dry, and did not hold their shape (**Figure A44 – Photo 3**).
Key Findings	Based on the topography of the site and field observations, it is likely that Edmonds 14 was surface water-fed from the stream at a nearby higher elevation which seeped through the topography. The wetland was also likely supported

	by a groundwater spring which emerged at the surface and by surface runoff during rainfall This is shown in **Figure A45** as a schematic.

Figure A44. Edmonds 14 photos.

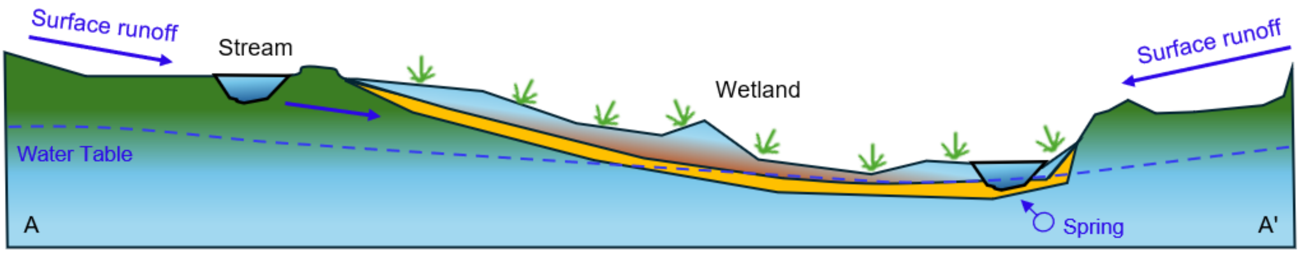

Figure A45. Hydrology schematic for Edmonds 14.

A.5.15 Edmonds 15

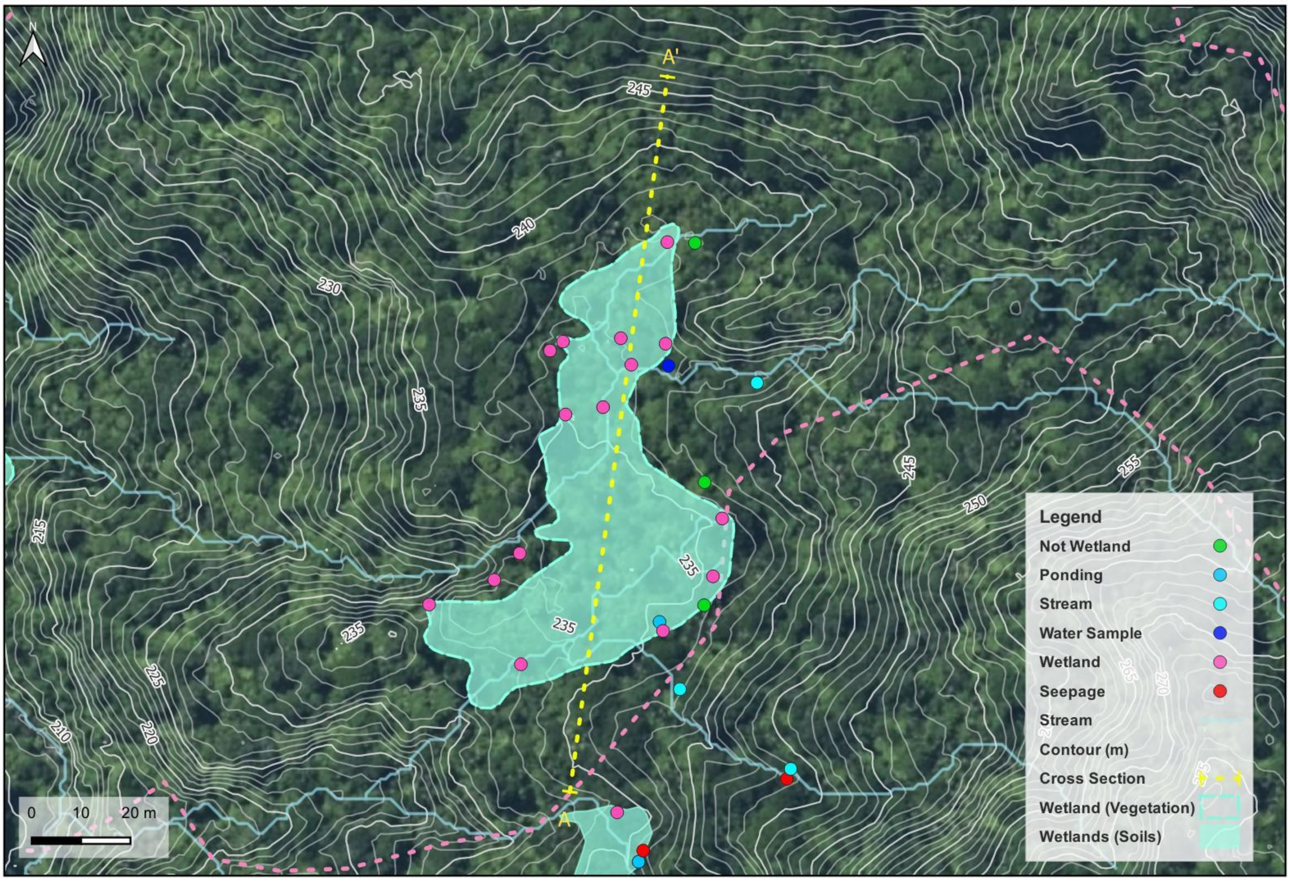

Figure A46. Edmonds 15 overview.

Table A19. Data summary for Edmonds 15.

Topic	Comments
Summary	Edmonds 15 (**Figure A46**), was identified as a wetland by Bioresearches. This assessment has confirmed the feature was a combination support wetland based on the soils and hydrology.
Geomorphology and Vegetation	The wetland was located in a valley with steep topography to the east and southwest. The site was covered by dense wetland vegetation.
Water Observations	Multiple small streams ran through the site, but these were at low points and did not appear to be feeding the entire wetland. Surface water (**Figure A47 – Photo 1**) was noted throughout the area despite the extended period of hot, dry weather during the first visit. In certain areas it appeared that the ponding was forming due to groundwater upwelling at the surface. Orange iron-oxidising bacteria was observed in these locations.
Soils	The wetland areas of this site with ponding were generally a bright orange-brown (6/8) during the first visit, which was likely the iron-oxidising bacteria. Wetland soils were generally very fluid and not possible to auger to the full 1 m depth. Wetland areas with no surface ponding were still highly saturated and showed clear redox conditions in the subsoil (clay 5/1 with orange) (**Figure A47 – Photo 2**). There were very plastic soils with majority clay. A shallow water table was identified at these sites. Non wetland soils were clearly unsaturated and very crumbly throughout (**Figure A47 – Photo 3**). The topsoil was generally a mid-brown with loamy texture (4/3), underlain by a small clay layer showing redox conditions (clay 5/1). This was further underlain by a light brown soil (7/8).