Pattle Delamore Partners Limited

TECHNICAL MEMORANDUM

INVESTIGATION	Additional Wetland Investigations	**PROJECT**	McLarin Road – Detailed Ecological Investigations for Plan Change
CLIENT	**HD Project 2 Ltd**	**PROJECT NO**	A03629901
CLIENT CONTACT	Henry Gao	**PREPARED BY**	Amber Simmonds and Emma Willmore
CLIENT WORK ORDER NO/ PURCHASE ORDER	N/A	**SIGNATURE**	
		DATE	5 April 2022

Introduction

Pattle Delamore Partners Ltd (PDP) has been engaged by HD Project 2 Ltd to undertake further wetland status and delineation assessments at 80 McLarin Road, Glenbrook (the site), at the request of Auckland Council (AC), to inform structure plans and to support an application for a private plan change (PPC).

The site forms part of a larger block of land in Glenbrook that is Future Urban zoned (FUZ) in the Auckland Unitary Plan-Operative in Part 2016 (AUP-OP). The site will need to be rezoned by way of a PPC and if the plan change is successful, the project design and consenting phase will follow. It is envisaged that the maintenance and enhancement of freshwater values and resources will be a key resource management issue for land development, particularly given the policy direction of the National Environmental Standard for Freshwater Regulations (NES-F 2020) and National Policy Statement for Freshwater Management (NPS-FM 2020).

Background

PDP first undertook ecological feasibility investigations at the site in October 2020 to identify constraints and opportunities for future site development (PDP, 2020). This investigation confirmed the presence of a number of overland flow paths (OLFPs) and two wetland areas at the site. A third area in the northern corner of the site also presented signs of a former wetland during the investigation, based on a number of indicators, however vegetation across the northern corner of the site had died off at the time of the investigation (possibly due to spraying), preventing a full assessment.

A further investigation was undertaken by PDP in July 2021, when vegetation had re-established in the northern paddock, in accordance with the Wetland Delineation Protocols (Ministry for the Environment, 2020). This investigation concluded that the northern corner of the site was no longer a functioning wetland as it did not meet the definition of a natural inland wetland under the NPS-FM 2020, despite some historic indicators. Vegetation was found to comprise entirely of exotic grass, with no established hydrophytic vegetation, and soils were lacking characteristics typical of hydric conditions present in wetlands. As such, the vegetation and soil criteria outlined in the Wetland Delineation Protocol was not met.

A site walkover in January 2022 with an Auckland Council (AC) ecologist found that hydrophytic vegetation had established in four new locations on the site, not previously observed by PDP. As such, further investigation to confirm the wetland status of these areas was requested by AC in an email dated 2nd February 2022. Specifically, AC requested that the assessments focused on current vegetation and further soils analysis and applying the Wetland Delineation Hydrology Tool for Aotearoa New Zealand (MfE, 2021). It is noted that this tool was published in July 2021 and was not available for PDP's earlier investigations.
This memo discusses the findings of the most recent investigations undertaken at AC's request.

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Methodology

Field investigations were undertaken on 24th February 2022 by a PDP ecologist. The weather was fine with 1.5 mm of rainfall recorded in the previous week at the nearest Auckland Council rain gauge (Waitangi @Diver Road). Prior to that approximately 26 mm of rainfall was recorded between the 10th and 17th February.

A follow up visit was undertaken on 4th April 2022 to incorporate the latest guidance provided by MfE on calculation of pasture grasses for wetland delineation (provided at a workshop by Bev Clarkson on 16 March 2022).

A total of seven 2x2 m vegetation plots were investigated at the four locations identified by AC across the site (illustrated in Figure 1):

- Northern Paddock (Plot 1 and 2),
- Northern Paddock Intermittent Stream (Plot 3),
- Western Paddock (Plots 4 and 5); and,
- Eastern Paddock (Plots 6 and 7).

Representative photographs of the plots assessed during the investigation are provided as Appendix A.

Wetland Delineation

Wetland delineations were undertaken in accordance with the Ministry for the Environment (MfE) Wetland Delineation Protocols (2020). This included an assessment of vegetation, hydrology and soils based on the following:

- Vegetation Tool (Clarkson, 2014);
- Hydrology Tool (MfE, 2021);
- Hydric soils – field identification guide/Hydric Soils tool (Fraser et al, 2018); and,
- Defining 'natural wetlands' and 'natural inland wetlands' (MfE 2020).

Wetland delineations were undertaken close to the recommended timeframe for field work (late spring to mid-summer) when most vegetation is in full leaf and flowering.

Wetland Classification

Wetlands are areas that are intermittently or permanently saturated by water and support natural ecosystems of plants and animals adapted to wet conditions. This is based on the Resource Management Act (RMA; 1993) term for 'wetland'. The NPS-FM 2020 definition of a 'natural wetland' is a wetland (as defined in the Act) that is not:

a) A wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore an existing or former natural wetland); or

b) A geothermal wetland; or

c) Any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

A 'natural inland wetland' is a wetland that is not located in the coastal marine area and includes both freshwater and inland saline wetlands.

Results

Table 1: Results of Wetland Delineation

Site	Rapid Test[1]	Dominance Test-50/20 Rule	Prevalence Index	Hydric Soils present	Wetland Hydrology Test	Improved Pasture [2]	Meets Natural Inland Wetland Definition
Plot 1 - Northern paddock	No	Yes (66%)	Yes (2.97) Marginal	No/Uncertain	No	No	Yes
Plot 2 - Northern paddock	No	Yes (100%)	Yes (2.57)	Yes	No	No	Yes
Plot 3 -Northern paddock intermittent stream (A4)	No	Yes (100%)	Yes (2.60)	No	No	No	Yes
Plot 4 - Western paddock	No	No (50%)	No (3.19)	Yes	No	No	No
Plot 5 -Western paddock	No	Yes (66%)	No (3.1)	Yes	No	No	No
Plot 6 -Eastern paddock	No	No (50%)	No (3.71)	Yes	No	Yes	No
Plot 7 -Eastern paddock	No	No (50%)	No (3.09)	Yes	No	No	No

Notes:
1. *All dominant plant species obligate wetland or facultative wetland.*
2. *Ground cover of more than 50 % exotic pasture species, and the presence of temporary rain derived pooling.*

MfE field forms showing the results of the vegetation plots, vegetation tests, soils tests and hydrology assessment are included in Appendix B.

Table 1 above presents a summary of the wetland delineations and classifications in relation to the MfE Wetland Delineation Protocols (2020) and NPS-FM (2020).

Northern Paddock

Two plots were conducted in the northern paddock in areas most likely to be dominated by hydrophytic vegetation. Plot 1 was conducted within the ephemeral channel (referred to as A2 in previous investigations) and Plot 2 at the toe of a slight hill in the depressional area.

Plot 1 was dominated by Yorkshire fog (*Holcus Lanatus),* followed by water pepper (*Persicaria hydropiper)*, and paspalum (*Paspalum dilatatum)*. The soil profile was only marginally indicative of hydric soils with only the lower section of the soil profile at 50 cm showing marginal low chroma colours and mottles (<10%). The upper soil profile was silty while the lower profile comprised plastic clays. Wetland hydrology was not present.

Plot 2 was dominated by water pepper (56%) followed by Yorkshire fog and paspalum. The soil profile was indicative of hydric soils with only the lower section of the soil profile at 40 – 50 cm showing low gley chroma colours with medium sized mottles. The upper soil profile was silty while the lower area comprised plastic clays. Wetland hydrology was not present.

A summary of the northern paddock plot results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Soils pass the hydric soil test at Plot 2, but the evidence is much less clear at Plot 1.
- Wetland hydrology was not present at either location.
- Plots 1 and 2 meet the RMA definition of a wetland given that the dominance test and prevalence index were both passed (marginally at Plot 1).
- Under the NPS-FM 2020 'natural wetland' assessment, Plots 1 and 2 are considered to be induced wetlands - unintentionally induced through human activities such as land clearance, stock pugging and water drainage, and resulting in conditions suitable for wetland vegetation and soils. As they are not dominated by >50% exotic pasture species in the current assessment (i.e., do not meet the improved pasture test), they meet the wider definition of 'natural inland wetlands'

Northern Paddock Intermittent Stream

A plot was conducted in the northern paddock along the intermittent watercourse (identified in former investigations as watercourse A4). The area was very uniform in vegetation through the channel as such, Plot 3 was conducted in the middle of the intermittent channel where there was most likely to be hydrophytic vegetation.

Plot 3 was dominated by water pepper, followed by Yorkshire fog and soft rush. The upper soil profile was silty with only very minimal (2%) mottles present with a slight change in chroma in the lower layers to a low chroma silty clay. No strong indicators of hydric soil were identified.

A summary of the northern paddock intermittent stream plot results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation does not pass the rapid test, but passes the dominance test and prevalence index, as such this is considered at wetland under the RMA definition.
- No hydric soils or wetland hydrological indicators were present at the time of the assessment.

- As above, this area is considered to be an induced wetland under the NPS-FM (2020), formed through human activity and stock pugging. This meets the wider definition of a 'natural inland wetland'.

Western Paddock

Two plots were conducted in the western paddock, targeting areas most likely to be dominated by hydrophytic vegetation. These plots were adjacent to the intermittent stream channel (A4).

Plot 4 was dominated by soft rush (40%) followed by kikuyu grass (*Cenchrus clandestinus*) (30%). Soils were silty sand with some clay in bottom layers. Low chroma colours were present with large mottles in the matrix, indicative of hydric soils. No hydrological indicators were present.

Plot 5 was dominated soft rush (25%) followed by penny royal (*Mentha pulegium)* (20%) and paspalum (15%). Soils were all silty sand. Low chroma colours were present with fine mottles in the matrix, also indicative of hydric soils. No hydrological indicators were present.

A summary of the western paddock plot results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation in Plot 4 failed the rapid test and the dominance test and prevalence index. Under MfE guidance, this is considered a non-wetland.
- Vegetation at Plot 5 failed the rapid test, passed the dominance test but failed the prevalence index. It passed the hydric soil test but failed the hydrology test.
- Under the NPS-FM (2020), the status of Plot 5 falls under the category of a 'drained wetland' or atypical environmental conditions, with further site assessment required to determine status. Based on site topography and all other supporting information obtained, it is considered that this plot does not meet the wetland definition under the RMA and is no longer a functioning wetland.

Eastern Paddock

Two plots were conducted in the eastern paddock in areas dominated by obvious hydrophytic vegetation. Plot 6 was conducted within an overland flow path and Plot 7 was conducted where two flow paths converge, slightly downhill from Plot 6.

Plot 6 was dominated with kikuyu grass (55%) followed by water pepper (42%). The soil profile was indicative of hydric soils with only the lower section of the soil profile at 40 - 50cm showing low chroma/grey colours with mottles.

Plot 7 was dominated by water pepper (70%). Kikuyu grass was also a dominant species (40%), growing around and below the water pepper. The soil profile is marginally indicative of hydric soils with only the lower section of the soil profile at 45 - 50cm showing low chroma/ gley colours.

A summary of the eastern plot results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation in Plots 6 and 7 did not pass the rapid test, dominance test or prevalence index and as such do not have wetland status under the RMA.
- Plot 6 is an area of improved pasture (more than 50% exotic pasture grass).

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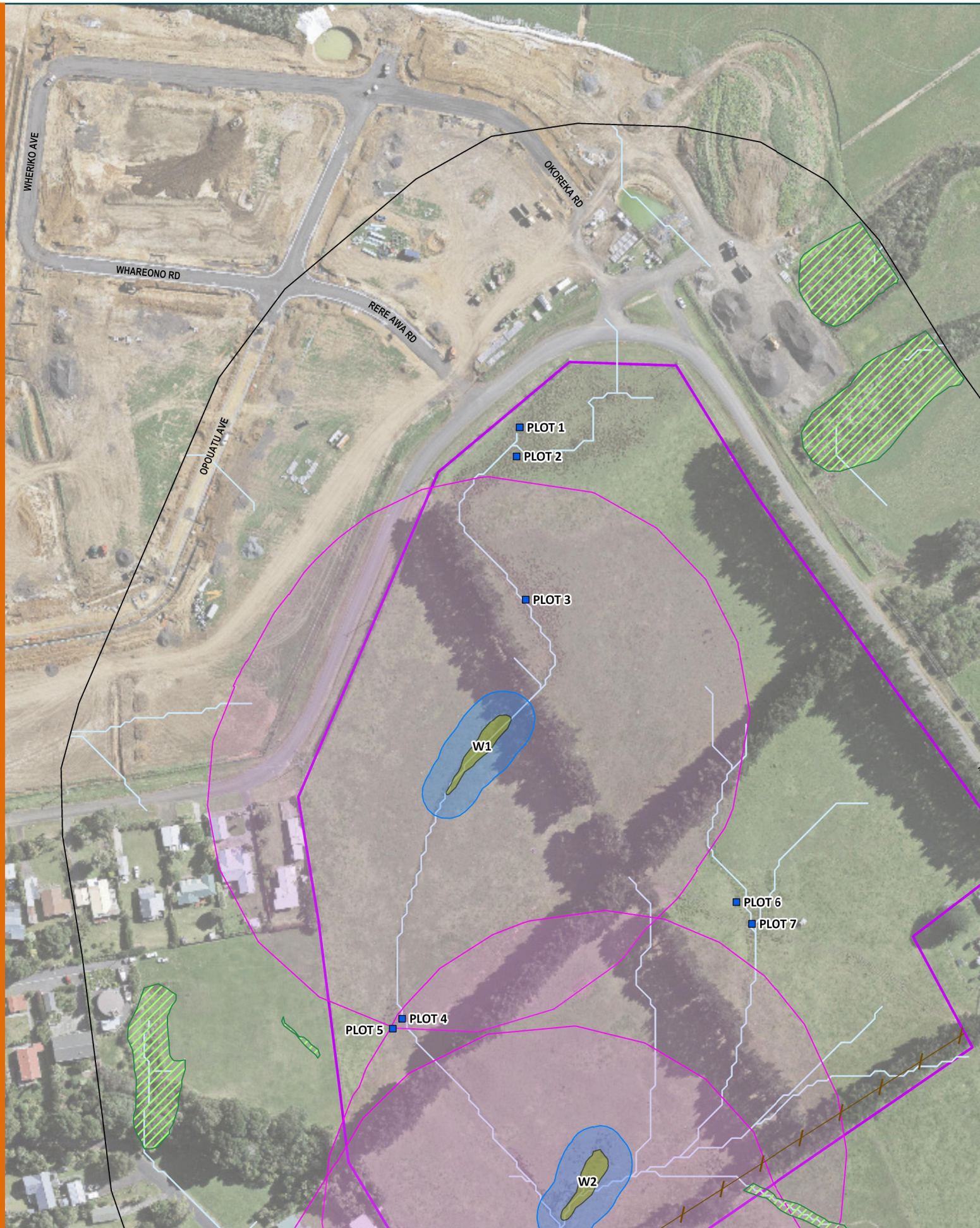
Conclusions

Plots 1, 2 and 3 were determined to meet the 'natural inland wetland' definition under the NPS-FM (2000) following the MfE Wetland Delineation Protocols. These areas are considered to be induced wetlands created through unintentional human disturbance. As such, any future site development must avoid impacts on these areas, and setbacks apply for earthworks and land disturbance to prevent drainage of these areas. Wetland hydrology was not identified in these three plots and strong hydric soils were only observed at Plot 2.

Hydrophytic vegetation was the strongest wetland indicator, assessed through the Vegetation Tool. The two previous investigations by PDP did not find hydrophytic vegetation in plots 1 and 2, possibly due to spraying and subsequent sowing of pasture grasses in this northern paddock prior to our assessments. The dominant hydrophytic species found in these three plots in 2022 was water pepper, a summer annual often found in damp pasture areas damaged by pugging. This species was found to be dying off during the subsequent visit on 4th April 2022. PDP observed the northern paddock being tilled while we were leaving site, suggesting that this area will be re-sown in pasture grass. If this is the case, this will again affect the results of the wetland delineation, as the vegetation will not pass the tests in the Vegetation Tool (i.e., it would be considered an area of improved pasture, dominated by exotic pasture species). Given the historical and ongoing land use practices in this area, PDP recommends AC take this into consideration when making a final decision on wetland status.

Plot 3 is located on the edge of the intermittent watercourse (formerly referred to as A4) which is already protected under the AUP-OP. In PDPs Detailed Ecological Assessment (PDP, 2021) we recommended restoration of the intermittent watercourses on site to improve ecological values, incorporating a 10 m wide riparian buffer to ensure vegetation is self-sustaining (in-line with AC guidelines). PDP has also recommended retaining overland flows where possible, directed into the stream network to sustain and protect the hydrology of streams and wetlands over the long-term.

We note that a discussion document on proposed changes to the wetland regulations has been recently released by MfE – Managing Our Wetlands (2021) which outlines a consenting pathway for urban development (land zoned for housing use). If these changes are approved, it would mean that the wetland areas identified by PDP would not be protected under the NPS-FM (2020) and the National Environmental Standard for Freshwater (2020) would not apply.



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Appendix A: Site Photographs

Photograph 1: Northern depressional area near Plot 1

Photograph 2: Plot 1 Overview (2x2 m)

Photograph 3: Plot 1 Soil

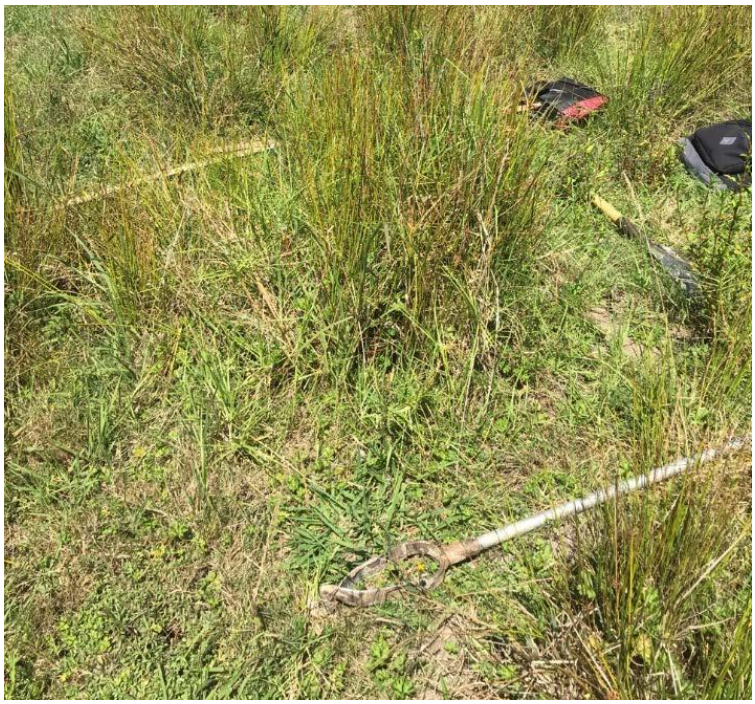
Photograph 4: Plot 2 Overview (2x2 m)

Photograph 5: Northern area tributary (intermittent stream A4)

Photograph 6: Plot 3 Overview (2x2 m)

Photograph 7: Plot 3 Soil

Photograph 8: Western paddock - Plots 4 and 5



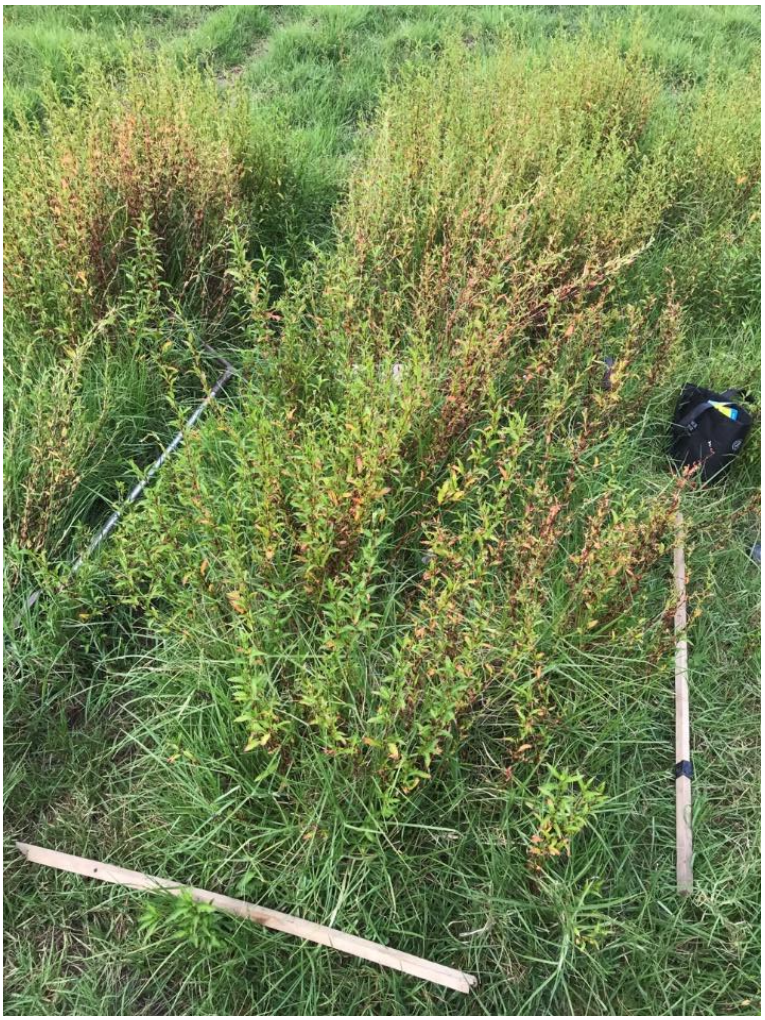
Photograph 9: Plot 4 Overview (2x2 m)

Photograph 10: Plot 4 Soil

Photograph 11: Plot 5 Overview (2x2 m)

Photograph 12: Plot 5 Soil

Photograph 13: Eastern paddock



Photograph 14: Plot 6 Overview (2x2 m)

Photograph 15: Plot 6 Soil

Photograph 16: Plot 7 Overview (2x2 m)

Photograph 17: Plot 7 Soil

Photograph 18: Location of Plot 1 and 2 in April 2022.

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Appendix B: Field Notes

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin - Northern Paddock Region: Auckland Sampling point: Plot 1

Owner: Glenbrook Date: 24/12/22 Land use: Grazed Pasture

Landform: In channel Local relief: Land cover: Exotic grassland

Is the land drained (circle) YES (NO) Investigator(s): AS, PW Soil °C: Slope°: Flat

GPS (NZTM): 1752186.074, 5886131.518 Altitude m: ~15m Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☑ NO ☐ **Is the sampled area within a wetland? YES ☑ NO ☐**

Hydric soils present? YES ☐ NO ☑

Wetland hydrology present? YES ☐ NO ☑

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. P. hydropiper	28	Y	FACW
2. Juncus effusus	10		FACW
3. Cyperus congestus	1		FAC
4. Holcus lanatus	35	Y	FAC
5. R. repens	5		FAC
6. Taraxacum oficinale	1		UPL
7. Isolepis cerua	1		OBL
8. P. dilatatum	29	Y	FACU
9. Lythrum hyssopifolia	1		FACW
10. Prunella vulgaris	1		FACU
11. Rumex obtusifolius	1		FAC
12. Trifolium repens	1		FAU
Total cover =	116		
13. C. clandenstinus	2		UPL

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 3

% OBL/FACW/FAC (A/B) 66

Prevalence Index:

Total % cover of:		Multiply by:	
OBL	1	x 1 =	1
FACW	39	x 2 =	78
FAC	42	x 3 =	126
FACU	31	x 4 =	124
UPL	3	x 5 =	15
Total	116 (A)		344 (B)

Prevalence Index (B/A) = 2.97

Hydrophytic vegetation indicators:

☑ Dominance Test is >50%

☑ Prevalence Index is ≤3.0[1]

☐ Morphological adaptations[1] (supporting data in Remarks)

☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑

NO ☐

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
0-20	10 YR 4/2					mineral	Dry silty sandy
20-30	10 YR 3/2					mineral	topsoil with
30-40	10 YR 4/2					mineral	dark hue
40-50	10 YR 5/2	10 YR 3/4	<10	F	matrix	mineral	Grey matrix clay

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W (MW) I P VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☐ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☒ Mottled

Horizon:
- ☒ Reductimorphic
- ☒ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully Slope

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☐ NO ☒ UNCERTAIN ☒ NZSC subgroup MOA & AQA

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☐ Surface water (1A)
- ☐ Groundwater <30 cm (1B)
- ☐ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

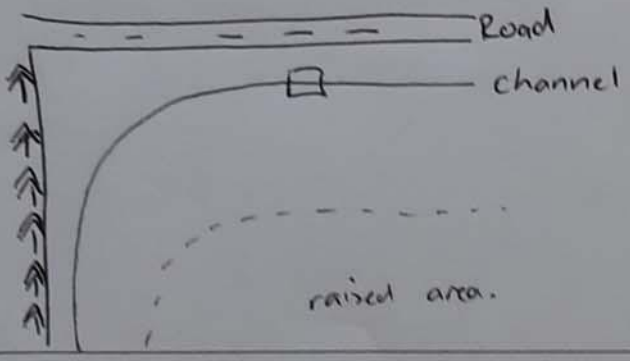
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☒ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☐ NO ☒

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin Rd, Glenbrook Region: Akl. Sampling point: Plot 2

Owner: Northern paddock Date: 24/2/22 Land use: Grazed pasture

Landform: Local relief: Flat Land cover: Exotic grassland

Is the land drained (circle) YES (NO) Investigator(s): AS, PW Soil °C: Slope°:

GPS (NZTM): 1752184 , 5886117 Altitude m: ~15 m Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☑ NO ☐ **Is the sampled area within a wetland? YES** ☑

Hydric soils present? YES ☑ NO ☐ **NO** ☐

Wetland hydrology present? YES ☐ NO ☑

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. P. hydropiper	56	Y	FACW
2. Juncus effusus	10		FACW
3. Paspalum dilatatum	15		FACU
4. R. repens	2		FAC
5. R. flammula	3		FACW
6. Holus lanatus	35	Y	FAC
7. C. congustus	4		FAC
8.			
9.			
10.			
11.			
12.			
Total cover =	125		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 100

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	69	x 2 =	138
FAC	41	x 3 =	123
FACU	15	x 4 =	60
UPL		x 5 =	
Total	125 (A)		321 (B)

Prevalence Index (B/A) = 2.57

Hydrophytic vegetation indicators:

- ☑ Dominance Test is >50%
- ☑ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑

NO ☐

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
1-20	10 YR 4/2					mineral	Dry loam soil
20-40	10 YR 3/1					mineral	with some organic material
40-50	10 YR 6/2	10 YR 6/4	20	m	roots	mineral	Grey soil hue, gley matrix clay

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W (MW) I P VP

Organic layers:
- [ ] Organic soil material
- [ ] Litter
- [ ] Fibric
- [ ] Mesic
- [ ] Humic
- [ ] Peaty topsoil
- [ ] Peaty subsoil

Concretions:
- [ ] Iron concretions
- [ ] Manganese concretions
- [ ] Nodular

Consistence:
- [ ] Plastic
- [x] Sticky
- [ ] Fluid

Colours: profile form either:
- [ ] Gley OR
- [x] Mottled

Horizon:
- [ ] Reductimorphic
- [ ] Redox mottled
- [x] Redox segregations
- [ ] Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully Slope

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

- [ ] Pugged

Hydric soils present? YES [x] NO [ ] UNCERTAIN [ ] NZSC subgroup MOA & AOA

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- [ ] Surface water (1A)
- [ ] Groundwater <30 cm (1B)
- [ ] Soil saturation <30 cm (1C)
- [ ] Water marks (2A)
- [ ] Sediment deposits (2B)
- [ ] Drift deposits (2C)
- [ ] Algal mat/crust (2D)
- [ ] Iron deposits (2E)
- [ ] Surface soil cracks (2F)
- [ ] Inundation on aerial imagery (2G)
- [x] Sparsely vegetated concave surface (2H)
- [ ] Salt crust (2I)
- [ ] Aquatic invertebrates (2J)
- [ ] Hydrogen sulphide odour (3A)
- [ ] Oxidised rhizosphere on roots (3B)
- [ ] Reduced iron (3C)
- [ ] Reduced iron in tilled soil (3D)
- [ ] High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

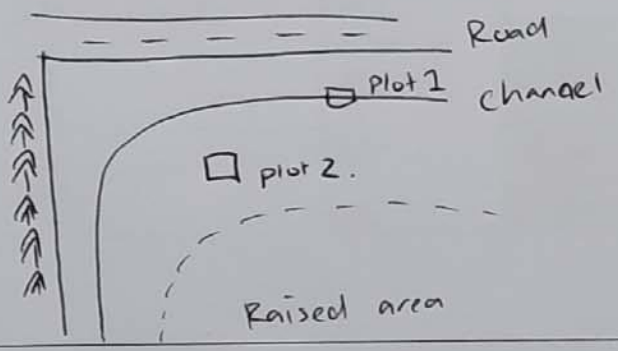
- [ ] Water-stained leaves (2K)
- [ ] Drainage patterns (2L)
- [ ] Dry-season water table (3E)
- [ ] Saturation in aerial imagery (3F)
- [x] Geomorphic position (4B)
- [ ] Shallow aquitard (4C)
- [ ] FAC-neutral test (4D)
- [ ] Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES [ ] NO [x]

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLaren Rd, Glenbrook | Region: Akl. | Sampling point: Plot 3 - Northern Paddock, Int. Stream.

Owner: | Date: 24/12/22 | Land use: Grazed pasture

Landform: | Local relief: Flat | Land cover: Exotic grassland

Is the land drained (circle) YES (NO) | Investigator(s): AS / PW | Soil °C: | Slope°:

GPS (NZTM): 1752188, 5886059 | Altitude m: ~15m | Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☑ NO ☐ **Is the sampled area within a wetland? YES ☑ NO ☐**

Hydric soils present? YES ☐ NO ☑

Wetland hydrology present? YES ☐ NO ☑

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: /)			
1.			
2.			
3.			
4.			
Tall herb Total cover =			
Sapling/~~Shrub~~ Stratum (Plot size: 2x2m)			
1. Persicaria hydropiper	45	Y	FACW
2. Rumex obtusifolius	5		FAC
3.			
4.			
5.			
Total cover =	50		
Herb Stratum (Plot size: 2x2)			
1. ~~P. hydropiper~~	~~45~~	~~Y~~	~~FACW~~
2. J. effusus	10		FACW
3. Rumex obtusifolius	5		FAC
4. R. repens	5		FAC
5. R. flammula	1		FACW
6. Cenchrus clandestinus	5		UPL
7. Holcus lanatus	35	Y	FAC
8. Lotus spp.	5		FAC
9. P. dilatatum	1		FACU
10. P. distichum	2		FACW
11. Cyperus eragrostis	2		FACW
12.			
Total cover =	71		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 100

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	60	x 2 =	120
FAC	55	x 3 =	165
FACU	1	x 4 =	4
UPL	5	x 5 =	25
Total	121 (A)		314 (B)

Prevalence Index (B/A) = 2.60

Hydrophytic vegetation indicators:

- ☑ Dominance Test is >50%
- ☑ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑

NO ☐

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
1-30	10 YR 4/2						Silty
30-50	10 YR 5/3	10 YR 6/4	2			Mineral	Slightly more clay

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W (MW) I P VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☐ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☐ Mottled

Horizon:
- ☐ Reductimorphic
- ☐ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully Slope

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☐ NO ☑ UNCERTAIN ☐ NZSC subgroup MOA

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☐ Surface water (1A)
- ☐ Groundwater <30 cm (1B)
- ☐ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

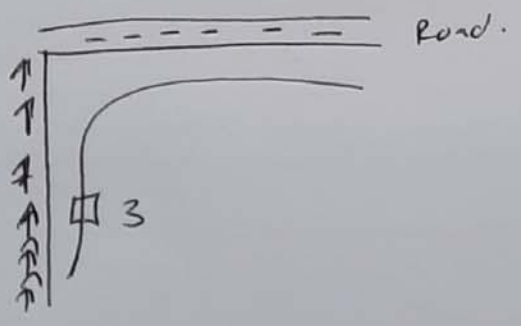
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☒ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☐ NO ☑

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin Rd, Glenbrook Region: AKL Sampling point: Plot 4, Western Paddock

Owner: Date: 24/12/22 Land use: Grazed pasture

Landform: Local relief: Hillside Land cover: Exotic grassland

Is the land drained (circle) YES (NO) Investigator(s): AS, PW Soil °C: Slope°:

GPS (NZTM): 1752136, 5885883 Altitude m: ~16 m Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☐ ☑ NO **Is the sampled area within a wetland? YES** ☐

Hydric soils present? YES ☑ ☐ NO **NO** ☑

Wetland hydrology present? YES ☐ ☑ NO

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. H. lanatus	1		FAC
2. R. repens	10		FAC
3. Lotus sp.	1		FAC
4. P. dilatatum	4		FACU
5. C. clandestinus	30	Y	UPL
6. Plantago lanceolata	1		FACU
7. Mentha pulegium	5		FAC
8. P. hydropiper	2		FACW
9. J. effusus	40	Y	FACW
10. Lotus corniculatus	1		FACU
11. P. distichum	5		FACW
12.			
Total cover =	100		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 1

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 50

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	47	x 2 =	94
FAC	17	x 3 =	51
FACU	6	x 4 =	24
UPL	30	x 5 =	150
Total	100 (A)		319 (B)

Prevalence Index (B/A) = 3.19

Hydrophytic vegetation indicators:

- [X] Dominance Test is >50%
- [X] Prevalence Index is ≤3.0[1]
- [ ] Morphological adaptations[1] (supporting data in Remarks)
- [ ] Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☐

NO ☑

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
1-15	10 YR 4/2					mineral	Loamy topsoil
15-40	10 YR 7/2					mineral	Sandy
40-50	10 YR 7/2	10 YR 6/8	40	L	matrix	mineral	low chroma sandy some clay

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W MW I P VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☐ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☒ Mottled

Horizon:
- ☐ Reductimorphic
- ☒ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☑ NO ☐ UNCERTAIN ☐ NZSC subgroup _____

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☐ Surface water (1A)
- ☐ Groundwater <30 cm (1B)
- ☐ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

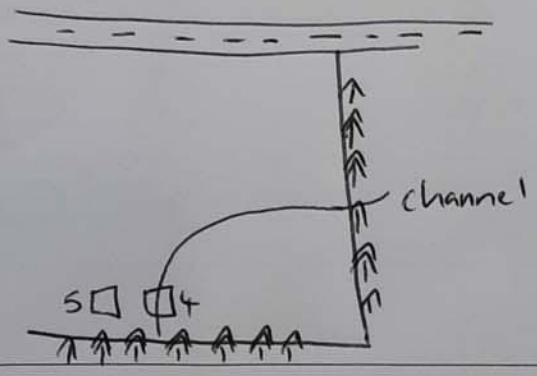
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☒ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☐ NO ☑

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin Rd, Glenbrook Region: Akl. Sampling point: Plot 5, Western Paddock

Owner: Date: 24/2/22 Land use: Grazed pasture

Landform: Local relief: Hillside Land cover: Exotic grassland

Is the land drained (circle) YES (NO) Investigator(s): AS, PW Soil °C: Slope°:

GPS (NZTM): 1752132, 5885879 Altitude m: ~16 m Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☑ NO ☐ **Is the sampled area within a wetland? YES** ☐

Hydric soils present? YES ☑ NO ☐ **NO** ☑

Wetland hydrology present? YES ☐ NO ☑

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. L. corniculatus	3		FACU
2. R. repens	12		FAC
3. J. effusus	25	Y	FACW
4. P. hydropiper	3		FACW
5. C. clandestinus	10		UPL
6. P. dilatatum	15	Y	FACU
7. M. pulegium	20	Y	FAC
8. Lotus sp.	2		FAC
9. Agrostis sp.	5		FACU
10. P. distichum	5		FACW
11.			
12.			
Total cover =	100		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 3

% OBL/FACW/FAC (A/B) 66

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	33	x 2 =	66
FAC	34	x 3 =	102
FACU	23	x 4 =	92
UPL	10	x 5 =	50
Total	100 (A)		310 (B)

Prevalence Index (B/A) = 3.10

Hydrophytic vegetation indicators:

- ☑ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑

NO ☐

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
1-30	10 YR 6/3					Mineral	Dry,
30-40	10 YR 6/3					mineral	Dry sandy
40-50	10 YR 6/2	10 YR 6/6	35	F	matrix	mineral	Dry sandy

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) (W) MW I P VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☐ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☒ Mottled

Horizon:
- ☐ Reductimorphic
- ☐ Redox mottled
- ☒ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☑ NO ☐ UNCERTAIN ☐ NZSC subgroup MOA

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☐ Surface water (1A)
- ☐ Groundwater <30 cm (1B)
- ☐ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

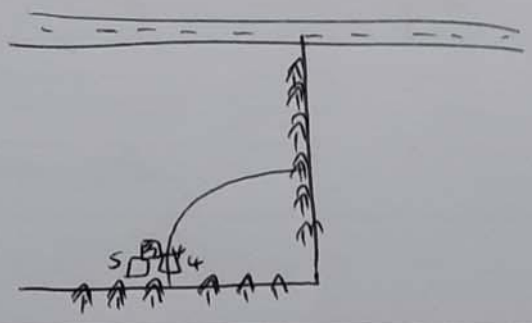
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☒ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☐ NO ☑

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLean Rd, Glenbrook | Region: Akl. | Sampling point: Plot 6, Eastern Paddock

Owner: | Date: 24/2/22 | Land use: Grazed pasture

Landform: | Local relief: Low gradient | Land cover: Exotic grassland

Is the land drained (circle) YES (NO) | Investigator(s): AS, PW | Soil °C: | Slope°:

GPS (NZTM): 1752276, 5885932 | Altitude m: 16 m | Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☐ ☑ NO

Hydric soils present? YES ☑ ☑ NO

Wetland hydrology present? YES ☐ ☑ NO

Is the sampled area within a wetland? YES ☐ NO ☑

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2 x 2)			
1. Persicaria hydropiper	42	Y	FACW
2. C. clandestinus	55	Y	UPL
3. Trifolium repens	3		FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
Total cover =	100		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 1

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 50

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	42	x 2 =	84
FAC		x 3 =	
FACU	3	x 4 =	12
UPL	55	x 5 =	275
Total	100 (A)		371 (B)

Prevalence Index (B/A) = 3.71

Hydrophytic vegetation indicators:

- ☒ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☐

NO ☑

UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
0-10	10 YR 4/2					mineral	Sandy silty soil
10-20	10 YR 3/2					mineral	
20-40	10 YR 5/2					mineral	
40-50	10 YR 5/2	10 YR 6/8	35	m	pore	mineral	

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W MW P VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☐ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☒ Mottled

Horizon:
- ☐ Reductimorphic
- ☒ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☑ NO ☐ UNCERTAIN ☐ NZSC subgroup _____

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☐ Surface water (1A)
- ☐ Groundwater <30 cm (1B)
- ☐ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

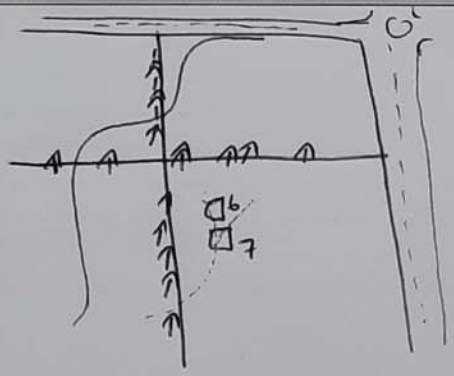
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☒ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☐ NO ☑

Sketch of site/soil:



Remarks:

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLean, Glenbrook | Region: Akl. | Sampling point: Plot 7, Eastern Paddock

Owner: | Date: 24/2/22 | Land use: Grazed pasture

Landform: | Local relief: gentle slope | Land cover: Exotic grassland

Is the land drained (circle) YES (NO) | Investigator(s): AS, PW | Soil °C: | Slope°:

GPS (NZTM): 1752283, 5885923 | Altitude m: 16 m | Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present?	YES ☐	☑ NO	**Is the sampled area within a wetland?**	**YES** ☐
Hydric soils present?	YES ☑	☐ NO		**NO** ☑
Wetland hydrology present?	YES ☐	☑ NO		

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. Persicaria hydropiper	70	Y	FACW
2. Cenchrus clandestinus	40	Y	UPL
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
Total cover =	110		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 1

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 50

Prevalence Index:

Total % cover of:		Multiply by:	
OBL		x 1 =	
FACW	70	x 2 =	140
FAC		x 3 =	
FACU		x 4 =	
UPL	40	x 5 =	200
Total	110 (A)		340 (B)

Prevalence Index (B/A) = 3.09

Hydrophytic vegetation indicators:

- [X] Dominance Test is >50%
- [X] Prevalence Index is ≤3.0[1]
- [ ] Morphological adaptations[1] (supporting data in Remarks)
- [ ] Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

- YES ☐
- NO ☑
- UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
0-30	10 YR 4/2					mineral	Dark low chroma
30-45	10 YR 4/2					organic	Dark
45-50	10 YR 6/2	10 YR 6/2	5	F	matrix	mineral	Grey hue, gley.

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W (MW) P VP

Organic layers:
- [ ] Organic soil material
- [ ] Litter
- [ ] Fibric
- [ ] Mesic
- [ ] Humic
- [ ] Peaty topsoil
- [ ] Peaty subsoil

Concretions:
- [ ] Iron concretions
- [ ] Manganese concretions
- [ ] Nodular

Consistence:
- [ ] Plastic
- [ ] Sticky
- [ ] Fluid

Colours: profile form either:
- [X] Gley OR
- [ ] Mottled

Horizon:
- [ ] Reductimorphic
- [ ] Redox mottled
- [ ] Redox segregations
- [ ] Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) ____

High GW Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

- [ ] Pugged

Hydric soils present? YES [✓] NO [ ] UNCERTAIN [ ] NZSC subgroup AOA

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- [ ] Surface water (1A)
- [ ] Groundwater <30 cm (1B)
- [ ] Soil saturation <30 cm (1C)
- [ ] Water marks (2A)
- [ ] Sediment deposits (2B)
- [ ] Drift deposits (2C)
- [ ] Algal mat/crust (2D)
- [ ] Iron deposits (2E)
- [ ] Surface soil cracks (2F)
- [ ] Inundation on aerial imagery (2G)
- [ ] Sparsely vegetated concave surface (2H)
- [ ] Salt crust (2I)
- [ ] Aquatic invertebrates (2J)
- [ ] Hydrogen sulphide odour (3A)
- [ ] Oxidised rhizosphere on roots (3B)
- [ ] Reduced iron (3C)
- [ ] Reduced iron in tilled soil (3D)
- [ ] High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

- [ ] Water-stained leaves (2K)
- [ ] Drainage patterns (2L)
- [ ] Dry-season water table (3E)
- [ ] Saturation in aerial imagery (3F)
- [X] Geomorphic position (4B)
- [ ] Shallow aquitard (4C)
- [ ] FAC-neutral test (4D)
- [ ] Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES [ ] NO [✓]

Sketch of site/soil:

Remarks:

Auckland Hamilton Tauranga Wellington Christchurch Invercargill

PATTLE DELAMORE PARTNERS LTD

Wetland Hydrology Assessment
80 McLarin Road, Glenbrook

HD Project 2 Limited

Wetland Hydrology Assessment
80 McLarin Road, Glenbrook

Prepared for

HD Project 2 Limited

December 2021

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Office +64 9 **523 6900**
Website **http://www.pdp.co.nz**
Auckland Tauranga Hamilton Wellington
Christchurch Invercargill

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Prepared by

SIGNATURE

Catherine Sturgeon

Reviewed by

SIGNATURE

Katy Grant

Approved by

Laura Drummond

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by HD Project 2 Limited and others (not directly contracted by PDP for the work), including Lander Geotechnical Consultants Limited and Harrison Grierson. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of HD Project 2 Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

PDP (2020) identified two wetlands (W1 and W2) within the Glenbrook development site and a subsequent site visit to a neighbouring property also identified a third wetland (W3) within 100 m of the development site (PDP, 2021a). PDP were engaged to undertake a hydrology investigation of the identified wetlands in order to support the client's application for the Private Plan Change (PPC).

The hydrology of three wetlands within the Glenbrook development site have been assessed and the results indicate that W1 and W2 are primarily sustained by surface water inflows such as overland flow and stream flow. However, it is likely that there is some sub-surface flow/groundwater component feeding W2 in the northern portion of the wetland. W3 was assessed to be sustained primarily by groundwater, with some flood flows from the adjacent stream (A3) and run-off from a relatively small catchment area which mainly falls within the neighbouring site.

The water balance components have been assessed to determine the relative importance of each inflow to sustaining the wetland for the use in future assessments of effects during the design phase. The results are likely to be refined as more site-specific data becomes available.

Development on site has the potential to affect the hydrology of the wetlands due to changes to the total catchment surface area, diversion of stormwater, retaining walls (affecting sub-surface flow), installation of soakage, and an increase in impervious area.

W1 is mainly run-off fed, and therefore will require the same volume of run-off being diverted into this wetland. This should remain as a combination of channelised flow and overland flow. W2 is considered to be similar to W1, however consideration also needs to be given to the potential impacts on groundwater recharge upgradient of the wetland as sub-surface flows could also be feeding this wetland. The W3 wetland is considered to be groundwater fed with some surface water contribution. The groundwater level is expected to be reflective of the regional groundwater table and therefore development at the site is unlikely to significantly influence groundwater levels and groundwater inflows provided mechanisms for recharge are considered during the design phase.

The following level of hydrological monitoring is considered appropriate and should be undertaken prior to and during any development on site.

- The installation of a groundwater monitoring well at W3 is recommended for the purposes of water level monitoring.

- Visual assessments of flow during periods of heavy rainfall is also recommended to confirm the hydrological understanding of the wetlands.
- Additional groundwater investigation is recommended if it can be combined with other works to be undertaken at the site.

Please note that this report addresses hydrology of the wetlands in Glenbrook development area, however it needs to be considered in conjunction with the PDP wetland delineation and ecology assessment.

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Appendices

1.0 Introduction

The National Policy Statement for Freshwater Management (NPS-FM, 2020) and the National Environmental Standards for Freshwater (NES-F, 2020) came into effect on 3 September 2020 and as a result there are implications for activities located within 100 m of natural wetlands. Under the NES-F (2020), the taking, use, damming, diversion, or discharge of water within a 100 m setback from a natural inland wetland has non-complying activity status if it results or is likely to result in the complete or partial drainage of all or part of the natural inland wetland. Earthworks or land disturbance within a 100 m setback of a natural inland wetland is also a non-complying activity, if it is likely to result in the complete or partial drainage of all or part of the wetland.

The site is currently zoned as Future Urban Zone (FUZ) but will need to go through a plan change to be rezoned as a live urban zone. HD Project 2 Limited (the client) are currently in the process of applying for the plan change. We understand that the plan change seeks to rezone approximately 8 hectares from Future Urban to Urban Residential Land Use under the Auckland Unitary Plan 2016 – Operative in Part (AUP(OP)).

PDP (2020) have identified two wetlands within the Glenbrook development site. A subsequent site visit to a neighbouring property also identified a third wetland within 100 m of the development site (PDP, 2021a). PDP have been engaged to undertake a hydrology investigation of the identified wetlands in order to support the client's application for the Private Plan Change (PPC).

This wetland hydrology assessment identifies the principal mechanism by which each wetland is sustained (e.g. groundwater or overland flow). This information can be used to support the stormwater design and development plan and will provide mitigation options where development (e.g. earthworks or the diversion of surface runoff) may impact the water sources feeding these wetlands. This report provides monitoring recommendations for the future development.

1.1 Objectives

The specific objectives of this technical report are to:

- Identify the principal mechanism by which the wetlands at each location are sustained (e.g. groundwater, overland flow, or stream flood flow);
- Assess the relative importance of each contribution (groundwater, overland flow, or stream flood flow) to sustaining the wetlands;
- Provide recommendations for minimising the effect on the hydrology of the wetlands during design and development, and
- Provide advice on wetland hydrological monitoring in order to support the plan change application.

2.0 Methodology

2.1 Desktop Assessment

PDP carried out an initial desktop review of available information relating to the site including feasibility studies.

2.1.1 Reviewed Reports

The following reports were reviewed:

- 80 McLarin Road, Glenbrook Beach: Development Feasibility Report, by Harrison Grierson (HG, 2020).
- Ecological Feasibility Assessment: 80 McLarin Road, Glenbrook, by PDP (PDP, 2020).
- Technical Memorandum: Northern Wetland Status and Delineation Assessment, McLarin Rd Ecological Investigations for Plan Change, by PDP (PDP, 2021b).
- Preliminary Geotechnical Assessment Report: 80 McLarin Road, Glenbrook, by Lander Geotechnical Consultants Limited (Lander Geotechnical, 2021).

2.1.2 Site Information

The following information was obtained from publicly available sources and the above reviewed reports:

- Topography: An understanding of the topography was achieved through Google Earth and the reviewed reports. Contours were also obtained from Auckland Council GeoMaps (Auckland Council, 2021a).
- Climate: Climate data was obtained from NIWA CliFlo (NIWA, 2021) and Auckland Council Environmental Data Portal (Auckland Council, 2021b).
- Soils: The soil map and data were obtained from the Landcare Research S-Map portal (Landcare Research, 2021).
- Geology: The geology map was obtained from the GNS New Zealand Geology Web Map portal (GNS, 2021) which, for the Auckland region, is based on Edbrooke (2001). New Zealand Geotechnical Database (NZGD, 2021) was also checked for bore hole information. The geotechnical report by Lander Geotechnical (2021) was reviewed.
- Groundwater: The geotechnical report by Lander Geotechnical (2021) provided information on groundwater levels.
- Surface water: Surface water catchment areas were delineated using contours. A description of the surface water features was outlined in PDP (2020) and PDP (2021a).

- Wetland delineation: The delineated wetland areas were provided in PDP (2021a).

2.2 Site Visit and Field Assessment

A site visit was undertaken on 22 October 2021 by PDP ecologists to delineate the third wetland on the neighbouring property. During this site visit the ecologists obtained information to enable the completion of the wetland hydrology assessment for all three wetlands. A site visit was unable to be undertaken by the PDP wetland hydrologists due to COVID restrictions.

The weather was fine during the site visit; however, conditions had been wet over the previous week. There had also been overnight rainfall of 4.5 mm. Groundwater levels were noted via ponded water and through shallow soil pits (approximately 0.3 m deep). The hand auger was used to determine soil type and also thickness of soil profile. Any evidence of springs or seeps was noted. Surface water channels were investigated with the intent to estimate flow rates.

3.0 Findings

3.1 Site Description

The site is approximately 8 ha of greenfield land. The majority of the site is dominated by grazed pasture with pine shelterbelts located along the eastern and southern boundaries and dissecting the site into quarters.

The north and eastern parts of the site are relatively flat. There are steeper slopes towards the centre of the site and in the southwestern corner (towards the coast). Slopes of greater than 1:5 prevail and there is a steep escarpment on the southwestern boundary with properties that front Ronald Avenue to the west (HG, 2020).

There is an approximate change in elevation of 19 m at the site from the northeast (approx. 22.5 m RL) to the southwest (approx. 3.5 m RL). A ridgeline runs from west to east across the central portion of the site and separates the elevated flatter northern portion of the site from the sloping land of the south (HG, 2020).

There are overland flow paths, streams and flood plain areas identified within the site. The drainage pattern of the site flows roughly from the northeast to the southwest. The main channel and lower lying flood plain are located in the southwestern corner of the site (HG, 2020). The southwestern corner is low-lying (3.5 m RL) and approximately 150 m away from the coast.

3.2 Wetlands

PDP (2020) identified two small wetlands in the upper and lower western portions of the site (W1 and W2). Both wetlands have an area of 0.02 ha (200 m^2). PDP were engaged to delineate a third wetland (W3) in the southern boundary on site which is also present on the neighbouring property (PDP, 2021a), this wetland was identified to have an area of 0.1 ha (1,000 m^2). All wetlands have been classified as marsh wetlands and are dominated by *Juncus effusus* (soft rush). Marshes are characterised with having moderate to good drainage, fed by groundwater or surface water of slow to moderate flow, and moderate to great fluctuation of water table or water level. Marshes are often periodically inundated by standing or slowly moving water. Marshes occur mainly on slight to moderate slopes, especially on valley margins, valley floors, and alongside water bodies such as rivers and lakes (Johnson and Gerbeaux, 2004). A figure of the wetland extents is provided as Figure 1 in Appendix A.

W1 is located on the north-western corner of the site and the extent of W1 falls within the 18.5 m RL contour. The W1 area is quite flat. W2 is located in the middle of the south-western corner and is located at a lower elevation. The wetland extent of W2 extends from 6 to 7.5 m RL. W3 lies on the southern boundary of the site and extends outside the development area. It is at the lowest elevation and extends from 3 to 5.5 m RL.

Investigations by PDP (2020) indicate that the land has been heavily modified over time. There is notable damage to the onsite vegetation, in particular due to pugging from livestock and general grazing activities.

3.3 Soils and Geology

The geology in the northern portion of the site is East Coast Bays Formation (Waitemata Group) and consists of alternating sandstone and mudstone with variable volcanic content and interbedded volcaniclastic grits (Edbrooke, 2001). The geology to the south (and the majority of the site including wetland locations) is Late Pliocene to Middle Pleistocene pumiceous river deposits (Puketoka Formation) and consists of pumiceous mud, sand and gravel with muddy peat and lignite, rhyolitic pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits (Edbrooke, 2001).

S-Map Online (Landcare Research, 2021) indicates that there are three soil types across the site. A large portion of the site is covered with acidic orthic allophanic soil (Te Rau). These soils are considered to be well drained. However, the wetlands are located on the imperfectly drained or poorly drained soil types further outlined below:

- The soil at W1 is mottled orthic allophanic soil (KarakaM). This soil is deep, imperfectly drained, clay, with a depth to hard soil/gravel/rock of greater than one metre.

- The soil at W2 is typic orthic gley soils (Temuka). These soils are deep, poorly to very poorly drained, clays, with a depth to hard soil/gravel/rock of greater than one metre.
- The soil at W3 is saline orthic gley soils (Manukau). These soils are deep, very poorly drained, clays, with a depth to soil/gravel/rock of greater than one metre.

The results of the soil investigation undertaken during the site visit were consistent with what was expected. Generally, topsoil was encountered in the top 300 mm followed by clay with mottling.

The geotechnical report by Lander Geotechnical (2021) was reviewed and the following was noted:

- 2 hand augers (HA01 and HA02) and 1 machine borehole (MH01) were drilled in the south-eastern area of the site. Four CPTs were undertaken (one in each corner of the site). These locations are shown on Figure 1 in Appendix A.
- The bore logs indicated that all sites had 300 mm of topsoil. HA01 and HA02 had a layer of ash deposit underlying the topsoil, followed by Puketoka Formation. At MH01, Puketoka Formation was encountered directly under the topsoil.

3.4 Climate

The annual average rainfall for the site of 1,243 mm/yr was obtained from measured data at the NIWA Pukekohe Ews gauge (14.2 km south-east from the site) (NIWA, 2021). This data is similar to Auckland Council Environmental Data Portal at the Waitangi @ Diver Road site (Auckland Council, 2021b). The annual average evaporation for Penman evapotranspiration (ET) was obtained from the NIWA Cliflo website. Climate data was consistent with annual rainfall and annual Penman ET presented in Chappell (2014).

Table 1: Climate Data for the Site

Data	Description	Time Period	Average Annual (mm)
Rainfall – Pukekohe Ews	Daily rainfall	1987 - 2021	1,243[1]
Evaporation – Pukekohe Ews	Daily Penman evaporation	1987 - 2021	876[1]

Notes:

1. *Years with missing records greater than 10 days were ignored in the calculation to determine average annual rainfall and evaporation.*

3.5 Surface Water

PDP (2021a) identified an intermittent stream channel (A4) which extends from the northern corner to the southern quarter of the site (Figure 1 in Appendix A), and an intermittent stream channel (A3) which is located in the southern quarter of the site and merges with A4. The intermittent streams did not contain water at the time of the site visit in October 2020, however during the site visit in October 2021, pooled water was noted in the intermittent streams (with flowing water only observed between W2 and W3). This suggests that significant flow is infrequent and generally short-lived.

The upper reaches of these streams were identified as ephemeral by PDP (2021a) and are shown as A1 and A2 in Figure 2. A2 extends north from intermittent stream A4. Ephemeral stream A1 is fed by a complex network of overland flow paths that drain the central and eastern portions of the site. Pooled water was noted in some parts of the ephemeral streams during the October 2021 site visit, but flow is likely to be limited and only occur following significant rainfall.

W1 is located on the intermittent stream channel A4. Water was pooled at this location during the site visit in October 2021 (Photograph 1 in Appendix B). The pooled water was noted in the pugged area created by stock.

The southern portion of W2 lies on the intermittent stream A3 and it is likely that surface flows of stream A4 bypass the wetland to the west (Photographs 2 and 3). Stream A3 is likely to provide surface flows to the southern portion of the wetland, however this stream is intermittent and therefore this will not occur continuously.

The intermittent stream channel (A3) bypasses W3 at the site boundary. W3 is slightly elevated above the stream channel (Photograph 6 in Appendix B), however in one section the channel levels out so high flows could potentially overflow into W3 (Photograph 7 in Appendix B). The A3 watercourse is approximately 0.3 m wide and ranges between 0.05 and 0.15 m deep. There is some flow in the watercourse after rain, however the majority of pools are small and shallow.

The A3 watercourse enters a channel on the neighbouring property that runs in a northwest to southeast direction. This is labelled as a ‘stormwater treatment facility’ in AC Geomaps and is densely vegetated (Photograph 8 in Appendix B). Flow is then directed through a pipe at the southern part of the vegetated stormwater channel and connects with the public stormwater network which is discharged at the coast.

W3 is slightly elevated compared to the vegetated stormwater channel and is also separated by an earth bund. Water from W3 may slowly seep into the drain via groundwater flow, and potentially over the bund during large rainfall events and large flow volumes.

3.6 Groundwater

The geotechnical report by Lander Geotechnical (2021) outlined the following:

- Groundwater levels were encountered in HA01 and HA02 at 4.0 m and 3.8 m below ground level (bgl) respectively. Both hand auger depths extended to 5 m depth.
- A piezometer was installed at MH01 (screened from 1 m to 15 m) and a groundwater level of 6.0 m bgl was recorded (after seven days to allow equilibrium to be reached). The elevation of MH01 is approximately 11 m RL. These locations are shown on Figure 1 in Appendix A.

The slope gradient at W1 is quite flat. The site visit noted ponded water across the surface at W1 and upgradient of the wetland. Stock has access to the wetland which has resulted in pugging of the soil.

The wetland at W2 extends partially up the hill slope to a slightly higher elevation than the stream channels. Water was not ponded at the surface in the northern portion of W2, but the soils were damp. Water was ponded at the southern edge of the wetland near stream A3. The slope gradient at the head of the wetland and the presence of vegetation extending up the slope may indicate that there is a groundwater or subsurface run-off contribution to this wetland.

Water was ponded at the surface at W3. The extent of the wetland is shown in Photographs 4 and 5 in Appendix B. Further southeast of the W3 and the site, a larger wetland is present at the same contour elevation (3 to 5.5 m RL). This indicates that W3 may be fed by discharge from the regional groundwater table.

3.7 Catchment Changes

Recent development north of the site (Glenbrook 3 Precinct) has resulted in an upgrade to McLarin Rd and new roundabout. The road upgrades appear to have modified the catchment boundary so that run-off from land on the north side of McLarin Rd no longer flows south and west across the site (HG, 2020). McLarin Road is assumed to define the catchment boundary and the site is considered to be at the top of its own local sub-catchment. These changes have already reduced the catchment area and potential surface water flows to the wetlands W1 and W3.

4.0 Wetland Hydrology Assessment

Wetland hydrology is driven by input through direct rainfall, groundwater inflows, and surface water inflows (overland flow or stream flow). This section outlines an understanding of the conceptual hydrological model of each wetland, based on the desktop investigation and the site visit undertaken by the PDP ecologists.

4.1 W1 Conceptual Model

The wetland hydrology onsite is likely driven by a combination of surface water flows (overland flow and intermittent stream flow), shallow groundwater (minimal) and direct rainfall. The primary mechanism for sustaining the hydrology of wetland W1 is likely to be surface run-off from the upper catchment for the reasons outlined below:

- The surface water catchment area for this wetland is approximately 2 ha which would provide run-off into this system.
- The wetland is located in the intermittent stream channel and the stream gradient is quite flat in this area. The imperfectly drained clays and geology in the area have a low vertical hydraulic conductivity which means that water takes a relatively long time to drain away at this site.
- Stock have access to this site and pugging was evident. Pugging, damaged or compacted soil can be produced if stock walk on the soil when the moisture content of the soil is high. This can cause a loss of soil structure and a loss of soil pores. This can reduce the rate at which water can enter soil (infiltration) and the rate at which water can drain through the soil (hydraulic conductivity) (McLaren and Cameron, 1996).
- The elevation of wetland in the 18.5 mRL contour. It is likely that water within the soils at W1 is perched above the regional water table due to the presence of low permeability layers. It may not be present continuously and will be dependent on rainfall, run-off and the extent of the low permeability layers. The regional groundwater table is likely to reflect the topography of the site but would be well below the surface at this location.
- Surface water flows are likely to be the dominant hydrological control on the wetland.

4.2 W2 Conceptual Model

The wetland will be fed by a combination of surface water flows (overland flow and intermittent stream flow), groundwater (seepages) and direct rainfall. The primary mechanism for sustaining the hydrology of wetland W2 is likely to be mainly surface run-off/overland flow for the reasons outlined below:

- The total surface catchment area is approximately 5 ha and this includes the catchment of stream A3. Stream A3 is likely to feed into the southern portion of the wetland. The surface catchment feeding the northern portion of the wetland is expected to be much smaller (approx. 0.3 ha). This partial catchment is identified in Figure 1. Within the surface catchment there is a distinct change in slope gradient so the surface flow velocity is likely to decrease suddenly and due to the clayey

soils would not be able to infiltrate into the ground very fast, potentially sustaining the wetland.

- The site visit also indicated that the northern portion of W2 could potentially be fed by subsurface flow or groundwater seepages. There is an increase in slope gradient at the head of the wetland. Ponded water is not present, and the stream channels bypass the wetland to the south; however, there is wetland vegetation present and the soil was damp in the northern portion of the wetland, which supports this theory.
- The elevation of W2 is between 6 and 7.5 m RL. This is at a higher elevation than W3 to the south, which is assumed to be mainly groundwater controlled (see Section 4.3). The regional groundwater table has been measured in MH01 at 6 m below ground level (5 m RL). This measurement was taken in July 2021 and we would expect groundwater levels to be quite high at this time, although there may be some groundwater contribution at periods of high water table (generally in September/October). This indicates that water levels at W2 are perched above the regional groundwater table and therefore that groundwater inputs are not the main hydrological driver for this wetland.

4.3 W3 Conceptual Model

Wetland W3 will be fed by a combination of surface water flows, groundwater and direct rainfall. The primary mechanism for sustaining the hydrology of wetland W3 is likely to be groundwater for the reasons outlined below:

- This wetland is likely to be influenced by the groundwater table due to the low-lying location near the coast. The elevation of the wetland is between 3 – 5 m RL and the coast is within 150 m. The highest elevation at 5 m RL is likely to be the expression of groundwater seeping to the surface. This corresponds with the large wetland to the south of the site (also at an elevation 3 – 5 m RL). It is also consistent with the level of the groundwater table measured at MH01 of 5 m RL.
- W3 extends into the adjacent stream (A3), however it is likely that A3 does not contribute largely to the overall water balance at W3 with most flow bypassing the wetland (the total surface catchment area for A3 is approximately 20 ha). However, there may be some inflows following flooding during times of heavy rainfall and high flow volumes.
- The surface catchment area for W3 is approximately 0.5 ha (not including stream A3), which is relatively small compared to the size of the wetland (when comparing to the other wetlands W1 and W2). Whilst run-off from this catchment will contribute to the wetland, it is unlikely to be sufficient to sustain a wetland of this size.

- Groundwater is likely to be the dominant hydrological control on the health of W3.

4.4 Wetland Mass Balance Calculation

A summary of the wetland delineated area and surface catchment areas is presented in Table 2. Existing information was used to develop a conceptual box model to estimate annual inputs into each wetland.

Table 2: Wetland Locations and Area

Wetland Number	Location	Wetland Area (m^2)	Surface Catchment Area (m^2)
1	W1	200	19,782 m^2
2	W2	200	W2 northern catchment: 3,585 m^2 W2 southern catchment (stream A1): 52,516 m^2
3	W3	1,000	W3 only: 4,958 m^2 Total catchment area of stream A3: 95,224 m^2

Wetlands have water inputs from precipitation (P), groundwater and surface water inflows. Water outputs from wetlands occur as evapotranspiration (ET), groundwater and surface water outflows. Change in water storage occurs when water is stored in soil and can result in water table changes. These inputs and outputs lead to the water balance equation:

$$(P + Q_{in} + G_{in}) - (ET + Q_{out} + G_{out}) = \Delta S$$

Where P = precipitation, Q_{in} = surface water inflows, G_{in} = groundwater inflows, E = evaporation, Q_{out} = surface water outflows, G_{out} = groundwater outflows and ΔS= change in storage (Campbell & Jackson, 2004).

On an annual basis change in storage can be assumed to be zero, and inflows can be assumed to equal the outflows. The equation therefore becomes:

$$(P + Q_{in} + G_{in}) = (ET + Q_{out} + G_{out})$$

For the scope of this project, we are primarily interested in the principal hydrological driver of these wetlands and therefore only the surface water and groundwater inflows have been estimated. This may be refined in the future if additional information is collected.

4.4.1 Wetland W1 and Wetland W2

Wetland W1 is considered to be the result of a perched water table and therefore fed by surface runoff and precipitation (rather than GW inflows). Wetland W2 potentially has GW inflows, however for the purpose of this exercise only the surface flows were considered.

The inflows (Q_{in}) into W1 and W2 were simply assessed using the following equation:

$$Q_{in} = P_{cat} - AET - G_{rec}$$

Where P_{cat} = annual precipitation across the catchment, AET = annual actual evapotranspiration calculated by assessing P and ET on a monthly time step, G_{rec} = groundwater recharge.

The groundwater recharge rate for Tauranga Group (including Puketoka Formation) has been estimated by Harding *et al*. (2000) and Williams & Sarris (2016) as 1 – 3% of precipitation however may reflect an impervious urban catchment. The recharge rate for the rural grassed site has therefore been increased and is estimated at between 2% and 10% of precipitation.

We have assumed that approximately 2% of surface water flows into the wetland bypass the wetland. This will occur during flood flows. The remaining surface water flows is assumed to pond at the wetland sites. This is considered reasonable as both streams are intermittent and therefore cease to flow during much of the year. The outflows (Q_{out}) are assessed using the following equation and subtracted from Q_{in}.

$$Q_{out} = Q_{in} \times 2\%$$

The result and their implications are discussed in Section 4.5.

4.4.2 Wetland W3

The surface inflows were estimated as above for W1 and W2, however an additional surface inflow from stream A3 (1% of annual flow) was included to account for potential flood flows from this catchment. Therefore, the equation became:

$$Q_{in} = (P_{cat} - AET - G_{rec}) + (Q_{in-A3} \times 1\%)$$

Q_{out} was excluded for this wetland as there was no evidence of a surface water flow channel out of this area.

As groundwater is considered to be the dominant control for wetland W3, the annual groundwater throughflow was estimated using Darcy's Law:

$$G_{in} = -KA \times \frac{dh}{dl}$$

Where Q = discharge in m^3/s, K = hydraulic conductivity, A = the cross-sectional area, dh/dl = the hydraulic gradient.

Freeze and Cherry (1979) gives K values of unweathered marine clay as $10^{-9} – 10^{-12}$ m/s and silt, loess as $10^{-5} – 10^{-9}$ m/s, and Williams & Sarris (2016) give Kh values of the Tauranga Group as 2×10^{-7} m/s. Due to this range, we have adopted a range in K values for this assessment ($10^{-5} – 10^{-9}$ m/s). This estimate may be refined by on-site testing of hydraulic conductivity (discussed further in Section 6.3).

The cross-sectional area was taken as the area of soil at the base of the wetland. The width was measured at 40 m and depth was assumed to be 5 m. This is not all topsoil but the contributing volume to the wetland groundwater. The hydraulic gradient was calculated using the elevations and distances of the seeps at the head and the base of the wetland.

The results are summarised in Section 4.5.

4.5 Water Mass Balance Results

The results of the water mass balance estimates are presented in Table 3.

Table 3: Water Mass Balance Results

	W1	W2	W3
Contributing flows to wetland	**m^3/yr**	**m^3/yr**	**m^3/yr**
Q	8,045 – 10,015	21,360 – 26,590	2,450 – 3,050
G	0	0	0.5 – 5,050

These results are estimated based on a number of assumptions which will be refined as more site-specific data becomes available. However, this assessment indicates that surface water contributions may be of more importance to W3 than the conceptual model suggested (depending on the site hydraulic conductivity). It is recommended that more information on the groundwater system is obtained to ensure that any potential effects can be effectively minimised during the design phase.

5.0 Recommendations for Development and Stormwater Design

The proposed development plan and final stormwater design have not yet been finalised and therefore an assessment of the potential effects on the wetlands cannot be completed at this stage. However, development on site has the potential to affect the hydrology of the wetlands due to:

- Changes to the total catchment surface area feeding the wetlands due to proposed road layouts;
- Diversion of stormwater;
- Retaining walls (affecting sub-surface flow);
- Installation of soakage for stormwater (which may lead to a loss of surface water run-off to the wetlands); and
- An increase in impervious area (roads, house lots etc) reducing groundwater recharge and therefore groundwater inflows into the wetlands.

Recommendations for the stormwater design to mitigate these effects are outlined in the sections below.

5.1 W1

W1 is mainly run-off fed, and therefore will require the same volume of run-off being diverted into this wetland. This should remain as a combination of channelised flow and overland flow. Should the flow become too channelised there is a risk that the majority of water will pass straight through the wetland without being retained. If the catchment size is altered consideration will be required as to how stormwater run-off can be diverted effectively into this wetland.

5.2 W2

The key contribution to W2 is slightly less clear-cut with run-off and stream flow likely to be the key contributors to the wetland. Similar measures as above are required to maintain the volume of run-off entering the wetland. However, consideration also needs to be given to the potential impacts on groundwater recharge upgradient of the wetland as sub-surface flows could also be feeding this wetland.

It is important that mitigation measures are undertaken during design to minimise imperviousness within the catchment in order to maintain overland flow and groundwater inputs. Other measures may include the addition of stormwater retention tanks to control the discharge of roof run-off. The water can be discharged to ground at a slower rate over a longer period of time, reducing the loss of water due to surface flow through and out of the wetlands. The use of this system would result in additional groundwater recharge which is likely to offset the reduction caused by the increase in impervious cover.

5.3 W3

The conceptual model indicates that the W3 wetland is largely groundwater fed, although there is some uncertainty in the water balance calculation. The surface water flows into the wetland would be flood flows from stream A3 and run-off from the relatively small catchment area, most of which is on the neighbouring property (and outside of the development site). The groundwater level is expected to be reflective of the regional groundwater table and therefore development at the site is unlikely to significantly influence groundwater levels and groundwater inflows, provided mechanisms for recharge are considered during the design phase. The mitigation measures that are required for W2 should be applied across the site to ensure that groundwater recharge rates are maintained at the development site and may also benefit wetland W3.

5.4 Stock Exclusion

Removing stock (via fencing) from within wetland W1 and W2 and allowing the wetlands to recover from pugging effects may inadvertently result in a change to the wetland hydrology. Pugging reduces the infiltration rate of the soil and infiltration rate may increase following recovery from pugging effects, therefore reducing the ability of ponding to occur. Native tree planting around the wetlands may also result in a natural conversion to a more defined channel rather than wetland. Therefore, a reduction in wetland extent following stock exclusion and native planting may not necessarily be a result of an effect of the development on the site, but a natural process.

6.0 Recommendation for Monitoring of Wetland Hydrology

This section covers recommendations for monitoring of wetland hydrology.

6.1 Water Level Monitoring

Wetland W1 and W2 are assessed to be mainly surface water fed, with potentially some sub-surface flows at W2. With the mitigation provided in sections 5.1 and 5.2 in place, we do not currently recommend monitoring the groundwater level at these wetlands. The wetland soil profile in these locations are also expected to be thin.

However, it is recommended that a shallow monitoring well (~3 m depth) is installed within wetland W3. This will facilitate water level monitoring prior to, during and on completion of the development and provide a means to monitoring the effects on the hydrology during development.

These should be installed using a hand auger to minimise any disturbance to the wetland vegetation and fitted with pressure transducers that will monitor water level at 30-minute intervals. The monitoring wells should be surveyed to the same datum to ensure comparisons can be made between them. Manual water

level checks and transducer downloads should be done on a quarterly basis to check instrument function and accuracy.

This data will allow wetland hydrology analysis to be undertaken including probabilities, frequencies and durations of inundation or saturation as outlined in the USDA NRC Hydrology Tools for Wetland Identification and Analysis (2015). It can also be used to identify any effects (if they occur) as early as possible so mitigation measures can be implemented effectively.

The monitoring of this location should commence as soon as possible to allow for some baseline data to be collected prior to construction. It will also be possible to compare this data with baseline data collected for the wider site to ensure that the effects on the wetlands are minimised.

Barometric compensation of water level data may be done through manual compensation of data using nearby meteorological stations, or using a barometric pressure transducer.

6.2 Flow Monitoring

There is inadequate water in the surface channels to undertake flow monitoring, however it would also be useful to undertake one or more visual flow assessments of all streams following heavy rain. This will confirm whether surface flows are a large source of input to W2 from stream A3 and to W3 from A3.

6.3 Groundwater Investigation

A more detailed understanding of the groundwater system at the site is considered necessary to fully understand the potential effects on the wetlands. It is recommended that during any geotechnical investigations, consideration is given to the installation of monitoring wells to determine the groundwater flow direction and gradient in more detail. These would also allow for slug testing to determine the local aquifer parameters, which are critical for a more accurate assessment of the groundwater contribution to W3.

7.0 Conclusion

The hydrology of three wetlands within the Glenbrook development site have been assessed based on available data and a site walkover inspection (undertaken by PDP ecologists).

The results indicate that:

- W1 and W2 are primarily sustained by surface water inflows such as overland flow and stream flow. However, it is likely that there is some subsurface flow/groundwater component feeding W2 in the northern portion of the wetland. W3 was assessed to be sustained primarily by groundwater.

- Water balance components have been assessed to determine the relative importance of each inflow to sustaining the wetland for the use in future assessments of effects during the design phase. The results are likely to be refined as more site-specific data becomes available.
- Development on site has the potential to affect the hydrology of the wetlands, the following was considered:
  - W1 is mainly run-off fed, and therefore will require the same volume of run-off being diverted into this wetland. This should remain as a combination of channelised flow and overland flow.
  - W2 is considered to be similar to W1, however consideration also needs to be given to the potential impacts on groundwater recharge upgradient of the wetland as sub-surface flows could also be feeding this wetland.
  - The W3 wetland is considered to be groundwater fed with some surface water contribution. The surface water flows into the wetland would be flood flows from stream A3 and run-off from the relatively small catchment area which mainly falls within the neighbouring site. The groundwater level is expected to be reflective of the regional groundwater table and therefore development at the site is unlikely to significantly influence groundwater levels and groundwater inflows provided mechanisms for recharge are considered during the design phase.
- The following monitoring was considered appropriate:
  - Wetland W1 and W2 are assessed to be mainly surface water fed, with potentially some sub-surface flows at W2. We do not currently recommend monitoring the groundwater level at these wetlands. Installation of a groundwater monitoring well at W3 is recommended.
  - Visual assessments of flow during periods of heavy rainfall is also recommended to confirm the hydrological understanding of the wetlands.
  - Additional groundwater investigation is recommended if it can be combined with other works to be undertaken at the site.

Please note that this report addresses hydrology of the wetlands in Glenbrook development area, however it needs to be considered in conjunction with the PDP wetland delineation and ecology assessment.

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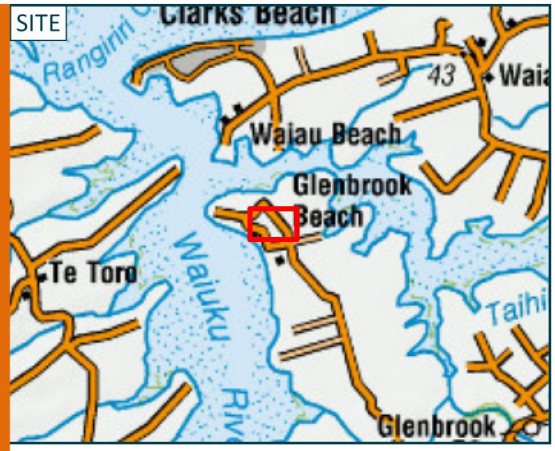
Appendix A

Figures



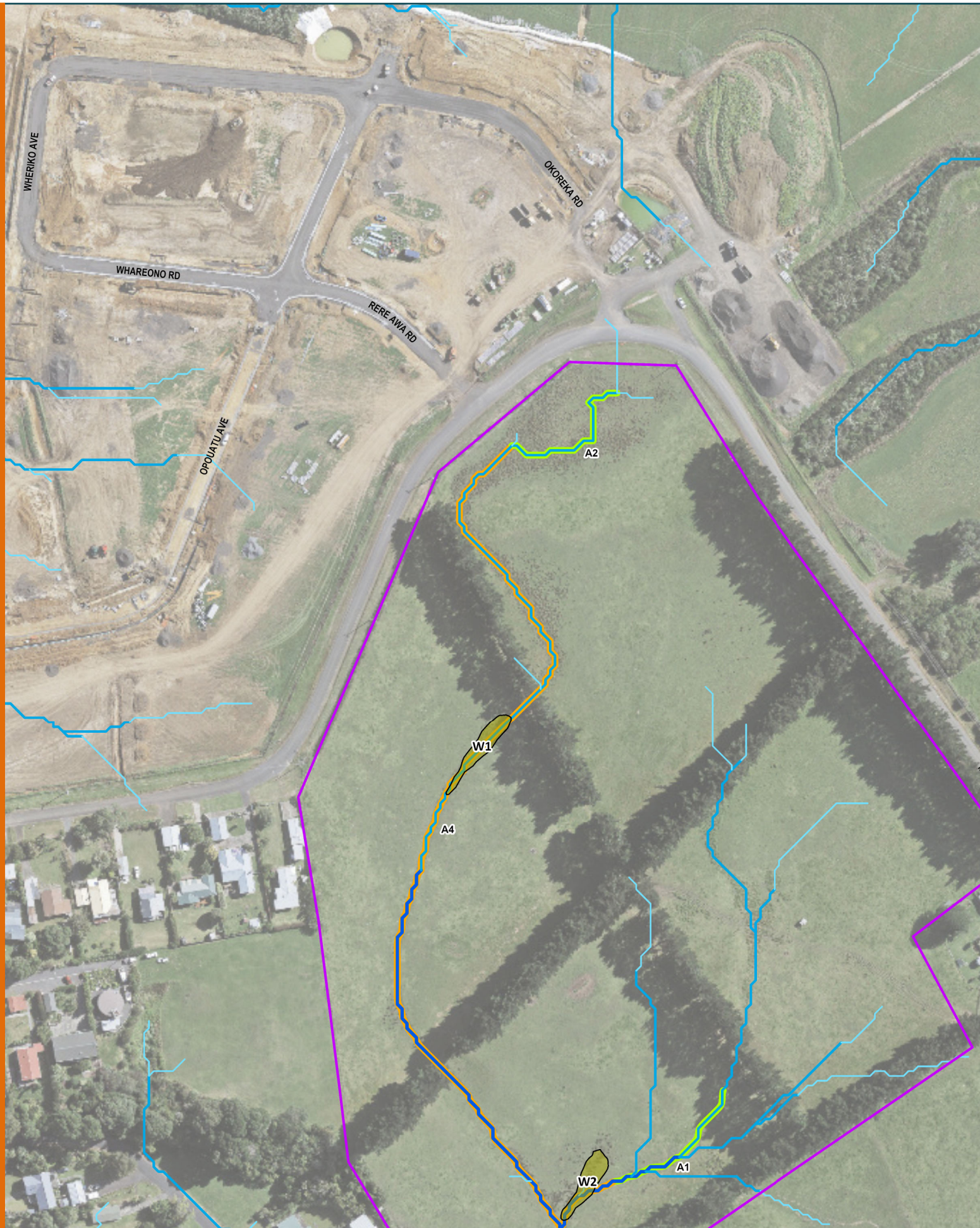
WHAREONO RD
RERE AWA RD
OPOUATU AVE
DAMIE NGANEKO DR
HILL RD
RONALD AVE
MCLA

CPT03
W1
CPT04
CPT02
HA01
HA02
MH01
CPT01
W2

KEY :

- GEOTECH INVESTIGATION SITES
- STORMWATER INLETS AND OUTLETS
- STORMWATER PIPELINE
- STORMWATER TREATMENT FACILITY
- SITE BOUNDARY

OVERLAND FLOW PATHS



Appendix B

Photographs

Photograph 1: Ponded water at the head of W1 with evidence of pugging from stock.

Photograph 2: W2 (northern portion).

Photograph 3: Location of W2 in relation to the stream channels.

Photograph 4: Extent of W3, looking north-west towards the site boundary.

Photograph 5: Extent of W3, looking west towards the vegetated stormwater channel.

Photograph 6: The bottom of the intermittent stream (A3), with W3 on the left. There is a defined bed and bank at this location.

Photograph 7: Looking north at A3, with W3 on the right of the photo. The channel levels out, so high flows will overflow into W3.

Photograph 8: Vegetated stormwater channel at the south-western edge of W3.

Auckland Hamilton Tauranga Wellington Christchurch Invercargill

PATTLE DELAMORE PARTNERS LTD

Ecological Feasibility Assessment
80 McLarin Road, Glenbrook

HD Project 2 Limited

Ecological Feasibility Assessment
80 McLarin Road, Glenbrook

Prepared for

HD Project 2 Limited

November 2020

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Website **http://www.pdp.co.nz**
Auckland Tauranga Wellington Christchurch

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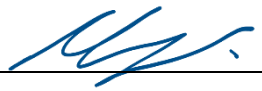
Prepared by

SIGNATURE PP   

Amber Simmonds | Emma Willmore | Marinus Boon

Reviewed by | Approved by

SIGNATURE  

Laura Drummond | Hamish Jones

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Harrison Grierson Ltd and others (not directly contracted by PDP for the work) including Auckland Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of HD Project 2 Ltd for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

HD Project 2 Limited (HD Project 2) engaged Pattle Delamore Partners Ltd (PDP) to carry out a high-level ecological feasibility assessment to inform future residential development at 80 McLarin Road, Glenbrook, Auckland. Specifically, this assessment focused on the status, location and extent of watercourses and wetlands present on the site, which may constrain future development.

PDP carried out an initial desktop review to identify the existing freshwater and terrestrial ecological values at the site, including Auckland Council (AC) Geomaps data, historic aerials and modelled stream transition points. The identification of potential wetland areas was undertaken through a rapid desktop assessment of landform, surface hydrology indicators and position in the landscape using a high-resolution light detection and ranging (LiDAR) digital elevation model (DEM).

A field survey was undertaken on 30th October 2020 to ground-truth data obtained from the desktop review, assess the status and map the extent of all watercourses and wetlands on the site. All watercourses were mapped as being permanent, intermittent, or ephemeral, based on the definition in the Auckland Unitary Plan-Operative in Part 2016 (AUP) and observations of shallow soil augers. Wetland surveys comprised a rapid identification of vegetation communities and soil validation augers, following the Ministry for Environment (MfE) Wetland Delineation Protocols (2020).

An intermittent stream channel (A4) and tributary (A3) were identified in the lower corner of the site (totalling 144 m in length). These reaches did not contain water at the time of the survey (with the exception of pooled water within a culvert), however hydric soils and hydrophytic vegetation were identified in the channels, and other AUP criteria of intermittent streams were present, such as a well-defined channel and lack of terrestrial vegetation.

Two ephemeral stream channels were identified (A1 and A2), also in the lower section of the site. These had defined channels, however lacked other definitive characteristics of intermittent streams. Terrestrial vegetation was rooted across the width of these channels and well-drained soil was observed.

Although not all the criteria under the AUP stream definitions could be assessed at the time of the survey due to lack of rainfall and a lower than average water table for this time of year, additional evidence was used to support our findings such the presence of hydric soils, hydrophytic vegetation and modelled stream transition points. Photos were also reviewed of the site following heavy rainfall (supplied by Harrison Grierson Ltd).

A qualitative habitat assessment was undertaken to provide a general characterisation of freshwater ecological conditions in the lower watercourse in the southern corner of the site. The stream generally had very low ecological

value due to lack of flow and riparian cover, and unsuitable instream habitat for aquatic fauna.

Terrestrial ecological values at the site are also considered to be low. The site supports little native plant or animal life and has no threatened or rare species recorded. No Significant Ecological Areas (SEAs) or protected trees were identified within the vicinity of the site which would constrain site development.

Based on the vegetation, soil, hydrological indicators, and terrain unit (landscape position) the site includes two small wetland areas (W1 and W2), both classified as marsh wetlands, in the upper and lower sections of the site (0.025 ha and 0.018 ha respectively). The wetland areas contain modified wetland species composition due to disturbances such as grazing and competition and invasion from pasture and exotic vegetation. They currently have limited wetland functionality and are not regarded as significant. These wetland areas are also less than 0.05 hectares in extent and are not of a type that is naturally smaller than 0.05 hectares in terms of the NPS-FM 2020 mapping requirements. However, to fully understand the value that these wetlands presently supply, a wetland value and condition assessment is recommended.

Other potential wetland areas have also been identified within a 100 m buffer of the site, including directly adjacent to the site on the southern corner (beyond the existing fence line). Despite the absence of wetland vegetation (possibly due to spraying), areas in the northern corner of the site also present signs of former wetlands, based on historical imagery, topographic indicators, and soil type.

The National Policy Statement for Freshwater Management 2020 (NPS-FM) includes new policies to avoid the loss of extent of natural inland wetlands, protect their values and promote their restoration. Resource consents must be assessed by applying the effects management hierarchy to manage any adverse effects on the wetland extent or values resulting from the proposed site development. The applicant must demonstrate that potential adverse effects on the wetlands will be avoided in the first instance, minimised then remedied wherever practicable, with any residual effects offset or compensated. Further, detailed investigations may be necessary to inform design and consent requirements.

The National Environmental Standards for Freshwater Regulations 2020 (Freshwater NES) requires strict measures for activities that can result in the loss of extent and values of natural wetlands. Of relevance to the development of the site, this includes a non-complying status for earthworks or land disturbance within a 10 m setback from a natural wetland, or within a 100 m setback if it is likely to result in the complete or partial drainage of all or part of the wetland. The taking, use, damming, diversion or discharge of water within a 100 m setback is also a non-complying activity under the Freshwater NES. A full planning assessment was outside the scope of this project but will provide further clarity on site development implications from proposed activities.

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Appendices

1.0 Introduction

HD Project 2 Limited (HD Project 2) has engaged Pattle Delamore Partners Ltd (PDP) to carry out a high level ecological feasibility assessment to inform future residential development at 80 McLarin Road, Glenbrook, Auckland (referred to herein as 'the site' and illustrated in Figure 1 below).

The site is approximately 9 hectares (ha), dominated by grazed pasture with shelterbelts crossing through the centre of the site from north-east to south-west and north-west to south-east. The site has a number of overland flow paths (OLFPs) in addition to potential wetland areas. The site forms part of a larger block of land at Glenbrook which is Future Urban Zoned (FUZ) in the Auckland Unitary Plan-Operative in Part 2016 (AUP). Ecological considerations will be a significant factor in determining the development potential of this block of FUZ land.

This report outlines the findings of the desktop reviews and field surveys undertaken by PDP and identifies the ecological constraints and resulting regulatory implications to future site development.

2.0 Methodology

2.1 Desktop Assessment

PDP carried out an initial desktop review of available information relating to the current freshwater and terrestrial ecological values at the site, including Auckland Council (AC) Geomaps data and historic aerials. Further detail is provided below.

2.1.1 Watercourses

AC GIS data was reviewed to assess the topography and hydrological features (existing watercourses and OLFPs) at the site and to assist with the field surveys of these features.

Historical aerials were reviewed to gain a better understanding of past land use and the location of hydrological features at the site throughout wet and dry seasons. Aerial photographs were obtained from Retrolens for the years 1942, 1961, 1975, and 1987, and from AC Geomaps for the years 2006 and 2010.

The findings of research by Storey and Wadwha (2009) and the AC Geomaps OLFP layer were used as a general guide to identify the point at which stream status likely transitions from ephemeral to intermittent. Storey and Wadhwa (2009) predict that intermittent streams are formed when contributing catchments exceed 1.68 ha in Waitemata sandstone hydrogeological areas (which underlies the subject site). Permanent streams are predicted to form when catchments exceed 2.8 ha.

This model is used by AC staff as an indicative tool to identify probable changes to stream type where field surveys are limited by season or access.

2.1.2 Terrestrial Ecology

AC Geomaps environment layers and planning maps were reviewed to identify significant or sensitive terrestrial ecological areas and/or features and potential habitats for native fauna in the vicinity of the site.

2.1.3 Wetlands

The identification of potential wetland areas/habitat was undertaken through a rapid desktop assessment of landform, quantification of topographic control on hydrological processes (surface hydrology indicators) and position in the landscape using a high-resolution light detection and ranging (LiDAR) digital elevation model (DEM). Additional tools that have been used to support desktop identification includes available:

- topographical maps;
- land surface contours;

- surface water layers; and,
- recent, relevant aerial and satellite imagery.

2.2 Field Assessment

A field survey was undertaken on 30th October 2020 by freshwater ecologists to ground-truth data obtained through the desktop assessment, including the modelled transition points, and to map the extent of all watercourses and wetlands within the site boundaries. Weather was cloudy, with no recorded rainfall in the 9 days prior to the survey (further detail provided in Section 3.2).

2.2.1 Stream Classification

All watercourses were mapped as being permanent, intermittent or ephemeral, based on the definitions in the AUP below, and a review of shallow soil augers to identify hydric soil conditions.

Permanent river or stream

The continually flowing reaches of any river or stream.

Intermittent stream

Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

(a) It has natural pools;

(b) It has a well-defined channel, such that the bed and banks can be distinguished;

(c) It contains surface water more than 48 hours after a rain event which results in stream flow;

(d) Rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;

(e) Organic debris resulting from flood can be seen on the floodplain; or

(f) There is evidence of substrate sorting processes; including scour and deposition.

Ephemeral stream

Stream reaches with a bed above the water table at all times, with water only flowing during or shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

Photographs were taken of the watercourses and wetlands at the site (provided in Appendix A) and ecological value and character was noted, including the extent of riparian cover, suitable instream habitat, and connectivity to other waterways.

Additional photographs were supplied to PDP by Harrison Grierson Limited (HG) of the site 10 days after our site visit, following a significant amount of rainfall (58 mm since our visit), to assist with our stream classification assessment. The most relevant of these photographs are also provided in Appendix A.

2.2.2 Terrestrial Ecology

Visual and audible observations of native and introduced birds were recorded during the site surveys and a high-level vegetation assessment was undertaken. Nesting habitat and food resources for birds were noted for the purpose of estimating the potential loss of resources associated with potential site development. Habitat potentially occupied by native lizards was also assessed.

2.2.3 Wetland Delineation

Wetlands were identified based on the following characteristic attributes:

- Wetland vegetation (presence of plants adapted to or tolerant of saturated soils);
- Hydric soils (soils that display characteristics resulting from prolonged saturation);
- Hydrological indicators (a high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within the soil surface); and,
- The terrain unit (those parts of the landscape where wetlands are more likely to occur).

The definition of **natural inland wetland** in The National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) is a natural wetland that is not in the coastal marine area. The definition of a **natural wetland** is a wetland (as defined in the Resource Management Act 1991) that is not:

(a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or

(b) a geothermal wetland; or

(c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

A **wetland** as defined in the Act includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions.

The desktop delineation was supported by a rapid identification of vegetation communities and soil validation augers, following the Ministry for Environment (MfE) Wetland Delineation Protocols (2020). The vegetation component included a rapid assessment of easily identifiable facultative (FACW) and obligate (OBL) wetland species. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicators species (Table 1). The dominance test using the 50/20 rule was completed to determine the presence of wetland vegetation. The 50/20 rule is based on the most abundant plant species that immediately exceed 50% of the total cover for the stratum, plus any additional species comprising 20% or more of the total cover for the stratum.

Table 1: Classification of plants according to occurrence in wetlands (Landcare 2018)

Plant type	Characteristics
Obligate wetland (OBL) species	Almost always grow in wetlands (>99% occurrences)
Facultative wetland (FACW) species	Usually grow in wetlands (67-99% of occurrences) but occasionally are found in non-wetland areas
Facultative (FAC) species	Are equally likely to grow in wetlands and non-wetland areas (34-66% of occurrences)
Facultative Upland (FACU) species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% of occurrences)
Upland (UPL) species	Rarely occurs in wetlands (1%), almost always in 'uplands' (non-wetlands)

The soil component was completed using the soil wetness indicator that refers to the redoximorphic features (Munsell Soil Color Book, 2009 and Landcare Research, 2018) in a soil profile which forms as a result of prolonged and frequent saturation (a high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within the soil surface). This method is based on the soil characteristics to a depth of 30-50 cm and how it relates to hydrological conditions and different soil saturation zones within a wetland.

The classifications of Johnson and Gerbeaux (2004) were used in this assessment, where wetlands are classified as either Bogs, Fens, Swamps, Marshes, Seeps, Shallow waters, Ephemeral wetlands, Pakihi and gumland or Saltmarshes. This level of wetland classification is practically important in order to assign a name to a functional wetland unit. Particular landforms, vegetation structural classes and plants are associated with each wetland class.

3.0 Findings

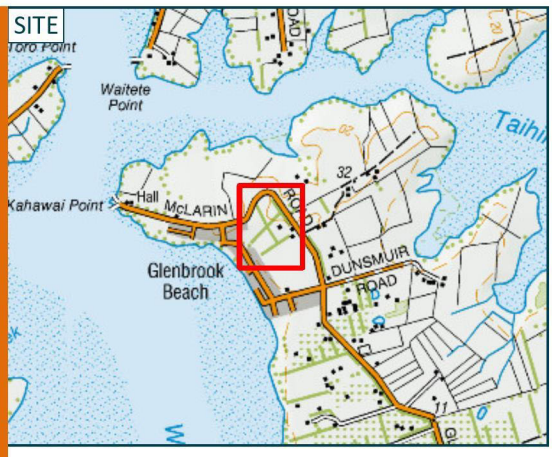
3.1 Site Features

The topography of the site is relatively low lying, with a drop in elevation from 22 metres (m) in the north-eastern corner down to 6 m in the southern corner (refer to Figure 1).

Multiple OLFPs are present across the site, with the main channel and lower lying flood plain located in the southern corner of the site. According to Geomaps, the catchment area for the OLFP in the southern corner of the site is 3 ha and above.

The majority of the site is dominated by grazed pasture with pine shelterbelts located along the eastern and southern boundaries and dissecting the centre of the site from north-east to south-west and north-west to south-east. Evidence of pugging from livestock was noted across the site, particularly in OLFPs and in steeper sections. At the time of our field surveys, vegetation in the northern section of the site had completely died off, possibly due to spraying. Following rainfall, and approximately one week after our visit, vegetation in this area was starting to grow back (refer to Photographs 12 and 13 of Appendix A).

A fenceline is located along the southern boundary, in front of the shelterbelt, with a potential wetland area beyond this on the lower section of the adjacent property. The fenceline boundary does not match the property boundary illustrated in Geomaps (as outlined in Figure 1). Our field survey was undertaken up to the fenceline boundary, as access had not been granted to the adjacent property.



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3.1.1 Historical Land Use and Site Features

Historical aerial photographs were reviewed to identify past land use, vegetation cover and overland flow paths at the site. Aerial photographs were obtained from the following years 1942, 1961, 1975, and 1987. The 1942 photograph clearly shows the subject site was grass with no obvious or significant vegetation since the 1940s. The current shelter belts do not appear until after the 1980s. No obvious watercourses can be seen in the historical photos, however potential wetland areas are evident in the northern section of the site from 2006 onwards (See Appendix B).

3.2 Stream Classification

At the time of the site visit the nearest rainfall gauge (Diver Road operated and maintained by AC) measured 0 mm of rainfall within 48 hrs prior to the assessment, and no rain in the preceding 9 days.

The assessment was conducted using all landscape features and tools available at the time of the visit, including shallow soil samples. PDP started the survey from the top of the site and walked along each identified OLFP, considering the modelled stream transition points.

The AUP intermittent stream criteria specifying organic debris from flood flows and evidence of substrate sorting processes could not be assessed with confidence during this survey due to the land use type in the upper catchment (grazed pasture) and size and scale of the watercourses. As such, the remaining AUP assessment criteria, OLFP modelling and soil observations were used to guide our classification.

A well-defined, intermittent stream channel is located in the lower, southern section of the (labelled A4 on Figure 2 and illustrated in Photographs 1 and 2 of Appendix A). This intermittent reach begins approximately at the top of the lower wetland area, in the vicinity of a culvert, and is approximately 120 m in length. This reach lacks riparian vegetation, with the exception of pasture grass, and is considered to have very low ecological value. The channel is incised at the lower end of the reach and has a distinct lack of terrestrial vegetation across the stream bed. Obligate wetland species (watercress) was noted to be growing in the thalweg of the channel, and a soil sample from the stream bed showed poorly drained, clay soils with mottling evident. This demonstrates hydric soils are present, and that the stream bed is periodically below the water table at certain times of the year. Photos reviewed following a period of significant rainfall after our site visit (58 mm) showed water to be present in this channel (Photograph 14 of Appendix A).

An intermittent tributary of the main stream channel (labelled A3 on Figure 2) and 24 m in length, has been classified based on evidence of well-defined channel sections, a lack of rooted terrestrial species in the thalweg of the stream

bed (See Photo 6 of Appendix A), the presence of hydrophytic vegetation such as *juncus effusus,* and indicators of poorly drained soils (e.g. mottles). Pugging was evident in this channel which has degraded the stream banks. Although no pooled water was evident in this channel at the time of our survey, this was likely due to the lack of substantial rainfall over winter resulting in a lower than normal water table at this time of year.

Stream reaches A1 and A2 were classified as ephemeral streams, totalling 285 m. These reaches had defined channels, however they had no other definitive characteristics of an intermittent stream. Terrestrial vegetation was rooted across the width of the channels and well-drained soil was observed. Photos reviewed following a period of significant rainfall after our site visit (58 mm) showed that no water was retained in these channels.

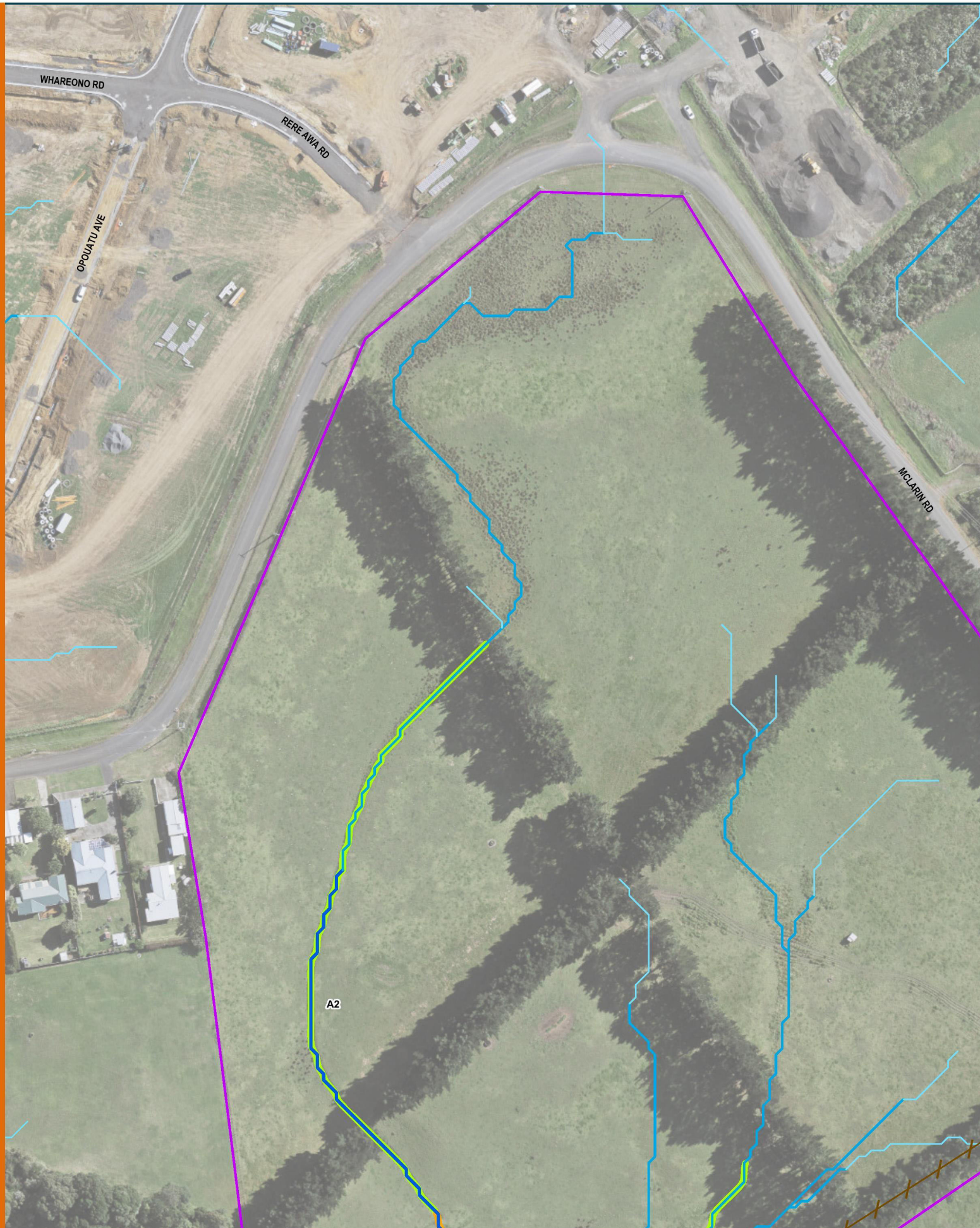


Table 2: Summary of Watercourses				
Stream Name	**Approximate Length**	**Classification**	**Riparian Cover**	**Overall Ecological Value**
A1	73 m	Ephemeral	None	Very low
A2	212 m	Ephemeral	None	Very low
A3	24 m	Intermittent	None	Very low
A4	120 m	Intermittent	None	Very low

3.3 Stream Ecological Valuation

The absence of water within the watercourses and OLFPs on the site meant that no Stream Ecological Valuation (SEV) assessment could be conducted to provide a detailed characterisation of instream flora and fauna, stream bed and riparian condition.

Instead, a qualitative habitat assessment was undertaken to provide a general characterisation of ecological conditions in the lower watercourse in the southern corner of the site (see results summary in Appendix D). Whilst several parameters could not be assessed due to a lack of flow, the stream was generally suboptimal with moderately stable banks, some channel sinuosity and minimal channel alteration. The limiting factors of assessable parameters were the lack of riparian cover and vegetation protection.

3.4 Terrestrial Assessment

The ecological state of the site is heavily modified with little remaining native vegetation and habitat for fauna. This is limited to a few sporadic plants along the eastern boundary such as karo (*Pittospurm crassifolium*) and pine shelterbelts across the property and boundaries. The majority of the site is grazed and comprises exotic pasture grasses.

There are no Significant Ecological Areas (SEA's) or notable, protected trees located within the boundaries of the proposed development. No threatened fauna or flora was identified at the site.

A remnant fragment of native bush is located adjacent to the south western boundary of the property (coastal broadleaved forest), in the Glenbrook Beach Recreation Reserve. This does not have any implications for development within the site.

3.4.1 Avifauna

Birds visually or audibly observed during our surveys are listed below. All native species observed are classified as Not Threatened, according to the Conservation Status of New Zealand Birds (Hugh *et.al.,* 2016).

Native birds:

- Spur wing plover (*Vanellus miles*)
- Kingfisher (*Todiramphus sanctus*)
- Tui (*Prosthemadera novaeseelandia*e)
- Fantail (*Rhipedura fuliginosa*)
- Pukeko (*Porphyrio porphyrio subsp. Melanotus*)

Exotic birds:

- Black bird (*Turdus merula*)
- Song Thrush (*Turdus philomelos*)
- Magpie (*Gymnorhina tibicen*)

The mature pine shelter belts at the site may provide nesting and roosting habitat for birds, however these are generally considered to be of low ecological value and are not afforded protected under the AUP.

3.4.2 Herpetofauna

Skinks can occupy modified areas with rank grass or scrubby weeds, however all the grass on site is currently grazed and is considered unsuitable habitat in its current state.

3.5 Wetland Delineation

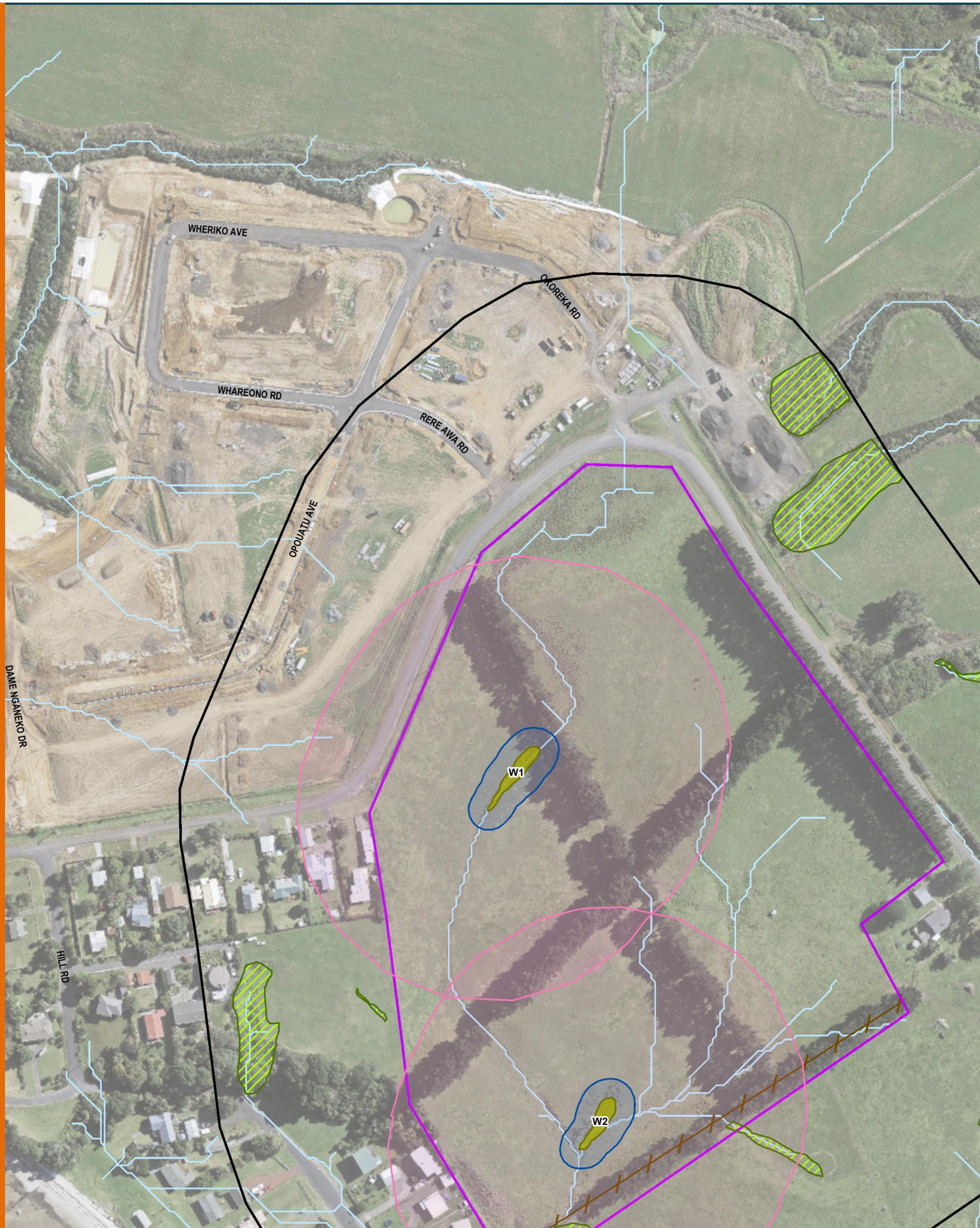
Based on the vegetation, soil, hydrological indicators, and terrain unit (landscape position) the site includes two small wetland areas (W1 and W2), both classified as marsh wetlands (illustrated in Figure 3 and photos 7, 10 and 15 of Appendix A).

Distinct marsh characteristics include slight slopes, sedge and grass vegetation, a water table that is usually below the surface, and temporary wetness. The size of the upper marsh is approximately 0.025 ha while the lower marsh area is approximately 0.018 ha. Despite the absence of wetland vegetation, the top, northern corner of the site also present signs of a former wetland area, based on historical imagery, topographic indicators, and soil. It is however noted that, in line with the scope, the delineation was undertaken at a coarse level from a rapid assessment. More detailed investigations can be undertaken if deemed necessary to inform design and consent requirements.

More potential wetland areas are located within a 100 m buffer of the site. One of these wetland areas directly borders the site in the southern corner (Photograph 4 of Appendix A).

It is evident from aerial imagery and the site visit that the hydrology of the site has been modified over the years. The wetland areas include a modified wetland species composition due to disturbances such as grazing and competition, and invasion from pasture and exotic vegetation. The indication is that historically the wetland areas covered a larger extent, but due to the disturbances mentioned above the surface flows became more concentrated and consequently the extent was reduced. It is noted that the local catchment has changed over the years (from agricultural to residential use) with an increase of excavation and impervious surfaces especially just upstream of the northern section of the site. These activities may gradually lead to the loss of wetland ecosystems. The wetland areas on the site will further deteriorate if the current conditions on the site and within the catchment prevail.

The soil profile in the wetland areas indicates typical hydromorphic conditions which form as a result of prolonged and frequent saturation (gley soil, signs of periodic wetting: mottles and concretions for permanent wet areas). Figure 4 shows the setting of the delineated wetlands within the landscape and wetness of the site based on topographic position including the field soil auger positions.



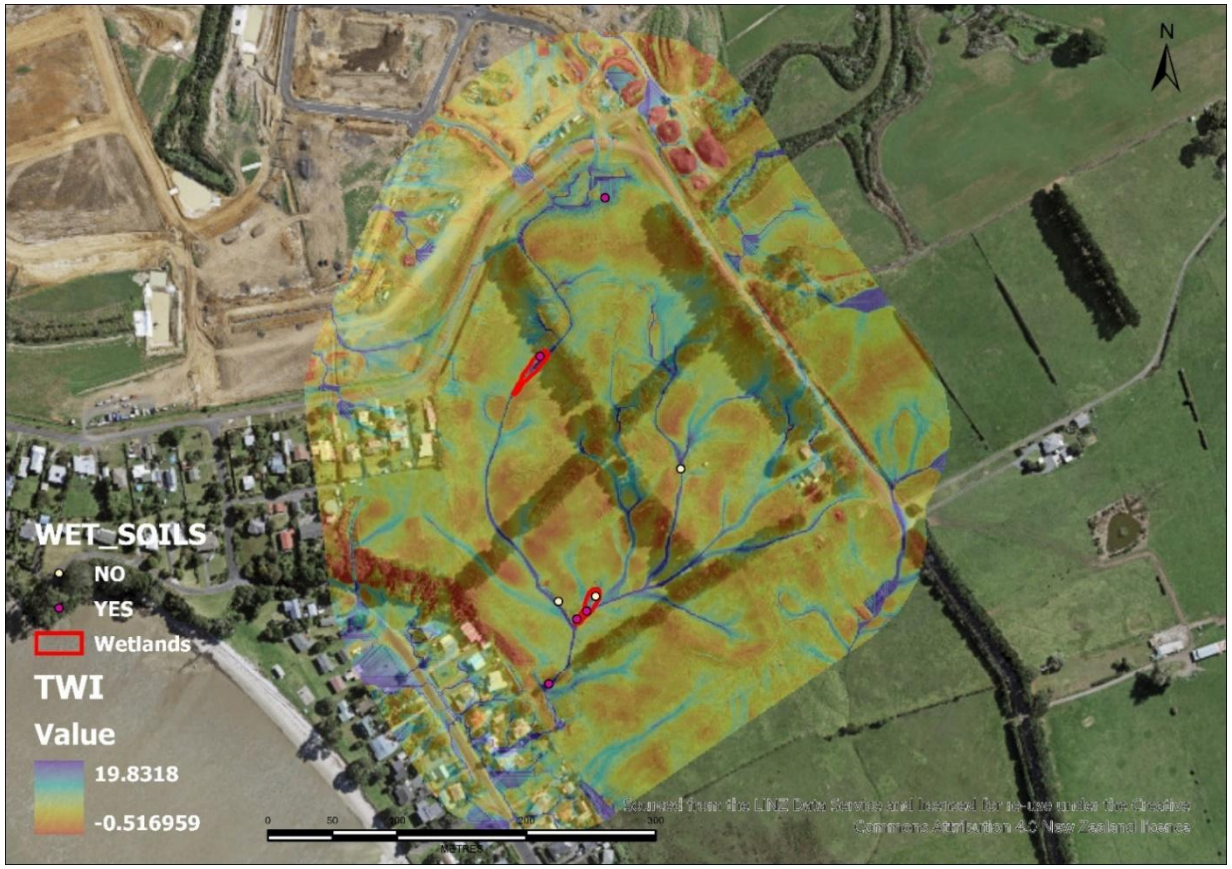


Figure 4: Landscape Setting

The assessment of vegetation classified different areas of the wetland and surrounds based on the dominance of readily identifiable facultative (FACW) and obligate (OBL) wetland species (outlined in Table 1). Areas dominated (>50% coverage) by facultative and obligate wetland species served as a good indicator for the completion of the delineation. Both wetland areas were dominated by *Juncus effusus* (soft rush), although the upper marsh (W1) presented the most diverse composition and included dominant species such as *Ranunculus flammula* (spearwort). The commonly observed wetland species encountered during the field survey are shown in Table 3.

Table 3: Commonly observed facultative and obligate wetland species

Common name	Scientific name	Wetland indicator rating
Soft rush	*Juncus effusus*	FACW
Spearwort	*Ranunculus flammula*	FACW
Willow weed	*Persicaria maculosa*	FACW
Polygonum decipiens R.Br. (N)	*Persicaria decipiens*	OBL
Watercress	*Nasturtium officinale*	OBL

From a vegetation and a hydric soil perspective, this assessment indicates that the extent of the wetlands at the site includes the delineated areas presented in Figure 3 (Wetland Delineation).

3.6 Freshwater NES and NPS Implications

The National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) includes new policies to avoid the loss of extent of natural inland wetlands, protect their values and promote their restoration. The new regulations in the National Environmental Standards for Freshwater (NES) place restrictions on damaging activities in and near natural wetlands. The Resource Management (Stock Exclusion) Regulations 2020 mandate that certain stock must be excluded from natural wetlands in some circumstances. The NES, NPS-FM 2020 and stock exclusion regulations came into force on 3 September 2020.

Important considerations in terms of the NPS-FM 2020 includes:

- The new 'hierarchy of obligations' prioritise the health and wellbeing of water bodies, then the essential needs of people (drinking water) and then any other uses (Te Mana o te Wai).
- 'National bottom lines' defined with all water bodies to be at least maintained, and degraded water bodies required to be improved.

- The NPS-FM does not support any loss in potential ecosystem values.

3.6.1 Managing Adverse Effects on Wetlands

The delineation of wetland areas found on the site, including possible wetlands within a 100 m buffer of the site, are mapped in Figure 3. Setbacks of 10 m and a 100 m were mapped for confirmed wetlands within the site, in line with the NPS-FM 2020 and Freshwater NES requirements to inform the feasibility study. The following recommendations should be taken in consideration:

- The two small wetland areas identified on the site have limited wetland functionality in their current state and are not regarded as significant. These wetland areas are less than 0.05 hectares in extent and are also not of a type that is naturally smaller than 0.05 hectares in terms of the NPS-FM 2020 mapping requirements. However, to fully understand the value that these wetlands presently supply a wetland value and condition assessment is needed.
- Resource consents must be assessed by applying the effects management hierarchy to manage any adverse effects on the wetland extent or values, including cumulative effects and loss of potential value, as a result of the proposed activity. Under the effects management hierarchy, adverse effects on the wetland extent or values caused by the activity are to be avoided, minimised then remedied (in that order) wherever practicable, then offset or compensated (in that order) where possible. If these cannot be achieved, the activity must be avoided, and consent declined.
- The ground-truthing was conducted as a once off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- The indications of the former wetland area (based on historical imagery, topographic indicators, and soil) in the top corner may need to be reassessed once vegetation has grown back.
- Detailed wetland investigations may be necessary to inform design and consent requirements.
- The AC will require a demonstration of the functional need of any planned activity that triggers the NES Freshwater regulations.

3.6.2 NES Freshwater Regulations

The regulations require strict measures, including but not limited to resource consents, for activities that can result in the loss of extent and values of natural wetlands. The NES Freshwater prescribes activity statuses and detailed conditions for various potentially damaging activities in and around wetlands. Some activities that cause complete or partial drainage of all or part of a natural wetland are now prohibited. A list of the relevant non-complying and prohibited

activities are shown in Table 4. One notable exception is that councils may grant resource consents for the construction or upgrade of specified infrastructure that will provide significant national or regional benefits, if the regional council is satisfied that there is a functional need for that infrastructure in that location. Residential development does not fall within this category.

Table 4: Non-complying and prohibited activities under the NES

Activity	Non-complying	Prohibited
Vegetation clearance.	Vegetation clearance within, or within a 10 m setback from, a natural wetland if they do not have another status (for example restoration, scientific research, maintenance, natural hazards)	N/A
Earthworks or land disturbance.	Earthworks within, or within a 10 m setback from, a natural wetland. Earthworks outside, but within a 100 m setback from a natural wetland if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51. Earthworks within, or within a 10 m setback from, a natural wetland if they do not have another status.	Earthworks within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51.
The taking, use, damming, diversion, or discharge of water.	The taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland is a non-complying activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51. The taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland if they do not have another status.	The taking, use, damming, diversion, or discharge of water within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51.

Engineering/stormwater assessments are also required for earthworks, stormwater diversions and discharges in relation to the NES Freshwater requirements for wetlands.

4.0 Summary and Conclusions

All watercourses at the site have been heavily modified through historical farming activities and are degraded by a lack of riparian cover and stock access. Overall, aquatic ecological values at the site are very low, with unsuitable habitat for instream fauna (fish and invertebrates).

Classification of the watercourses and OLFPs at the site concludes that intermittent and ephemeral stream reaches are present. The survey was conducted within AC's definition of the 'wet season' for stream classification, being the start of August to the end of November, however Auckland has experienced a particularly dry winter following drought conditions over summer and no rain was recorded in the 9 days preceding the site visit. These conditions meant that not all of the criteria under the AUP stream definitions could be assessed during the survey. Additional evidence was used to support our findings such hydric soils, hydrophytic vegetation and modelled stream transition points. Additional surveys after 48 hours of rainfall, or during the 'wet season' next year would provide further confidence in stream classifications.

Under the provisions of E3.4.1 (A53) any activity that is undertaken in, on, under, or over or within the bed of an ephemeral stream complying with standards E3.6.1.1 is a permitted activity. Consideration of the AUP rules and standards for OLFPs will need to be assessed and is considered outside the scope of this report.

Terrestrial ecological values at the site are also considered to be low. The site supports little native plant or animal life and has no threatened or rare species recorded. No SEA's or protected trees were identified within the vicinity of the site.

Based on the vegetation, soil, hydrological indicators, and terrain unit (landscape position) the site includes two small wetland areas (W1 and W2), both classified as marsh wetlands, in the upper and lower sections of the site (0.025 ha and 0.018 ha respectively). The wetland areas contain a modified wetland species composition due to disturbances such as grazing and competition and invasion from pasture and exotic vegetation. The two small wetland areas identified on the site currently have limited wetland functionality and are not regarded as significant. These wetland areas are also less than 0.05 hectares in extent and are not of a type that is naturally smaller than 0.05 hectares in terms of the NPS-FM 2020 mapping requirements. However, to fully understand the value that these wetlands presently supply a wetland value and condition assessment is recommended.

Potential wetland areas have also been identified within a 100 m buffer of the site, including directly adjacent to the site on the southern corner. Although part of this adjacent wetland was technically within the site boundary, the location of the existing fenceline prevented access onto the neighbouring property.

Despite the absence of wetland vegetation (possibly due to spraying), areas in the northern corner of the site also present signs of former wetland, based on historical imagery, topographic indicators, and soil type. These areas may need to be reassessed once vegetation has grown back.

The NPS-FM includes new policies to avoid the loss of extent of natural inland wetlands, protect their values and promote their restoration. Resource consents must be assessed by applying the effects management hierarchy to manage any adverse effects on the wetland extent or values, including cumulative effects and loss of potential value, resulting from the proposed site development. The applicant must demonstrate that potential adverse effects on the wetlands will be avoided in the first instance, minimised then remedied wherever practicable, with any residual effects offset or compensated. If this cannot be achieved, consent is unlikely to be granted. Further, detailed investigations may be necessary to inform design and consent requirements.

The Freshwater NES requires strict measures for activities that can result in the loss of extent and values of natural wetlands. This includes a non-complying status for earthworks or land disturbance within a 10 m setback from a natural wetland, or within a 100 m setback if it is likely to result in the complete or partial drainage of all or part of a natural wetland. The taking, use, damming, diversion or discharge of water within a 100 m setback is also a non-complying activity under the Freshwater NES. A full planning assessment was outside the scope of this project but will provide further clarity on site development implications from proposed activities.

5.0 References

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Appendix A

Site Photographs

Photograph 1: Incised intermittent channel at southern corner of site.

Photograph 2: Intermittent channel. No baseflow but hydric soil and hydrophytic vegetation present in channel (watercress).

Photograph 3: Water pooled in culvert in southern corner of site.

Photograph 4: Fenceline in southern corner of site with potential wetland located on adjacent property.

Photograph 5: Southern corner of site, facing north. Low lying, flood plain area now dominated by pasture grasses.

Photograph 6: Top section of intermittent channel (A3). Lack of terrestrial vegetation in stream bed. Facultative wetland species present.

Photograph 7: Lower wetland area (W2), facing north to top of intermittent channel (W2)

Photograph 8: Ephemeral watercourse with well-defined channel (A1), facing east.

Photograph 9: Ephemeral channel looking south-east towards lower wetland area (A2)

Photograph 10: Upper wetland area (W1)

Photograph 11: Obligate and facultative wetland plants in upper wetland area (W1)

Photograph 12: Vegetation in northern section of site.

Photograph 13: Vegetation growing back in northern section of site, one week after PDP visit (photo supplied by HG).

Photograph 14: Water present in lower intermittent channel (A4) following significant rainfall (photo supplied by HG).

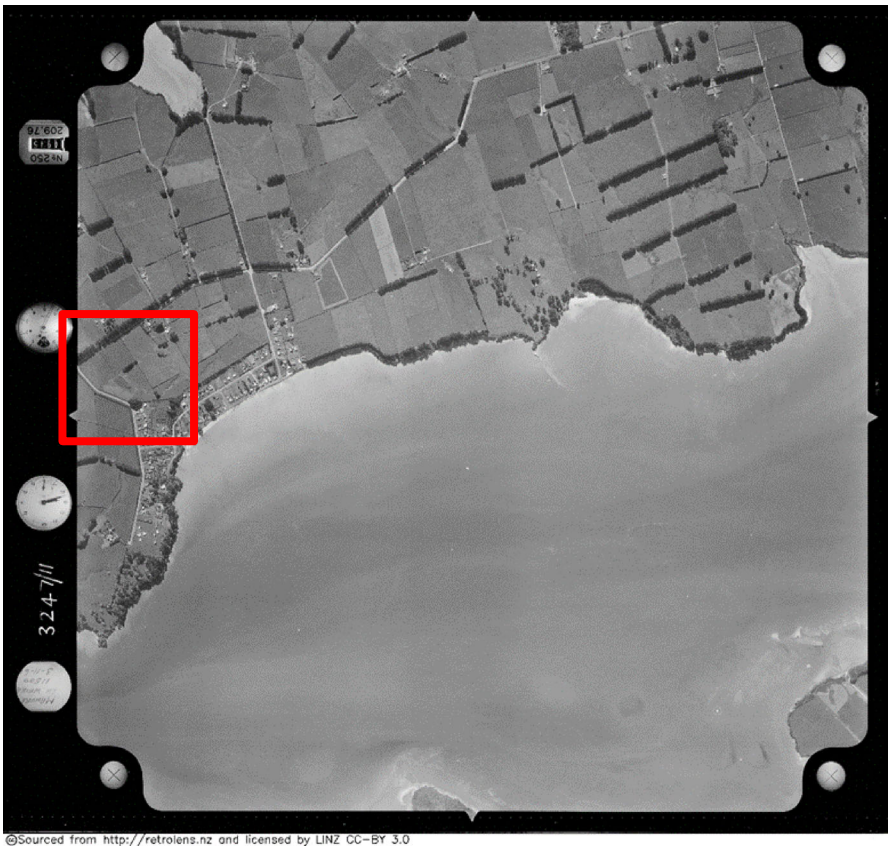
Photograph 15: View south-west across lower wetland area (W2) (photo supplied by HG).

Photograph 16: Ephemeral channel (A2) looking south-east following significant rainfall. No water present (photo supplied by HG).

Appendix B

Historic Photographs

Photograph B1: 1942. Source Retrolens



Photograph B2: 1961. Source Retrolens

Photograph B3: 1975. Source Retrolens.

Photograph B4: 1987. Source Retrolens.

Photograph B5: 2006. Source Auckland Council Geomaps.

Photograph B6: 2010. Source Auckland Council Geomaps.

Appendix C

Semi-Quantitative Habitat Assessment

Table C-1: Stream A4 Habitat Assessment [1,2]	
	Stream A4
1. Riparian Vegetative Zone Width [3]	3
2. Vegetation Protection [3]	4
3. Bank Stability [3]	32
4. Channel sinuosity [3]	8
5. Channel Alteration	19
6. Sediment Deposition	-
7. Pool variability	-
8. Abundance and Diversity of Habitat	-
9. Periphyton	-
TOTAL	**66 (of 120)**

Notes:

1. *Field Assessment Cover Form from the Regional Guidelines for Ecological Assessments of Freshwater Environments. Macroinvertebrate Sampling in Wadeable Stream. Prepared by Kevin Collier and Johlene Kelly for Environmental Waikato Regional Council. Accessed 20/07/20 https://waikatoregion.govt.nz/services/publications/tr200502/*
2. *Each score is out of 20. The maximum score is 180. However, parameter 6 to 9 could not be assessed due to lack of water flow.*
3. *Mean of left and right bank values.*

Score categories and description
16 - 20 = 'Optimal'
11 - 15 = 'Suboptimal'
6 - 10 = 'Marginal'
1 - 5 = 'Poor'

Auckland Hamilton Tauranga Wellington Christchurch Invercargill

PATTLE DELAMORE PARTNERS LTD

Detailed Ecological Assessments
80 McLarin Road, Glenbrook

HD Project 2 Limited

Detailed Ecological Assessments
80 McLarin Road, Glenbrook

Prepared for

HD Project 2 Limited

December 2021

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Office +64 9 **523 6900**
Website **http://www.pdp.co.nz**
Auckland Tauranga Hamilton Wellington
Christchurch Invercargill

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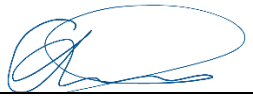
SIGNATURE  

Amber Simmonds, Marinus Boon

Reviewed by

SIGNATURE 

Emma Willmore

Approved by 

Laura Drummond

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Harrison Grierson Ltd and others (not directly contracted by PDP for the work), including Auckland Council. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Executive Summary

Pattle Delamore Partners Ltd (PDP) was engaged by HD Project 2 Ltd to undertake detailed ecological assessments of watercourses and wetlands at 80 McLarin Road, Glenbrook (the site) to inform structure plans and to support an application for a private plan change.

The specific objectives of this assessment were to assess the ecological values of the watercourses and overall condition of wetlands on the site, refine the initial delineation of the wetlands, and confirm the classification of watercourses on the site. In addition, PDP have identified opportunities for mitigation and enhancement of freshwater ecological values on site and assessed findings against the context of regional level policies of the Auckland Unitary Plan-Operative in Part 2016 (AUP-OP) and recent freshwater legislation (National Policy Statement for Freshwater Management, 2020 and National Environmental Standards for Freshwater Regulations, 2020).

Field investigations were undertaken on 22 October 2021, to build on initial findings from the previous investigations completed by PDP in October 2020. Wetland delineations were undertaken in accordance with the Ministry for the Environment Wetland Delineation Protocols (2020) and based on a combination of vegetation, hydric soils, hydrological and terrain indicators. Stream classification surveys were undertaken to confirm transition points between intermittent and ephemeral reaches in accordance with the Auckland Council Practice and Guidance Note for River/Stream Classification, RC 3.3.17 (V2), July 2021 (AC, 2021). The previous surveys were undertaken during a particularly dry winter, following summer drought conditions.

Stream classification surveys were undertaken on 22 October 2021, with another follow up assessment on 19 November 2021, following a dry period of 48 hours without rainfall. During these surveys three of the AUP-OP intermittent stream criteria were met at various locations along the watercourse from the northern site boundary (below the former wetland) to the southern corner of the site (watercourse A4). Evidence of natural pools, surface water, and lack of rooted terrestrial vegetation across the width of the channel was observed, in addition to the presence of hydrophytic (aquatic) vegetation. Overall, 500 m of intermittent stream reaches were identified across the site in the current investigation (A3 and A4), spanning from the southern corner up to the northern site boundary, with approximately 134 m of ephemeral stream reaches located above these (A1 and A2). The increase in total intermittent stream length in 2021 is likely due to the increased rainfall and resulting higher water table, causing longer periods of surface water in the channels.

Results of the stream ecological assessment in the southern intermittent corner of the site confirmed low ecological value, with the watercourse in marginal condition. Ecological function is limited by lack of shade, stock pugging and

insufficient water to provide good quality instream habitat for aquatic fauna. Macroinvertebrate Community Index (MCI) scores are indicative of poor water quality, falling below the Interim MCI Guidelines of the AUP-OP (2016) for rural land use and the NPS (2020) National Bottom Line.

Based on the vegetation, soil, hydrological indicators, and terrain unit (landscape position) from the October 2021 assessment, the site includes two small natural inland wetland areas (W1 and W2) and an additional natural inland wetland on the site boundary (W3). All have been classified as marsh wetlands (covering 0.025, 0.02 and 0.1 hectares, respectively) and meet the definition of an NPS-FM (2020) natural inland wetland.

The overall findings of the wetland condition assessment indicate that all three wetlands are in a moderate condition. A moderate change in ecosystem processes and loss of natural habitats has taken place but some natural habitat remains. These wetlands may still supply important regulating and supporting ecosystem services (although at a reduced capacity due to degradation), such as streamflow regulation and water quality enhancement (nitrate assimilation, sediment trapping and erosion control). Only pockets of the wetlands are still dominated by native vegetation while the rest is dominated by exotic vegetation.

The watercourses and wetlands identified on site have been degraded by historical agricultural land use and subsequently have a low ecological value. However, current freshwater legislation prevents the further loss of extent and values of natural inland wetlands and rivers and requires the maintenance and improvement of degraded waterbodies. Resource consent applications for the development of the site must apply the effects management hierarchy to manage any adverse effects on these waterbodies. Site development must therefore avoid impacts on identified wetlands and intermittent watercourses in the first instance.

Restoration of the intermittent watercourses through riparian planting during site development will significantly improve the ecological values of the streams by providing shade to assist with water retention during drier periods of the year, improving in-stream habitat for aquatic fauna (macroinvertebrates) and improving the water quality of surface water runoff. Development on site has the potential to affect the hydrology of the wetlands. Where possible, overland flows should be retained and directed into the stream network to sustain and protect streams and wetlands in the long-term, through the consideration of best practice Low Impact Design principles.

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1.0 Introduction

1.1 Project Background

Pattle Delamore Partners Ltd (PDP) has been engaged by HD Project 2 Ltd to undertake detailed ecological assessments of watercourses and wetlands at 80 McLarin Road, Glenbrook (the site) to inform structure plans and to support an application for a private plan change (PPC).

The site forms part of a larger block of land in Glenbrook that is Future Urban zoned (FUZ) in the Auckland Unitary Plan-Operative in Part 2016 (AUP-OP). The site will need to be rezoned by way of a PPC and if the plan change is successful, the project design and consenting phase will follow. It is envisaged that the maintenance and enhancement of freshwater values and resources will be a key resource management issue for land development, particularly given the policy direction of the new National Environmental Standard for Freshwater Regulations (NES-F 2020) and National Policy Statement for Freshwater Management (NPS-FM 2020).

1.2 Previous Investigations

PDP undertook ecological feasibility investigations at the site in October 2020 to identify constraints and opportunities for future site development (PDP, 2020). This investigation confirmed the presence of a number of overland flow paths (OLFPs) and two wetland areas at the site. A third area in the northern corner of the site also presented signs of a former wetland during the investigation, based on a number of indicators, however vegetation across the northern corner of the site had died off at the time of the investigation (possibly due to spraying), preventing a full assessment.

A further investigation was undertaken in July 2021, when vegetation had re-established in the northern corner, in accordance with the Wetland Delineation Protocols (Ministry for the Environment, 2020). This investigation concluded that the northern corner of the site was no longer a functioning wetland as it did not meet the definition of a natural inland wetland under the NPS-FM 2020, despite some historic indicators. Vegetation was found to comprise entirely of exotic grass, with no established hydrophytic vegetation, and soils were lacking characteristics typical of hydric conditions present in wetlands. Hydrophytic vegetation are plant species capable of growing in soils that are often or constantly saturated with water during the growing season. As such, the vegetation and soil criteria outlined in the Wetland Delineation Protocol was not met.

PDP have also completed a wetland hydrology assessment to support the PPC (PDP, 2021). This investigation identifies the principal mechanism by which each wetland is sustained (e.g., groundwater or overland flow), and should be considered in conjunction with this report.

1.3 Project Scope and Objectives

This technical report will support the HD Project 2 Limited application for a PPC and provide support to stormwater design and development plans. The specific objectives of this investigation are to:

- Assess the ecological values of the watercourses and overall condition of wetlands identified on site;
- Refine the delineation of wetlands on and adjacent to the site;
- Undertake further surveys during the 'wet season' to confirm the classification of watercourses on site;
- Identify opportunities for avoidance, mitigation and measures to enhance freshwater ecological values on site, potentially as offsetting where loss of some freshwater values cannot be practically avoided;
- Report and assess findings against the context of regional level policies of the AUP-OP and freshwater legislation (NPS-FM 2020 and NES-F 2020); and
- Provide recommendations in relation to future urban development of the site.

A comprehensive assessment of vegetation was not included in the current study. However, a limited number of vegetation plot surveys was undertaken to determine the presence of hydrophytic vegetation.

2.0 Methodology

2.1 Desktop Review

PDP undertook a detailed desktop review of the site as part of the previous investigation (PDP, 2020). A summary of findings from the initial review is provided in Section 3 below for completeness.

2.2 Field Investigations

Field investigations were undertaken on 22 October 2021 by PDP ecologists. The weather was cloudy with 4.5 mm of rainfall recorded in the previous 24 hrs at the nearest Auckland Council rain gauge (Waitangi @Diver Road).

Representative photographs of the streams and wetlands assessed during the investigation are provided as Appendix A.

2.2.1 Wetland Delineation

Wetland delineations were undertaken in accordance with the Ministry for the Environment (MfE) Wetland Delineation Protocols (2020). This included an assessment of vegetation, hydrology and soils based on the following:

- *Vegetation Tool* (Clarkson, 2014);
- *Hydrology Tool* (MfE, 2021); and.
- *Hydric soils – field identification guide/Hydric Soils tool* (Fraser et al, 2018).

Wetland delineations were undertaken close to the recommended timeframe for field work (late spring to mid-summer) when most vegetation is in full leaf and flowering.

2.2.2 Wetland Classification

Wetlands are areas that are intermittently or permanently saturated by water and support natural ecosystems of plants and animals adapted to wet conditions. This is based on the Resource Management Act (RMA; 1993) term for '**wetland'**.

The NPS-FM 2020 definition of a '**natural wetland**' is a wetland (as defined in the Act) that is not:

a) A wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore an existing or former natural wetland); or

b) A geothermal wetland; or

c) Any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.

A '**natural inland wetland**' is a wetland that is not located in the coastal marine area and includes both freshwater and inland saline wetlands.

The term wetland encompasses many different landforms that can be further classified based on their hydrological regime, substrate, nutrient status and geographical location.

The classifications of Johnson and Gerbeaux (2004) were used in this assessment, where wetlands are classified as either Bogs, Fens, Swamps, Marshes, Seeps, Shallow waters, Ephemeral wetlands, Pakihi and gumland or Saltmarshes. This level of wetland classification is practically important in order to assign a name to a functional wetland unit. Particular landforms, vegetation structural classes and plants are associated with each wetland class.

2.2.3 Wetland Condition and Value Assessment

PDP assessed the overall wetland condition (index of ecological condition/ integrity) through a rapid visual assessment of key indicators on-site, existing knowledge of the site, and remotely sensed data. This largely followed the protocol in the Wetland Monitoring Handbook (Clarkson et al. 2004).

The wetland pressure index is based on threats that are in the catchment, rather than in the actual wetland itself (although they may be in both). They include things like sources of water pollution from urban or rural land uses, weeds that could seed into the wetland, or likely presence of introduced mammalian predators (rats, possums etc), that may enter the wetland to prey on native wildlife.

The pressure measure is the extent of change from the likely original state. Original state does not have to be pre-human, and can include more recently created wetlands, either through natural processes (e.g., landslide) or constructed deliberately or inadvertently by humans.

A high score indicates a higher level of pressure on the wetland, with a maximum score of 30.

The condition measures are assessed separately for the wetland and the perimeter of the wetland. As with the wetland pressure assessment, the extent of change from the likely original state is assessed (this does not have to be a pre-human state and can include more recently created wetlands). The wetland condition assessment is scored out of 25 while perimeter condition assessment scored out of 30, with a higher score indicating the most unmodified condition.

2.2.4 Stream Classifications

PDP undertook a desktop analysis and initial stream classification surveys in October 2020 during unseasonably dry conditions (a particularly dry winter followed a summer drought), and as such additional field surveys were recommended to provide further confidence in classifications, during the subsequent wet season (July to October 2021).

Stream classification surveys were undertaken on 22 October 2021 and again a few weeks later, on 19 November to build on and provide further confidence in findings. Surveys focused on transitional points between intermittent and ephemeral stream reaches, to confirm the length of protected, intermittent reaches.

Stream classification assessments followed the Auckland Council Practice and Guidance Note for River/Stream Classification, RC 3.3.17 (V2), July 2021 (AC, 2021).

All watercourses were mapped as being permanent, intermittent or ephemeral, based on the AU-OP definitions and criteria for river and stream types below.

- ***Permanent river or stream***

The continually flowing reaches of any river or stream.

- ***Intermittent stream***

Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

(a) It has natural pools;

(b) It has a well-defined channel, such that the bed and banks can be distinguished;

(c) It contains surface water more than 48 hours after a rain event which results in stream flow;

(d) Rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;

(e) Organic debris resulting from flood can be seen on the floodplain; or

(f) There is evidence of substrate sorting processes; including scour and deposition.

- ***Ephemeral stream***

Stream reaches with a bed above the water table at all times, with water only flowing during or shortly after rain events. This category is defined as those stream reaches that do not meet the definition of permanent river or stream or intermittent stream.

2.2.5 Stream Ecological Assessments

During the previous investigation, detailed ecological assessments of the water courses could not be completed due to a lack of surface water in the channels.

During the October 2021 field investigations, a semi-quantitative aquatic habitat assessment was conducted on the lower intermittent stream reach (A3), following the Waikato Regional Council (WRC) Field Assessment Cover Form for Wadeable Soft-Bottomed Streams, and a qualitative habitat assessment was conducted following the WRC Qualitative Habitat Assessment Field Data Sheet for Wadeable Soft-bottomed Streams. The habitat assessment is a composite of landscape characteristics and biotic variables, which use different scales when evaluating the streams (Collier and Kelly, 2005).

Due to the low levels of water in the majority of this short reach, this methodology was considered more appropriate than the Stream Ecological Valuation (SEV), as originally proposed.

Given that there is no aquatic habitat downstream of the site (the area beside Glenbrook Beach has already been developed and piped), surveys of fish assemblages were not undertaken during the assessment.

2.2.6 Benthic Macroinvertebrates

Composite benthic macroinvertebrate samples were collected in accordance with NEMS methodology which is based on Stark et al. (2001) (NEMS, 2020). PDP staff used a kick-net (500 µm mesh) following the soft-bottomed, semi-quantitative Protocol C2 method. The sampling method involved the disturbance of a fixed area of approximately 3 m^2 (10 replicate unit efforts of 0.3 m^2 each), of woody debris and bank margins. Aquatic habitats were sampled in proportion to their relative occurrence.

Samples were preserved in 70% ethanol in the field and processed in the laboratory by Environmental Impact Assessments Ltd, following Protocol P2 (Stark *et al*. 2001).

Biological indices used to assess the stream health included:

- **Macroinvertebrate Community Index for soft bottomed streams (MCI-sb)** (Stark and Maxted, 2004) – a presence/absence-based measurement which describes the 'health of the stream' based on individual taxa scores between 1 and 10 (tolerant or sensitive to organic enrichment respectively).
- **EPT** – a measure of the relative abundance of Ephemeroptera, Plecoptera and Trichoptera taxa, the major pollution sensitive taxonomic groups within macroinvertebrate communities, providing insight into water and habitat quality conditions.
- **Taxonomic richness** – a measure of the number of different macroinvertebrate taxa present in each sample.

Quality thresholds for interpretation of MCI-sb results (Stark, 2004), along with interim MCI guideline scores under the AUP-OP Section E1.3.1, and the NPS-FM (2020) National Bottom Line were used to assess MCI and QMCI scores (refer to Table 1 below).

Table 1: Interpretation of Macroinvertebrate Community Index Scores		
Quality thresholds for interpretation of MCI-sb (Stark *et. al.*, 2004)		
Quality	**Descriptions**	**MCI-sb**
Excellent	Clean water	>120
Good	Doubtful quality/possibly mild pollution	100-120
Fair	Probable moderate pollution	80-100
Poor	Probable severe enrichment	<80
Interim MCI Guidelines (AUP-OP E1.3.1)		
Land Use		**MCI Score**
Native Forest		123
Exotic Forest		111
Rural		94
National Policy Statement – Freshwater Management		
National Bottom Line QMCI		4.5
National Bottom Line MCI		90

3.0 Findings of Desktop Review

3.1 Locality of the Study Site

The site is situated inland of the Glenbrook peninsula 16 km west of Pukekohe, Auckland (see Figure 1). The peninsula sits between the Waiuku River and Taihiki River and their associated estuaries which discharge into the Manukau Harbour. The northern corner of the site is bordered by McLarin Road and the land beyond this to the north-west has recently been developed into residential housing. The site is approximately eight hectares (ha) in size and is dominated by grazed pasture with pine shelterbelts located along the eastern and southern boundaries and crossing through the centre of the site.

OKOREKA RD

RERE AWA RD

OPOUATU AVE

3.2 Topography

There is an approximate change in elevation of 19 m at the site from the northeast (approx. 22.5 m RL) to the southwest (approx. 3.5 m RL). A ridgeline runs from west to east across the central portion of the site and separates the elevated flat in the northern portion of the site from the sloping land of the south (HG, 2020). The southwestern corner is low-lying (3.5 m RL) and approximately 150 m from the coast.

3.3 Catchment, Watercourses and Surface Water Management

There are multiple overland flow paths (OLFPs), ephemeral and intermittent streams, and flood plains identified across the site and the drainage pattern of the site flows roughly northeast to the southwest. Previous investigations by PDP (2020) identified a well-defined, intermittent stream channel in the lower, southern corner of the site, considered to be of low ecological value due to lack of riparian vegetation and shading. All watercourses on site have been heavily modified through historical farming activities and are degraded by a lack of riparian cover and stock access.

The watercourse in the southern corner of the site is piped through a small residential area and drains into the Waiuku River inlet of the Manukau Harbour 100 m downstream of the site.

3.4 Geology and Soils

The geology in the northern portion of the site is East Coast Bays Formation (Waitemata Group) and consists of alternating sandstone and mudstone with variable volcanic content and interbedded volcaniclastic grits (Edbrooke, 2001). The geology to the south (and the majority of the site including wetland locations) is Late Pliocene to Middle Pleistocene pumiceous river deposits (Puketoka Formation) and consists of pumiceous mud, sand and gravel with muddy peat and lignite, rhyolitic pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits (Edbrooke, 2001).

S-Map Online (Landcare Research, 2021) indicates that there are three soil types across the site. A large portion of the site is covered with acidic orthic allophanic soil (Te Rau). These soils are considered to be well drained. However, the wetlands are located on the imperfectly drained or poorly drained soil types further outlined below:

- The soil at W1 is typical orthic gley soils (Temuka). These soils are deep, poorly to very poorly drained, clays, with a depth to hard soil/gravel/rock of greater than one metre.
- The soil at W2 and W3 is saline orthic gley soils (Manukau). These soils are deep, very poorly drained, clays, with a depth to soil/gravel/rock of greater than one metre.

A detailed geotechnical report has been prepared by the site by Lander Geotechnical (2021) and the results of this investigation have been discussed further in PDPs Wetland Hydrology Assessment report (PDP, 2021).

3.5 Local Terrestrial and Wetland Ecosystems and Vegetation

Figure 1 depicts the current indigenous terrestrial and wetland ecosystem extent in the vicinity of the site (AC Geomaps layer based on Singers *et. al.* (2016)).

To the west of the site a small section of remaining forest (less than 1 ha in size) has been identified as pōhutukawa, pūriri, broadleaved forest (WF4) with an IUCN threat status of Endangered. The potential or historical extent of indigenous vegetation for this area has been identified as pūriri forest (WF7) (threat status of Critically Endangered). Pūriri Forest in the Auckland region was originally widespread on alluvial terraces and on the volcanic soils of the isthmus, but is now reduced to small, scattered remnants (Singers *et al.*, 2016). No current or historical wetland ecosystems were identified in the vicinity of the site.

The current canopy cover is virtually non-existent on the site, with the exception of mature exotic shelter belts along the site boundaries and crossing through the centre of the site.

3.6 Landcover and Land Use

Historical aerial photographs were reviewed in the previous report prepared by PDP (PDP, 2020) to identify past land use, vegetation cover and overland flow paths at the site. Historical photos clearly show the site was grass with no obvious or significant vegetation since the 1940s. The current shelter belts do not appear until after the 1980s. No obvious watercourses can be seen in the historical photos, however potential wetland areas were evident in the northern section of the site from 2006 onwards (PDP, 2020). Land use at the site and surrounding areas have historically been pastoral with grazed grasses. Desktop investigations by PDP (2020) concluded that the site has been modified over time by farming, with ongoing disturbance to watercourses and wetlands from stock impact and competition and invasion from exotic vegetation.

Historically, it is likely that the wetland areas covered a larger extent, but due to disturbances mentioned above, the surface flows have become more concentrated over time and consequently their extent has been reduced. The local catchment has also changed, with an increase in excavation and impervious surfaces which will also impact on the wetland ecosystems. Residential development above the northern corner of the site has only occurred within the past 3 years.

4.0 Findings of Field Investigations

4.1 Stream Classification

As recommended in PDP's feasibility report (PDP, 2020) additional stream surveys were undertaken to provide further confidence in the initial stream classifications, which were conducted during a particularly dry winter and following summer drought conditions.

The additional surveys were conducted at the end of AC's definition of the 'wet season' for stream classification (July to October). Rainfall recorded at the nearest rainfall gauge (Waitangi@ Diver Road, Glenbrook) prior to these site visits is provided in Table 2 below.

Table 2: Rainfall Prior to Stream Classification Assessments

Date of Visit	Rainfall in previous 48 hrs (mm)	Rainfall in previous month
22 October 2021	4.5	138.2
19 November 2021	0	113.5

Notes:

1. *Rainfall recorded at AC's Waitangi@Diver Road rainfall gauge.*

Following the AC River/Stream Classification Guidance Note (AC, 2021), channels were inspected for evidence of intermittently or permanently flowing water in the first instance. During the stream classification survey on 22 October 2021, flowing water was observed in the steeper sections of the watercourse between W1 and W2, suggesting intermittent status but possibly as a result of prior rainfall (4.5 mm recorded in the morning prior to the survey). Standing water was also noted in the watercourse above W1, and hydrophytic vegetation (water starwort, *Callitriche stagnalis)* was observed growing in this location, which is evidence of extended periods of surface water in the channel.

A subsequent survey was undertaken on 19 November 2021, after a period of at least 48 hours without rainfall. Although flowing water was not observed in the same watercourse, surface water was present in pools and a clear channel, lacking rooted terrestrial vegetation, was observed from the northern site boundary, below the former wetland (photographs 7 and 8 of Appendix A), to the lower southern corner of the site. A small section of flowing water was observed in the lower stream reach, prior to entering a culvert. Hydrophytic vegetation (obligate or facultative wetland or aquatic species) was observed growing at various points along the channel, including water starwort (*Callitriche stagnalis)*, water pepper (*Persicaria hydropiper*), willow weed (*Persicaria maculosa),* speedwell (*Veronica spp.)* and juncus (*juncus spp.)*, refer to photographs 6 and 7 of Appendix A.

The AUP intermittent stream criteria regarding organic debris from flood flows and evidence of substrate sorting processes could not be assessed with confidence at this site due to the land use type (negligible upstream sources of organic debris), impacts from stock trampling and the size and scale of the watercourses. As such, the remaining AUP assessment criteria, OLFP modelling, and site observations were used to guide classification.

The presence of hydrophytic vegetation identified during the surveys is clear evidence of extended periods of surface water or base flow in the watercourse flowing south from the northern site boundary, and this feature alone strongly suggests intermittent status. In addition, this watercourse exhibits at least three of the AUP intermittent stream criteria:

1. Evidence of natural pools,
2. Surface water present (more than 48 hrs after a rain event), and
3. Rooted terrestrial vegetation is not present across the entire cross-sectional width of the channel.

Evidence of hydrophytic vegetation, natural pooling, surface water and lack of rooted terrestrial vegetation is provided in photographs 1 to 7 (Appendix A).

The location and extent of intermittent and ephemeral watercourses is illustrated in Figure 2. A summary of stream lengths and ecological value is provided in Table 3 below.

Table 3: Summary of Watercourses

Stream Name	Approximate Length	Classification	Riparian Cover	Overall Ecological Value
A1	65 m	Ephemeral	None	Very low
A2	69 m	Ephemeral	None	Very low
A3	100 m	Intermittent	None	Very low
A4	401 m	Intermittent	None	Very low

4.2 Stream Ecological Assessment

The semi-quantitative and qualitative stream habitat assessment covered an approximately 50 m reach of the intermittent watercourse located on the south-western corner of the site. This reach comprised predominantly of grazed exotic grass riparian vegetation. The true left bank has a line of mature exotic trees providing some shade to the watercourse. The watercourse is approximately 0.3 m wide and ranging between 0.05 – 0.15 m deep. There is some flow in the watercourse after rain, however the majority of pools are small and shallow. The stream bed is entirely soft sediment with limited organic material and woody debris.

Lack of riparian vegetation has resulted in limited habitat available for both aquatic and terrestrial organisms. The banks were pugged and had occasional evidence of erosion, however they were generally stable.

The stream is considered to be in marginal condition, bordering suboptimal and scored 89.5 out of 180 on the WRC habitat assessment forms (See Appendix B).

Representative photos of this reach are provided in Appendix A.

4.2.1 Benthic Macroinvertebrates

A summary of biotic index scores for the benthic macroinvertebrate sample collected in the southern, intermittent watercourse is provided in Table 4. Biotic indices are indicative of poor water quality at the site, with only pollution tolerant taxa identified. Dominant taxa comprise of midges (chironomus), seed shrimp (ostracoda) and ribbon worms (nemerteans). The MCI-sb score falls below the interim MCI guidelines for rural land use specified in the AUP-OP and both QMCI and MCI scores fall below the NPS-FM (2020) National Bottom Line. Raw benthic macroinvertebrate data is provided in Appendix C.

Table 4: Summary of Biodiversity Indices Across Sites

MCI Indices	Stream A3
Quality Indicator (Stark *et al.* 2004)	Poor
Number of invertebrate taxa	16
% EPT taxa	0
MCI-sb value	***82.25***
QMCI – sb	**3.41**

Notes:

1. ***Bold*** *denotes below NPS-FM National Bottom Line*
2. *Italics denotes below AUP Interim MCI Guideline for rural areas*

Overall, the ecological value of the stream reach assessed is very low. The stream is highly degraded by stock access and lack of riparian vegetation.

4.3 Wetland Delineation and Classification

PDP (2020) previously identified two small wetlands in the upper and lower western portions of the site (W1 and W2) in October 2020. Both wetlands were classified as Marsh wetlands and were dominated by soft rush (*Juncus effusus)*.

Further wetland investigations were undertaken of W1 and W2 by PDP ecologists on 22 October 2021, including an additional assessment of the potential wetland (W3) area identified on the southern site boundary and adjacent property. The wetlands were ground-truthed and classified following the methodology outlined above in Section 2.2.

Based on these investigations it can be confirmed that three wetlands (W1, W2 and W3) all classified as Marsh wetlands, have been delineated. All three of these wetlands represented wetland vegetation, soil and hydrological characteristics. Overall, these wetlands meet the definition of an NPS-FM (2020) natural inland wetland. The location and extent of these wetlands are illustrated in Figure 3. Potential wetlands within 100 m of the site have also been included in Figure 3. It is noted that the small potential wetland crossing the eastern site boundary is situated upgradient of the site, and the hydrology of this potential wetland is likely to be surface water fed (similar to W1). As such, it is considered that the hydrology of this potential wetland would unlikely be impacted by site development and further investigation of this area has not been undertaken. If required, further investigation and mitigation can be provided.

As discussed in PDP's Wetland Hydrology Assessment (PDP, 2021) W1 and W2 are primarily sustained by surface water inflows such as overland flow and stream flow. However, it is likely that there is some subsurface flow/groundwater component feeding W2 in the northern portion of the wetland. W3 was assessed to be sustained primarily by groundwater.

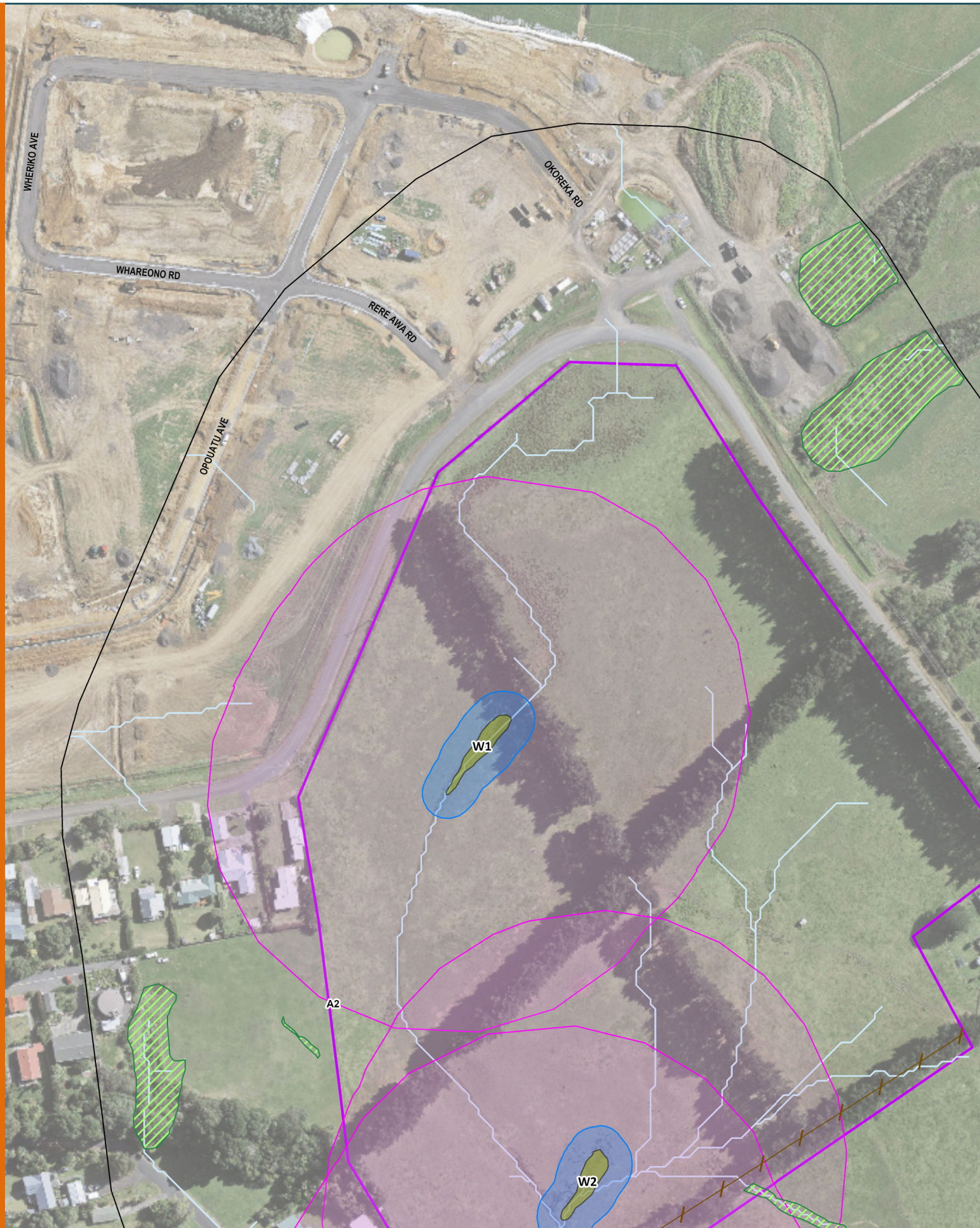
Table 5 presents a summary of the wetland delineations and classifications in relation to the MfE Wetland delineation Protocols (2020) and NPS-FM (2020).

The results of the vegetation plots, vegetation tests, soils tests and hydrology assessment are included in Appendix D.

Photographs of each wetland are included in Appendix A.

Table 5: Results of Wetland Delineation

Site	Area (ha)	Rapid Test	Dominance Test-50/20 Rule	Prevalence Test	Pasture Test	Soils	Hydrology
W1	0.025	No	Yes	Yes (1.9)	Yes	Yes	Yes
W2	0.020	No	Yes	Yes (2.21)	Yes	Yes	Yes
W3	0.1	No	Yes	Yes (2.58)	Yes	Yes	Yes



4.3.1 Wetland W1

W1 was dominated by creeping bent (*Agrostis stolonifera*), soft rush, glaucous sweetgrass *(Glyceria declinate*), creeping buttercup *(Ranunculus repens*) and spearwort (*Ranunculus flammula*), collectively making up approximately 68% of the wetland vegetation plot.

The 2021 soil profile is marginally indicative of hydric soils with only the lower section of the soil profile at 50cm showing marginal low chroma colours. The upper soil profile was silty while the lower area showed plastic clays. The 2020 soil augers had low chroma colours from 10 cm and lower.

Wetland hydrology indicators were present with evidence of inundation, water table and soil saturation, including the presence of localised geomorphology.

A summary of W1 results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation does not pass the rapid test but passes the dominance test and prevalence index test;
- Vegetation passes the improved pasture test. None of the dominant species are listed as pasture species in terms of the New Zealand Grasslands Association. Listed pasture species included Yorkshire fog *(Holcus Lanatus*), although at a low coverage;
- Soils marginally pass the hydric soil test;
- Wetland hydrology is present; and,
- The overall vegetation community, soils and hydrology is representative of a wetland ecosystem.

4.3.2 Wetland W2

W2 was dominated by soft rush and creeping buttercup, collectively 57% of the wetland vegetation plot. Other species with a high coverage included speedwell *(Veronica americana*).

Hydric soils were present. The upper section of the profile presented the chroma of a topsoil while the middle and lower section had low chroma colours typical of hydric soils.

Wetland hydrology indictors were present with evidence of inundation, water table and soil saturation including the presence of localised geomorphology.

A summary of W2 results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation does not pass the rapid test but passes the dominance test and prevalence index test;

- Vegetation passes the improved pasture test. None of the dominant species are listed as pasture species in terms of the New Zealand Grasslands Association. Listed pasture species included Yorkshire fog, Trefoil-Birdsfoot *(Lotus corniculatus*), kikuyu (*Cenchrus clandestinus)* and plantain (*Plantago lanceolata)* although at a low coverage;
- Soils pass the hydric soil test;
- Wetland hydrology is present; and,
- The overall vegetation community, soils and hydrology is representative of a wetland ecosystem.

4.3.3 Wetland W3

W3 was dominated by soft rush and creeping buttercup, collectively 67% of the wetland vegetation plots. Other species with a high coverage included Yorkshire fog. The vegetation community also includes the native wetland obligate plant slender clubrush (*Isolepis cernua)*.

Hydric soils were present. The entire profile presented low chroma colours typical of hydric soils. The consistence of the soil was sticky with fine mottles.

Wetland hydrology indicators were present, with evidence of inundation, water table and soil saturation including the presence of localised geomorphology.

A summary of W3 results in terms of NPS-FM (2020) and MfE delineation protocols is provided below:

- Vegetation does not pass the rapid test but passes the dominance test and prevalence test;
- Vegetation passes the improved pasture test. None of the dominant species are listed as pasture species in terms of the New Zealand Grasslands Association. Listed pasture species included Yorkshire fog, Trefoil-Birdsfoot and white clover (*Trifoluim repens)* although at a low coverage;
- Soil profile represents typical wetland soil;
- Wetland hydrology is present; and,
- The overall vegetation community, soils and hydrology is representative of a wetland ecosystem.

4.4 Wetland Condition Assessment

An assessment of the condition of the wetlands was undertaken based on the wetland condition assessment methodology (Clarkson et al. 2004) outlined above in Section 2.2.

The overall findings of the condition assessment indicate that all three wetlands are in a **moderate condition**. A moderate change in ecosystem processes and loss of natural habitats has taken place but some natural habitat remains. These wetlands may still supply important regulating and supporting ecosystem services (although at a reduced capacity due to degradation) such as streamflow regulation and water quality enhancement (nitrate assimilation, sediment trapping and erosion control). Only pockets of the wetlands are still dominated by native vegetation while the rest is dominated by exotic vegetation, particularly the grazed areas.

The catchment pressure condition is considered **moderate** while the wetland perimeter is in **poor** condition for all three wetlands. Modifications in the catchment hydrology includes recent construction activities, subdivision and associated residential development that has resulted in modifications to surface hydrology. Stock access, and runoff from stormwater and roads will be impacting on the water quality of the wetlands. There is limited suitable habitat for mammalian predators. The remainder of the catchment includes mostly farmed areas with low amounts of undesirable plant species and a fair amount of introduced species. Within the immediate catchment there are also further potential wetland areas, as indicated in Figure 3.

Table 6 presents a summary of the wetland condition assessment.

The field results of the edge condition, wetland pressure and wetland condition assessment are included in Appendix D.

Table 6: Results of Wetland Classification

Site	Edge Condition Index	Score Category	Wetland Pressure Index	Score Category	Wetland Condition Index	Score Category
W1	12/30	Low	15/30	Moderate	19/25	Moderate
W2	11/30	Low	15/30	Moderate	17.6/25	Moderate
W3	13/30	Low	15/30	Moderate	18.9/25	Moderate

4.5 Freshwater NES and NPS Implications

As covered in PDP's Ecological Feasibility Report (PDP, 2020), the NPS-FM (2020) includes new policies to avoid the loss of extent of natural inland wetlands and rivers, protect their values and promote their restoration. The new regulations in the NES-F (2020) place restrictions on damaging activities in and near natural wetlands. Implications for site development have not changed from PDP's initial assessment.

Important considerations in terms of the NPS-FM (2020) for site development include:

- The 'hierarchy of obligations' to prioritise the health and wellbeing of water bodies, then the essential needs of people (drinking water) and then any other uses (Te Mana o te Wai).
- 'National bottom lines' defined with all water bodies to be at least maintained, and degraded water bodies required to be improved.
- Adverse effects on wetland or river extent or values to be managed by the effects management hierarchy.
- The NPS-FM (2020) does not support any loss in potential ecosystem values (e.g., loss of streams through reclamation or piping).

4.5.1 Managing Adverse Effects on Wetlands

The updated delineation of wetland areas confirmed on the site and southern boundary are mapped in Figure 3. Setbacks of 10m and a 100m were also mapped in line with the NPS-FM (2020) and NES-F (2020) requirements. The following recommendations should be taken in consideration:

- Resource consents must be assessed by applying the effects management hierarchy to manage any adverse effects on the wetland extent or values, including cumulative effects and loss of potential value, as a result of the site development. Under the effects management hierarchy, adverse effects on the wetland extent or values caused by development are to be avoided, minimised then remedied (in that order) wherever practicable, then offset or compensated (in that order) where possible. If these cannot be achieved, the activity must be avoided, and consent declined.
- The AC will require a demonstration of the functional need of any planned activity that triggers the NES-F 2020 regulations.

4.5.2 NES-F (2020) Regulations

The regulations require strict measures, including but not limited to resource consents, for activities that can result in the loss of extent and values of natural inland wetlands. The NES-F (2020) prescribes activity statuses and detailed conditions for various potentially damaging activities in and around wetlands.

Some activities that cause complete or partial drainage of all or part of a natural inland wetland are now prohibited. A list of the relevant non-complying and prohibited activities are shown in Table 7.

Table 7: Non-complying and Prohibited Activities under the NES-F 2020

Activity	Non-complying	Prohibited
Vegetation clearance.	Vegetation clearance within, or within a 10 m setback from, a natural wetland if they do not have another status (for example restoration, scientific research, maintenance, natural hazards).	N/A
Earthworks or land disturbance.	Earthworks within, or within a 10 m setback from, a natural wetland. Earthworks outside, but within a 100 m setback from a natural wetland if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51. Earthworks within, or within a 10 m setback from, a natural wetland if they do not have another status.	Earthworks within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under regulations 38 to 51.
The taking, use, damming, diversion, or discharge of water.	The taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland is a non-complying activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any of regulations 38 to 51. The taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland if they do not have another status.	The taking, use, damming, diversion, or discharge of water within a natural wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under regulations 38 to 51.

Engineering/stormwater assessments are also required for earthworks, stormwater diversions and discharges in relation to the NES-F 2020 requirements for wetlands.

It should be noted that MfE are proposing to make amendments to natural wetland provisions in the NPS-FM (2020) and NES-F (2020) (final policy advice is still in progress). MfE propose changes to the NPS-FM natural wetland definition and regulations by the introduction of consent pathways for various land development, including urban development listed in a regional or district plan document.

The three options MfE are currently proposing include the following:

- Option 1 – Amend natural wetland definition;
- Option 2 – Fully or partially remove prohibited activity classification (Regulation 53); and,
- Option 3 – New consent pathways and amend natural wetlands definition.

5.0 Mitigation of Effects and Recommendations

The watercourses and wetlands identified on site have been degraded by historical agricultural land use and subsequently have a low ecological value. However, current freshwater legislation prevents the further loss of extent and values of natural inland wetlands and rivers and requires the maintenance and improvement of degraded waterbodies. Resource consent applications for the development of the site must apply the effects management hierarchy to manage any adverse effects on these waterbodies, including cumulative effects and loss of potential values. Site development must therefore avoid impacts on identified wetlands and intermittent watercourses in the first instance.

Restoration of the intermittent watercourses through riparian planting would significantly improve the ecological values of the streams by providing shade to assist with water retention during drier periods of the year, improving in-stream habitat for aquatic fauna (macroinvertebrates) and improving the water quality of surface water runoff. AC guidelines recommend a minimum riparian buffer width of at least 10 m to ensure vegetation is self-sustaining with relatively low maintenance requirements. Development on site has the potential to affect the hydrology of the wetlands. Where possible, overland flows should be retained and directed into the stream network to sustain and protect the hydrology of streams and wetlands in the long-term, through the consideration and incorporation of best practice Low Impact Design (LID) principles. The Wetland Hydrology Assessment report (PDP, 2021) provides recommendations for further monitoring of groundwater levels at W3 and surface flows at W1 and W2 to confirm the hydrological understanding of the wetlands.

Riparian planting will increase native biodiversity on the site by providing food resources and habitat for native wildlife. Establishing a connection with the remaining coastal broadleaved forest on the south-western property boundary would further enhance ecological value. Broader enhancement opportunities to improve amenity and aesthetics from site development could include a walkway along the riparian margin and greenspace in the southern, low-lying corner of the site, in the vicinity of W2 and W3.

6.0 References

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Appendix A

Photographic Log

Photograph 1: Incised intermittent watercourse at southern corner of site.

Photograph 2: Intermittent watercourse facing north, towards W2.

Photograph 3: End of intermittent stream reach and start of ephemeral reach, facing east.

Photograph 4: Intermittent watercourse downstream of W1, facing south.

Photograph 5: Intermittent watercourse downstream of W1, facing north. Lack of rooted terrestrial vegetation in channel.

Photograph 6: Hydrophytic vegetation growing in watercourse downstream of W1, pooled water in channel.

Photograph 7: Intermittent watercourse above W1. Hydrophytic vegetation present and pooled water in channel.

Photograph 8: Transition point to ephemeral watercourse. Rooted terrestrial vegetation across channel and no water present.

Photograph 9: W1, 2m X 2m vegetation plot.

Photograph 10: W1 facing upstream

Photograph 11: W2, facing north.

Photograph 12: W2, area of 2m X 2m vegetation plot.

Photograph 13: W3, facing west towards site.

Photograph 14: W3, facing south towards drainage channel. Area of 2m X 2m vegetation plot.

Appendix B

Habitat Assessment Data

Table B1: Habitat Assessment Data Summary	
Reach Scale Habitat Quality Assessment	**Notes**
Canopy cover	Open
Fencing	None
Riparian Vegetation	Grass
Channel width (m)	0.3 max
Depth (m)	0.05 – 0.15 m
Compaction	Loose
Large wood (% cover)	<5
Coarse detritus (% cover)	<5
Fine organic deposits (% cover)	5- 25
Stream bed Substrate	Silty sand
Filamentous Algae (% cover)	<5
Macrophytes (% cover)	5-25
Mosses/Liverworts (% cover)	<5
Reach Scale Habitat Quality Assessment	**Score**
1. Riparian Vegetative Zone Width 3	10
2. Vegetation Protection 3	10.5
3. Bank Stability 3	18
4. Channel sinuosity 3	7
5. Channel Alteration	16
6. Sediment Deposition	3
7. Pool variability	3
8. Abundance and Diversity of Habitat	2
9. Periphyton	20
TOTAL	**89.5**

Appendix C

Macroinvertebrate Results Data

Table C1: Macroinvertebrate Data			
Site Name:	80 McLarin Rd, Glenbrook		
Taxa	**MCI**	**MCI-sb score**	
Caddisfly Oxyethira	2	1.2	1
Beetle Hydrophilidae	5	8	2
Beetle Liodessus	5	4.9	1
True Fly Chironomus	1	3.4	60
True Fly Empididae	3	5.4	1
True Fly Hexatomini	5	6.7	4
True Fly Muscidae	3	1.6	3
True Fly Tanypodinae	5	6.5	2
True Fly Zelandotipula	6	3.6	5
Crustacea Ostracoda	3	1.9	22
Crustacea Paraleptamphopus	5	5.5	10
MITES	5	5.2	7
SPIDERS Dolomedes	5	6.2	1
Mollusc Physa	3	0.1	1
OLIGOCHAETES	1	3.8	9
NEMERTEANS	3	1.8	17
Number of Taxa			**16**
EPT Value			**0**
Number of Individuals			**146**
% EPT (taxa number)			**0**
Sum of recorded scores			**65.8**
SBMCI Value			**82.25**
Sum of abundance load			**498.4**
QMCI-sb Value			**3.41**

Appendix D

Wetland Delineation Field Sheets

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin Rd | Region: AKL. | Sampling point: W1, Plot 1

Owner: | Date: 22.10.21 | Land use: Grazed pasture

Landform: Within OLFP | Local relief: | Land cover: Grass

Is the land drained (circle) YES NO | Investigator(s): EW, AS | Soil °C: 18.1 | Slope°: Flat

GPS (NZTM): 1752165, 5885995 | Altitude m: 18 | Photo Nos:

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed Pugging from stock

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present?	YES ☑	NO ☐	**Is the sampled area within a wetland?**	**YES ☑**
Hydric soils present?	YES ☑	NO ☐		**NO ☐**
Wetland hydrology present?	YES ☑	NO ☐		

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2) Plot 1			
1. Juncus effusus	15		FACW
2. Callitriche stagnalis	5		OBL
3. Ranunculus repens	10		FAC
4. Ranunculus flammula	10		FACW
5. Miriophyllum sp.	5		OBL
6. Holcus Lanatus	5		FAC
7. Rumex conglomeratus	2		FAC
8. Glyceria declinata	13		OBL
9. Agrostis stoloni	20		FACW
10.			
11.			
12.			
Total cover =	85		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC	(A) 1
Tot. Dominant Spp. across strata	(B) 1
% OBL/FACW/FAC	(A/B) 20

Prevalence Index:

Total % cover of:		Multiply by:	
OBL	23	x 1 =	23
FACW	45	x 2 =	90
FAC	17	x 3 =	51
FACU		x 4 =	
UPL		x 5 =	
Total	85 (A)		164 (B)

Prevalence Index (B/A) = 1.9

Hydrophytic vegetation indicators:

- ☐ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

- YES ☑
- NO ☐
- UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
0 - 10	10YR 3/2	-					Silty
10 -50	10YR 3/3	-					
50-60	10 YR 4/3	10YR 3/6	2		Matrix		Saturated, plastic

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W MW I (P) VP

Organic layers:
- [✓] Organic soil material
- [ ] Litter
- [ ] Fibric
- [ ] Mesic
- [ ] Humic
- [ ] Peaty topsoil
- [ ] Peaty subsoil

Concretions:
- [ ] Iron concretions
- [ ] Manganese concretions
- [ ] Nodular

Consistence:
- [ ] Plastic
- [ ] Sticky
- [ ] Fluid

Colours: profile form either:
- [ ] Gley OR
- [✓] Mottled 2020

Horizon:
- [✓] Reductimorphic 2020
- [ ] Redox mottled
- [ ] Redox segregations
- [ ] Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) ____

(High GW) Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

[ ] Pugged

Hydric soils present? YES [ ] NO [ ] UNCERTAIN [ ] NZSC subgroup TOGS

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- [✓] Surface water (1A)
- [✓] Groundwater <30 cm (1B)
- [✓] Soil saturation <30 cm (1C)
- [ ] Water marks (2A)
- [ ] Sediment deposits (2B)
- [ ] Drift deposits (2C)
- [ ] Algal mat/crust (2D)
- [ ] Iron deposits (2E)
- [ ] Surface soil cracks (2F)
- [ ] Inundation on aerial imagery (2G)
- [ ] Sparsely vegetated concave surface (2H)
- [ ] Salt crust (2I)
- [ ] Aquatic invertebrates (2J)
- [ ] Hydrogen sulphide odour (3A)
- [ ] Oxidised rhizosphere on roots (3B)
- [ ] Reduced iron (3C)
- [ ] Reduced iron in tilled soil (3D)
- [ ] High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

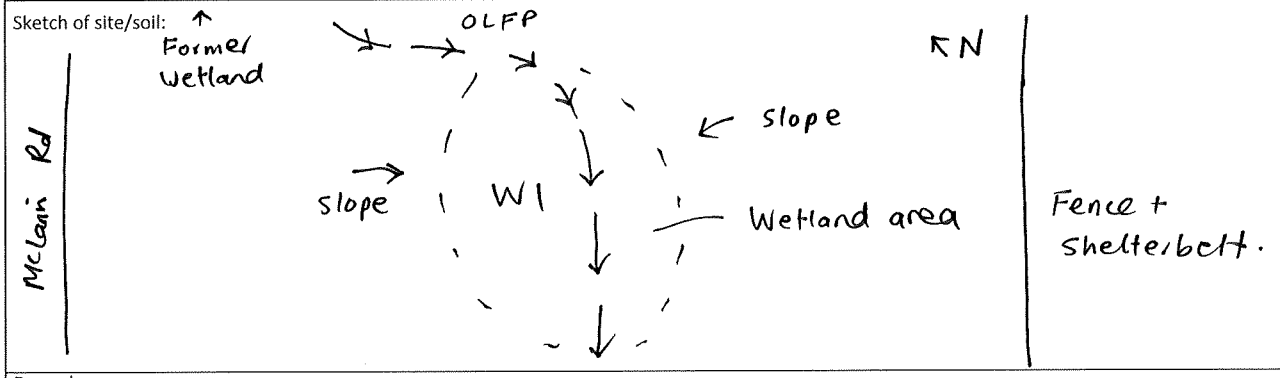
- [ ] Water-stained leaves (2K)
- [ ] Drainage patterns (2L)
- [ ] Dry-season water table (3E)
- [ ] Saturation in aerial imagery (3F)
- [✓] Geomorphic position (4B)
- [ ] Shallow aquitard (4C)
- [ ] FAC-neutral test (4D)
- [ ] Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES [ ] NO [ ]

Sketch of site/soil:



Remarks:

Wetland #: 1 **Date:** 20211022

3. From perimeter walk

Edge condition index		
Indicator[1]	**Comment**	**Score (0-5)**
Shape index [2]	m:ha 1.8	2
Stock access	yes	0
Weed density	Weedy, most of the weeds also in wetland.	1
Canopy dieback	None noted.	5
Perimeter buffer	No buffer.	0
Perimeter drains	No drains but OLFP running through wetland.	4
Total (max 30)		12 / 30
Proportion viewed	Est. length (m) assessed and % total length 110 **m**	100 %

[1] Assign degree of modification as follows:
5=v. low/ none **4**=low **3**=medium **2**=high **1**=v. high **0**=extreme

[2] Assign shape index scores as follows:
5 = <1.2 **4** = 1.2-1.3 **3** = 1.3-1.5 **2** = 1.5-2 **1** = 2-3 **0**=>3

4. From all data (catchment scale indicators)

Wetland pressure index (note for this indicator a High score is bad)		
Pressure	**Specify and Comment**	**Score**[3]
Modifications to catchment hydrology	Effects from adjacent/upstream sub division	3
Water quality decline in catchment	Stock in immediate catchment. Increased road-run off.	2
Animal pest presence (excl. stock)	No evidence of any pest control	3
Key undesirable plant species in catchment	Various exotic weeds	3
% catchment in introduced vegetation	2/3 of immediate catchment in farmland with introduced vegetation.	4
Wetland isolation	More confirmed wetlands just upstream	0
Total pressure index (max 30)		15/30

[3]Assign pressure scores as follows: 5=extreme, 4=very high, 3=high, 2=moderate, 1 = low 0=none /v. low

Wetland #: 1 **Date:** 20211022

5. From all data

Wetland condition index				
Indicator	**Indicator components**	**Specify and Comment**	**Score 0– 5***	**Mean score**
Change in hydrological integrity	Impact of manmade structures	Modification over time to watercourse.	4	4
	Water table depth	High when surveyed.	4	
	Dry-land plant invasion	Some exotic species	4	
Change in physico-chemical parameters	Fire damage	None	5	4
	Degree of sedimentation/erosion	Development in catchment. Pugging in channel.	4	
	Nutrient levels	Not measured. Relative nutrient level suspected	3	
	Von Post index	N/A	–	
Change in ecosystem intactness	Loss in area of original wetland	Some loss due to historic hydrological changes including trampling/shade.	1	3,3
	Recent vegetation damage/clearance	None	5	
	Hydrological connectivity barriers	None observed	4	
Change in browsing, predation & harvesting regimes	Damage by domestic or feral ungulate animals	Medium browsing/trampling damage evident	3	3.6
	Introduced predator impacts on wildlife	Rodents, cats suspected	3	
	Harvesting levels	None	5	
Change in dominance of native plants	Introduced plant canopy cover	Shelterbelt	4	4
	Introduced plant understorey cover	Lots of herbaceous exotics	4	
Total wetland condition index (max 25)				19 /25

* Assign degree of modification as follows (if answer is 'don't know' calculate average excluding that indicator component): 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLaren Rd | Region: Akl. | Sampling point: WZ

Owner: | Date: 22/10/21 | Land use: Grazed pasture

Landform: Toe of slope | Local relief: | Land cover: Exotic grassland

Is the land drained (circle) YES NO | Investigator(s): AS / EW | Soil °C: 18 | Slope°: 1/18

GPS (NZTM): 1762211, 5885812 | Altitude m: 6 | Photo Nos: WZ.1 – WZ.23

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed: some pugging evident.

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present?	YES ☑	NO ☐	**Is the sampled area within a wetland?**	**YES ☑**
Hydric soils present?	YES ☑	NO ☐		**NO ☐**
Wetland hydrology present?	YES ☑	NO ☐		

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. Ranunculus repens	22		FAC
2. Juncus effusus	35		FACW
3. Veronica americana	15		OBL
4. Sphag. moss	5		OBL
5. Holcus lanatus	5		FAC
6. Rumex conglomeratus	1		FAC
7. Lotus sp.	5		FACU
8. Plantago lanceolata	1		FACU
9. Isolepis cernua	5		OBL
10. Paspalum distichum	3		FACW
11. Cenchrus clandestinus	3		FACU
12.			
Total cover =	100		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 57

Prevalence Index:

Total % cover of:		Multiply by:	
OBL	25	x 1 =	25
FACW	38	x 2 =	76
FAC	28	x 3 =	84
FACU	9	x 4 =	36
UPL		x 5 =	
Total	100 (A)		221 (B)

Prevalence Index (B/A) = 2.21

Hydrophytic vegetation indicators:

- ☑ Dominance Test is >50%
- ☑ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑ NO ☐ UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
0 - 18	10 YR 3/4	—	0	0	0	Soft silt	Saturated
18 - 32	10 YR 6/4	10YR 5/8	50	matrix	matrix	mineral	silty CLAY
32 - 45	10 YR 6/3	10 YR 6/8	20	matrix	matrix	mineral	"

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W MW I (P) VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☑ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☑ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☑ Mottled

Horizon:
- ☐ Reductimorphic
- ☐ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) 0

(High GW) Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☑ NO ☐ UNCERTAIN ☐ NZSC subgroup SOGS

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☑ Surface water (1A)
- ☑ Groundwater <30 cm (1B)
- ☑ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☑ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☑ NO ☐

Sketch of site/soil:

Remarks:

Wetland #: 2 **Date:** 2021 1022

3. From perimeter walk

Edge condition index		
Indicator[1]	**Comment**	**Score (0-5)**
Shape index [2]	m:ha 2.5	1
Stock access	yes, pugging	0
Weed density	Weedy, most of the weeds also in wetland.	1
Canopy dieback	None noted	5
Perimeter buffer	No buffer.	0
Perimeter drains	No drains but OLFP nearby but not through wetland.	4
Total (max 30)		11 / 30
Proportion viewed	Est. length (m) assessed and % total length 80 m	100%

[1] Assign degree of modification as follows:
5=v. low/ none **4**=low **3**=medium **2**=high **1**=v. high **0**=extreme

[2] Assign shape index scores as follows:
5 = <1.2 **4** = 1.2-1.3 **3** = 1.3-1.5 **2** = 1.5-2 **1** = 2-3 **0**=>3

4. From all data (catchment scale indicators)

Wetland pressure index (note for this indicator a High score is bad)		
Pressure	**Specify and Comment**	**Score**[3]
Modifications to catchment hydrology	Construction near perimeter of catchment some changes due to	3
Water quality decline in catchment	Cow faeces in waterways pastoral use & fertilizers & sediments	2
Animal pest presence (excl. stock)	No trapping known. high edge to area	3
Key undesirable plant species in catchment	Lots of exotic grasses from paddock - some gorse nearby.	3
% catchment in introduced vegetation	Pasture 2/3 catchment farmland with introduced vegetation	4
Wetland isolation	More confirmed wetlands just upstream	0
Total pressure index (max 30)		15/30

[3]Assign pressure scores as follows: 5=extreme, 4=very high, 3=high, 2=moderate, 1 = low 0=none /v. low

Wetland #: 2 **Date:** 2021 10 22

5. From all data

Wetland condition index				
Indicator	**Indicator components**	**Specify and Comment**	**Score 0– 5***	**Mean score**
Change in hydrological integrity	Impact of manmade structures	Modification overtime to watercourse	4	3.6
	Water table depth	High when surveyed.	4	
	Dry-land plant invasion	Some exotic species	3	
Change in physico-chemical parameters	Fire damage	None	5	4
	Degree of sedimentation/erosion	Development in catchment. Pugging	4	
	Nutrient levels	Not measured. Relative nutrient level suspected.	3	
	Von Post index	NA	–	
Change in ecosystem intactness	Loss in area of original wetland	Some loss due to historic hydrological changes incl. trampling/stock	1	3.3
	Recent vegetation damage/clearance	~~None~~ Some effects from grazing	4	
	Hydrological connectivity barriers	None observed	4	
Change in browsing, predation & harvesting regimes	Damage by domestic or feral ungulate animals	Trampled and browsed.	1	3
	Introduced predator impacts on wildlife	Rodents, cats suspected.	3	
	Harvesting levels	None	5	
Change in dominance of native plants	Introduced plant canopy cover	No canopy	5	4
	Introduced plant understorey cover	Lots of herbaceous exotics	3	
Total wetland condition index (max 25)				17.6/25

* Assign degree of modification as follows (if answer is 'don't know' calculate average excluding that indicator component): 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme

NEW ZEALAND WETLAND DELINEATION DATA FORM

SECTION A – SITE INFORMATION

Site: 80 McLarin Rd | Region: AKl | Sampling point: W3

Owner: | Date: 22/10/21 | Land use: Grazed pasture

Landform: Toe of slope | Local relief: | Land cover: Exotic grassland

Is the land drained (circle) YES (NO) | Investigator(s): EW/AS | Soil °C: 18 | Slope°: 1/17

GPS (NZTM): 1752192, 5885747 | Altitude m: 4 | Photo Nos: W3.1 - W3.28

Are climatic/hydrologic conditions on the site typical for this time of year? (YES) NO (circle appropriate; if NO explain in Remarks)

Are vegetation, soil or hydrology significantly disturbed? (circle) | Are 'normal circumstances' present? (circle) (YES) NO

Are vegetation, soil or hydrology naturally problematic? (circle) | Explain answers in Remarks if needed

SUMMARY OF FINDINGS—Attach site map showing sampling point locations, transects, important features etc.

Hydrophytic vegetation present? YES ☑ NO ☐ **Is the sampled area within a wetland? YES ☑ NO ☐**

Hydric soils present? YES ☑ NO ☐

Wetland hydrology present? YES ☑ NO ☐

SECTION B – VEGETATION

Use scientific names of plants.	Absolute % cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size:)			
1.			
2.			
3.			
4.			
Total cover =			
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
Total cover =			
Herb Stratum (Plot size: 2x2)			
1. Juncus effusus	~~20~~ 37		FACW
2. Holcus lanatus	15		FAC
3. Ranunculus repens	30		FAC
4. Trifolium repens	<5		FACU
5. Isolepis cernua	5		OBL
6. Lotus corniculatus	8		FACU
7.			
8.			
9.			
10.			
11.			
12.			
Total cover =	100		

Dominance Test:

No. Dominant Spp. OBL/FACW/FAC (A) 2

Tot. Dominant Spp. across strata (B) 2

% OBL/FACW/FAC (A/B) 52

Prevalence Index:

Total % cover of:		Multiply by:	
OBL	5	x 1 =	5
FACW	37	x 2 =	74
FAC	53	x 3 =	159
FACU	5	x 4 =	20
UPL		x 5 =	
Total	100 (A)		258 (B)

Prevalence Index (B/A) = 2.25

Hydrophytic vegetation indicators:

- ☑ Dominance Test is >50%
- ☑ Prevalence Index is ≤3.0[1]
- ☐ Morphological adaptations[1] (supporting data in Remarks)
- ☐ Problematic hydrophytic vegetation[1]

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic vegetation present?

YES ☑ NO ☐ UNCERTAIN ☐

Remarks:

SECTION C – SOIL AND HYDROLOGY

Profile description: (Describe to the depth needed to confirm indicator presence/absence, 30 cm default)

Depth (cm)	Matrix colour (moist)	Mottles colour (moist)	Mottles %[1]	Mottles Size[2]	Mottle location[3]	Material[4]	Remarks
1-28	10YR 3/2	10YR 3/6	5	fine	matrix	mineral	Saturated
28-43	10YR 6/2	10YR 6/8	50	fine	matrix	mineral	sticky
43-56	10YR 6/2	10YR 6/6	10	fine	matrix	mineral	sandy

[1]Use % area charts; [2]Use size classes; [3]Ped face, pore, within ped along roots, within matrix; [4]Organic (peaty), humic, mineral soil

Hydric soil indicators:

Soil drainage (circle) W MW I (P) VP

Organic layers:
- ☐ Organic soil material
- ☐ Litter
- ☐ Fibric
- ☐ Mesic
- ☐ Humic
- ☐ Peaty topsoil
- ☐ Peaty subsoil

Concretions:
- ☐ Iron concretions
- ☐ Manganese concretions
- ☐ Nodular

Consistence:
- ☐ Plastic
- ☑ Sticky
- ☐ Fluid

Colours: profile form either:
- ☐ Gley OR
- ☑ Mottled

Horizon:
- ☑ Reductimorphic
- ☑ Redox mottled
- ☐ Redox segregations
- ☐ Perch-gley features

Cause of wetness (circle appropriate):

Location: Depression Flat Valley Gully (Slope)

Water table: Depth (cm) Saturated

(High GW) Perched Seepage Tidal Lithic

Pans: Depth (cm) _____

Pan Humus Fe-pan Densi- Duri- Fragi Ortstein

Layers: Depth (cm) _____

Slow perm argillic

☐ Pugged

Hydric soils present? YES ☑ NO ☐ UNCERTAIN ☐ NZSC subgroup S O G S

Primary hydrology indicators: minimum of 1 required; check all boxes that apply

- ☑ Surface water (1A)
- ☑ Groundwater <30 cm (1B)
- ☑ Soil saturation <30 cm (1C)
- ☐ Water marks (2A)
- ☐ Sediment deposits (2B)
- ☐ Drift deposits (2C)
- ☐ Algal mat/crust (2D)
- ☐ Iron deposits (2E)
- ☐ Surface soil cracks (2F)
- ☐ Inundation on aerial imagery (2G)
- ☐ Sparsely vegetated concave surface (2H)
- ☐ Salt crust (2I)
- ☐ Aquatic invertebrates (2J)
- ☐ Hydrogen sulphide odour (3A)
- ☐ Oxidised rhizosphere on roots (3B)
- ☐ Reduced iron (3C)
- ☐ Reduced iron in tilled soil (3D)
- ☐ High water table stunted/stressed plants (4A)

Secondary hydrology indicators: minimum of 2 required; check all boxes that apply

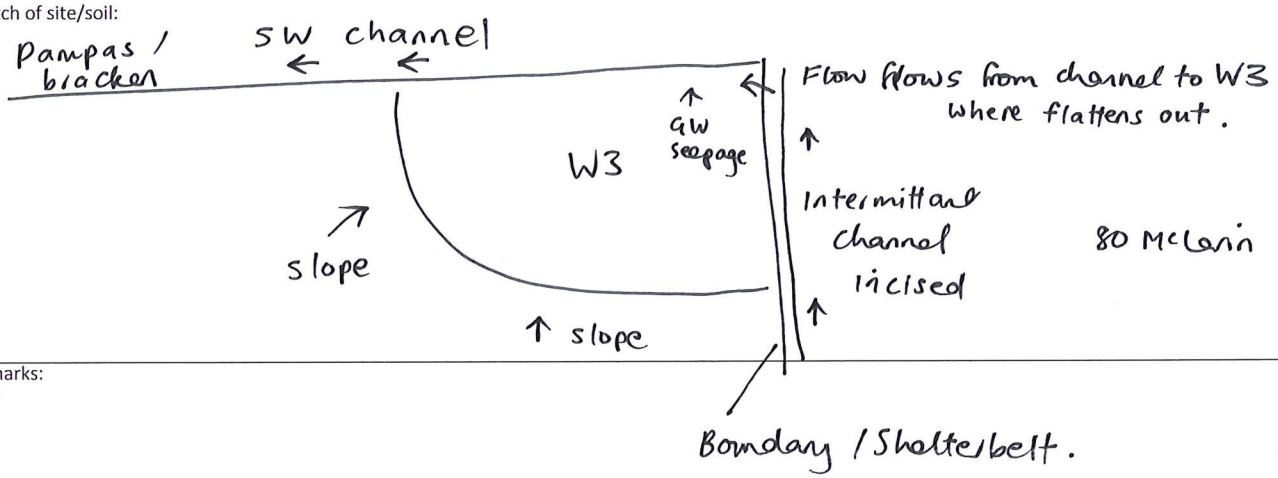
- ☐ Water-stained leaves (2K)
- ☐ Drainage patterns (2L)
- ☐ Dry-season water table (3E)
- ☐ Saturation in aerial imagery (3F)
- ☑ Geomorphic position (4B)
- ☐ Shallow aquitard (4C)
- ☐ FAC-neutral test (4D)
- ☐ Frost-heave hummocks (4E)

FAC-neutral test (4D); refer to Section B: Vegetation

1. No. OBL & FACW dominant species _____(A)
2. No. FACU & UPL dominant species _____(B)
3. Total _____(A+B)
4. FAC-neutral (>50%) _____(A/A+B)*100

Wetland hydrology present? YES ☑ NO ☐

Sketch of site/soil:



Remarks:

Wetland #: 3 **Date:** 20211022

3. From perimeter walk

Edge condition index		
Indicator[1]	**Comment**	**Score (0-5)**
Shape index [2]	m:ha 1.5	3
Stock access	yes. No fencing.	0
Weed density	Moderately weedy, most of the weeds also in the wetland.	2
Canopy dieback	No dieback	5
Perimeter buffer	No buffer.	0
Perimeter drains	yes. Not directly connected. Abuts the stormwater pond.	3
Total (max 30)		13 / 30
Proportion viewed	Est. length (m) assessed and % total length 125m	100 %

[1] Assign degree of modification as follows:
5=v. low/ none **4**=low **3**=medium **2**=high **1**=v. high **0**=extreme

[2] Assign shape index scores as follows:
5 = <1.2 **4** = 1.2-1.3 **3** = 1.3-1.5 **2** = 1.5-2 **1** = 2-3 **0**=>3

4. From all data (catchment scale indicators)

Wetland pressure index (note for this indicator a High score is bad)		
Pressure	**Specify and Comment**	**Score**[3]
Modifications to catchment hydrology	Largely include pasture although increased urban development.	3
Water quality decline in catchment	Increased road run-off and stock in immediate catchment.	2
Animal pest presence (excl. stock)	No evidence of any pest control	3
Key undesirable plant species in catchment	moderate amount Exotic grasses, gorse, pampas, lilly	3
% catchment in introduced vegetation	2/3 of immed catchment in farmland with introduced vegetation	4
Wetland isolation	More confirmed wetlands just upstream.	0
Total pressure index (max 30)		15 /30

[3]Assign pressure scores as follows: 5=extreme, 4=very high, 3=high, 2=moderate, 1 = low 0=none /v. low

Wetland #: 3 **Date:** 2021/10/22

5. From all data

Wetland condition index				
Indicator	**Indicator components**	**Specify and Comment**	**Score 0– 5***	**Mean score**
Change in hydrological integrity	Impact of manmade structures	Adjacent drains/stormwater pond must have some effect	2	3.3
	Water table depth	High when surveyed.	4	
	Dry-land plant invasion	Some exotic species (herbaceous) incl. shelterbelt (woody)	4	
Change in physico-chemical parameters	Fire damage	None	5	4
	Degree of sedimentation/erosion	Development in catchment and modifications from dairy farming would have released sods - Paggley	4	
	Nutrient levels	Not measured. Relative nutrient level suspected.	3	
	Von Post index	N/A	–	
Change in ecosystem intactness	Loss in area of original wetland	Some loss due to historic (stock) hydrological changes including trampling	3	4
	Recent vegetation damage/clearance	None	5	
	Hydrological connectivity barriers	No downstream barriers observed.	4	
Change in browsing, predation & harvesting regimes	Damage by domestic or feral ungulate animals	Medium browsing/trampling damage evident.	3	3.6
	Introduced predator impacts on wildlife	Rodents, cats suspected.	3	
	Harvesting levels	None	5	
Change in dominance of native plants	Introduced plant canopy cover	Shelterbelt	4	4
	Introduced plant understorey cover	Lots of herbaceous exotics.	4	
Total wetland condition index (max 25)				18.9 /25

* Assign degree of modification as follows (if answer is 'don't know' calculate average excluding that indicator component): 5=v. low/ none, 4=low, 3=medium, 2=high, 1=v. high, 0=extreme