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PLANNING GUIDANCE
15 June 2018

**Adare Stage 2A
Peacocke Farm
Hamilton**

**PRELIMINARY
FRESHWATER
ECOLOGICAL RESOURCE
ASSESSMENT**

**Report prepared by
Argo Environmental Ltd**

argoenvironmental
ENVIRONMENTAL CONSULTANTS

TABLE OF CONTENTS

1. INTRODUCTION	1
1.1 BACKGROUND	1
1.2 THIS REPORT	2
2. METHODOLOGY	3
2.1 INTRODUCTION	3
2.2 WATERCOURSE STATUS	3
2.3 GENERAL HABITAT CHARACTERISTICS	4
2.4 MACROINVERTEBRATE COMMUNITIES	4
2.5 FISH FAUNA	5
2.6 WATER QUALITY	5
3. RESULTS	6
3.1 STREAM CLASSIFICATION	6
3.2 AQUATIC HABITAT	6
3.2.1 WATERCOURSE S5	6
3.2.2 WATERCOURSE S7B	6
3.2.3 WATERCOURSE S11	9
3.2.4 OTHER WATERCOURSES	12
3.3 MACROINVERTEBRATES	13
3.4 FISH FAUNA	15
3.5 WATER QUALITY	17
4. SUMMARY	19
5. REFERENCES	20
APPENDICES	21
APPENDIX A HABITAT ASSESSMENT SHEET	
APPENDIX B MACROINVERTEBRATE DATA	
APPENDIX C LABORATORY REPORT	

1. Introduction

1.1 Background

A residential land development (Adare Stage 2A) is proposed for Peacocke Farm, Tamahere, Hamilton (see Figure 1.1). The site itself is located on River terraces directly adjacent to the true left bank of the Waikato River.

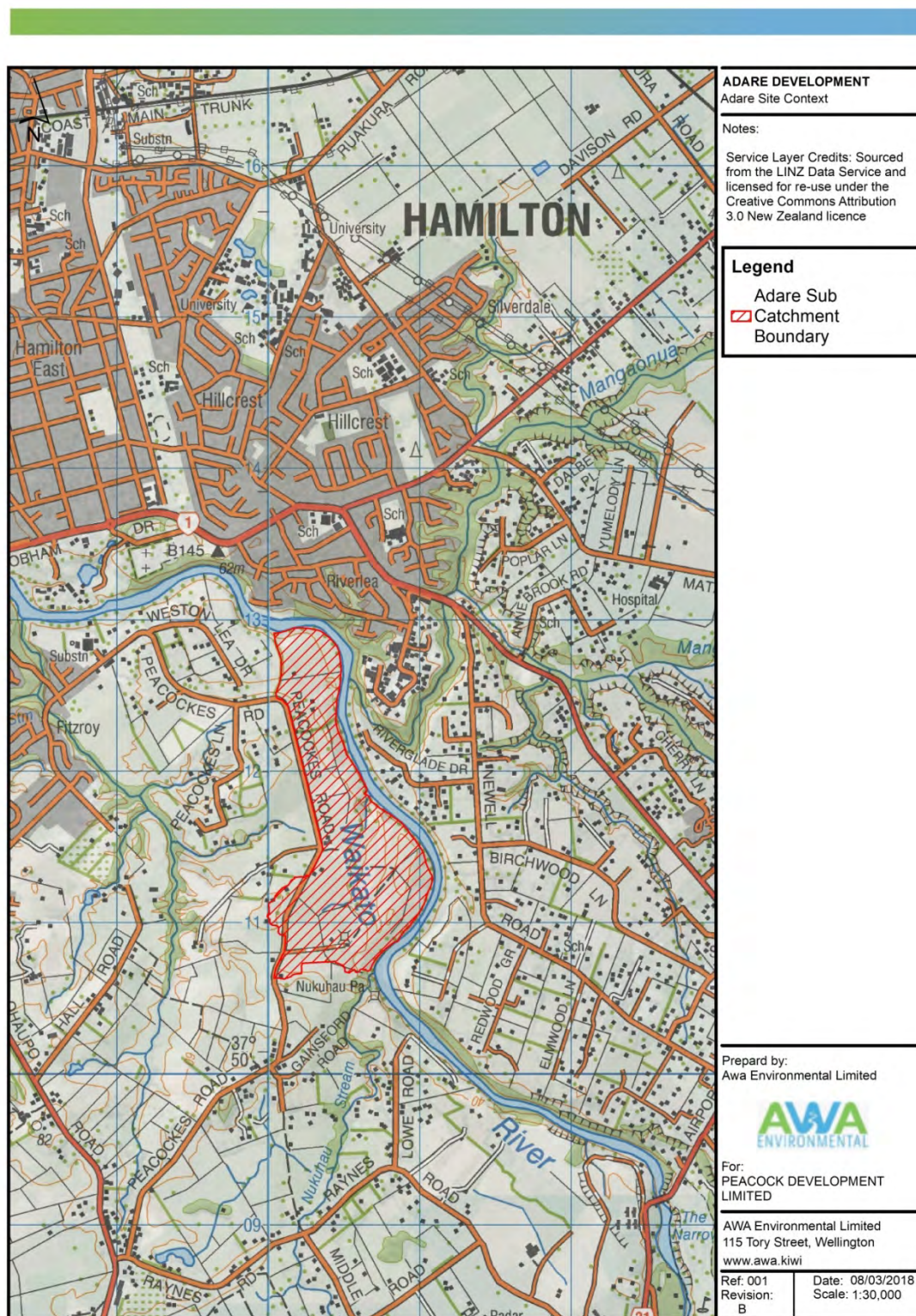


Figure 1.1: Approximate location of the Adare Stage 2A Farm site and sub-catchment boundary

Despite its proximity to Hamilton, the site is rural in character and currently an operational dairy farm. All the vegetation within the site is largely modified, comprising pasture grass, exotic trees/shrubs and occasional native plants. Riparian vegetation lies adjacent to the site along the Waikato River. In general, the watercourses on the site have been created to assist with draining the wetter areas.

1.2 This Report

This report presents the results of a preliminary assessment of the freshwater ecological resources present on the site to inform the preparation of the integrated sub-catchment management plan and application and assessment of environmental effects for a subdivision of approximately 1000 lots.

2. Methodology

2.1 Introduction

This section of the report describes the methodology used to determine the status of the watercourses present on the site and the freshwater ecological resources present.

2.2 Watercourse Status

The Waikato Regional Plan defines ephemeral streams as *“streams that flow continuously for at least three months between March and September but do not flow all year.”* A Farm drainage canal is defined as *“an artificial watercourse on a farm that contains no natural portions from its confluence with a river or stream to its headwaters, and includes a farm drain or a farm canal.”*

A more detailed definition can also be found in the Auckland Unitary Plan Operative (AUPOP) where a River or stream is defined as *“a continually or intermittently flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal (except where it is a modified element of a natural drainage system))”*.

Further, a watercourse can also be defined as follows:

- 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 process, including scour and deposition.
- Ephemeral stream - Stream reaches with a bed above the water table at all times, with water only flowing during and 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.
- Artificial watercourse - Constructed watercourses that contain no natural portions from their confluence with a river or stream to their headwaters including: canals that supply water to electricity power generation plants; farm drainage canals; irrigation canals; and water supply races. Excludes: naturally occurring watercourse.

To assist with determining ecological significance of the watercourses on the site this, more detailed definition, has been adopted.

The Peacocke Farm site was visited on 8, 9th and 20th November 2017 and 15th February 2018 to determine the status of the watercourses according to the above definition. An additional site visit was made on 19th February with WRC to get agreement on the approach taken and the definitions used.

2.3 General Habitat Characteristics

A range of aquatic and riparian habitat characteristics were assessed along watercourses within the site including: channel width and water depth; streambed substrate composition; organic matter (leaf litter and woody debris); aquatic flora (periphyton and aquatic plants); riparian habitat characteristics and shade; and erosion and channel modification. Appendix A presents a copy of the habitat assessment field sheet.

2.4 Macroinvertebrate Communities

The assessment of macroinvertebrates is based on samples collected from key watercourses draining the site. Samples were collected using a kick-net (mesh 0.5 mm) following protocols outlined in Stark *et al.* (2001), preserved in 70% ethanol and processed by a taxonomist using Protocol C1 (presence/absence). The following indices were calculated:

- **Species number.** This is a measure of the types of invertebrate taxa present in each sample. As a rule-of-thumb, the more species present the better the quality of the environment.
- **Macroinvertebrate Community Index (MCI) (Stark & Maxted, 2004).** The MCI is a measure of waterway eutrophication. Although the MCI was developed for streams in the Auckland region of New Zealand, it allows useful comparisons in this case. Taxa are allocated sensitivity scores between 1 and 10 based on their tolerance to pollution. MCI scores can be used to describe the 'health' of a stream by averaging the assigned scores for presence/absence of taxa. Table 2.1 shows the range of MCI and estimated levels of enrichment. The scores are calculated as:

$$MCI = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

where S is the total number of taxa in a sample and a_i is the score for the i -th taxa.

- **% EPT.** This is the percentage of three generally pollution-sensitive orders of insects recorded in a sample (ephemeroptera (mayflies); plecoptera (stoneflies); and trichoptera (caddisflies)).

Raw data is presented in Appendix B.

Table 2.1: Estimates of eutrophication using MCI scores.

Water Quality	MCI
Clean Water	> 120
Doubtful quality or possible mild enrichment	100 - 120
Probable moderate enrichment	80 - 100
Probable severe enrichment	< 80

2.5 Fish Fauna

The assessment of fish is based on information collected during electric fishing survey using a 12 volt electro-fishing, and a Fyke and g minnow net survey on 8-9 November 2017 of key sites (Figure 2.1) where habitat was present. All fish were released after identification.

2.6 Water Quality

Field measurements were collected at four sites (S7, S9, S11 and the Waikato River (below S7) using an Aqua DO2 (dissolved oxygen, temperature) and TPS WP-81 (pH, conductivity) water quality meters. Table 2.2 presents the GPS co-ordinates for these sites. Laboratory analysis was undertaken for a range of parameters including total suspended solids, turbidity, total nitrogen, nitrate, nitrite, total kjeldahl nitrogen, ammoniacal nitrogen, total phosphorus and dissolved reactive phosphorus.

Water samples were collected midstream where possible. All water samples were retained in ice in a chilli bin and delivered to Watercare laboratory, Auckland, New Zealand, within the required timeframes and using standard analytical procedures.

Table 2.2: Water quality sampling sites GPS co-ordinates

Description	GPS Co-ordinates
S7	S37°48'56.1" E175°19'25.3"
S9	S37°49'38.7" E175°19'33.9"
S11	S37°49'04.7" E175°19'30.5"
Waikato River	S37°48'55.5" E175°19'24.4"

3. Results

3.1 Stream Classification

Figure 3.1 shows the location of the watercourses identified during site visits. The status of the various reaches within the key watercourses on the site with an overlay of the proposed development are shown in Figure 3.2.

There was 16 and 34 mm respectively of rainfall two days prior to 8 & 9 November 2017 and 15 February 2018 surveys respectively (based on the WRCs Te Awamutu monitoring station). Stream classifications were therefore carried out during wet conditions.

3.2 Aquatic Habitat

3.2.1 Watercourse S5

Although Watercourse S5 (a 1st order stream) originates from a seep it meets the intermittent stream criteria (including has sufficient flow) (see Section 2.2). The seep, which breaks out in two locations to the east of the farmhouse and main race, is initially boggy with a poorly defined channel. The substrate is mud and silt providing poor quality habitat for macroinvertebrates.

Further downstream the channel is better defined (ranging from 0.4 to 1.3m) (Plate 1). The watercourse is approximately 75m long. The substrate in the lower section provides better quality habitat for macroinvertebrates with a greater proportion of gravel material. The end of the watercourse, located in the riparian vegetation, is perched with a 5m drop to the River below which severely restricts upstream fish migration.

The proposed development footprint will extend across the upper reaches of this watercourse requiring reclamation of a section of the upper reach (see Figure 3.3).



Plate 1: Watercourse 5 channel (left and middle) and perched outfall to the River (right).

3.2.2 Watercourse S7b

Watercourse S7b has two branches: the 'western' branch originates east of Peacockes Road; and the 'northern' branch in the paddock south of several farmhouses where they are ephemeral in nature. The 'western' branch (a 1st order stream) is ephemeral for approximately 115m up to the point where it meets a small intersecting drain on account of the rooted terrestrial vegetation (i.e., grass) present across the entire channel width. The streambed substrate is silt and weathered clay providing unstable benthic habitat for invertebrates. Plate 2 provides images of Watercourse S7b.

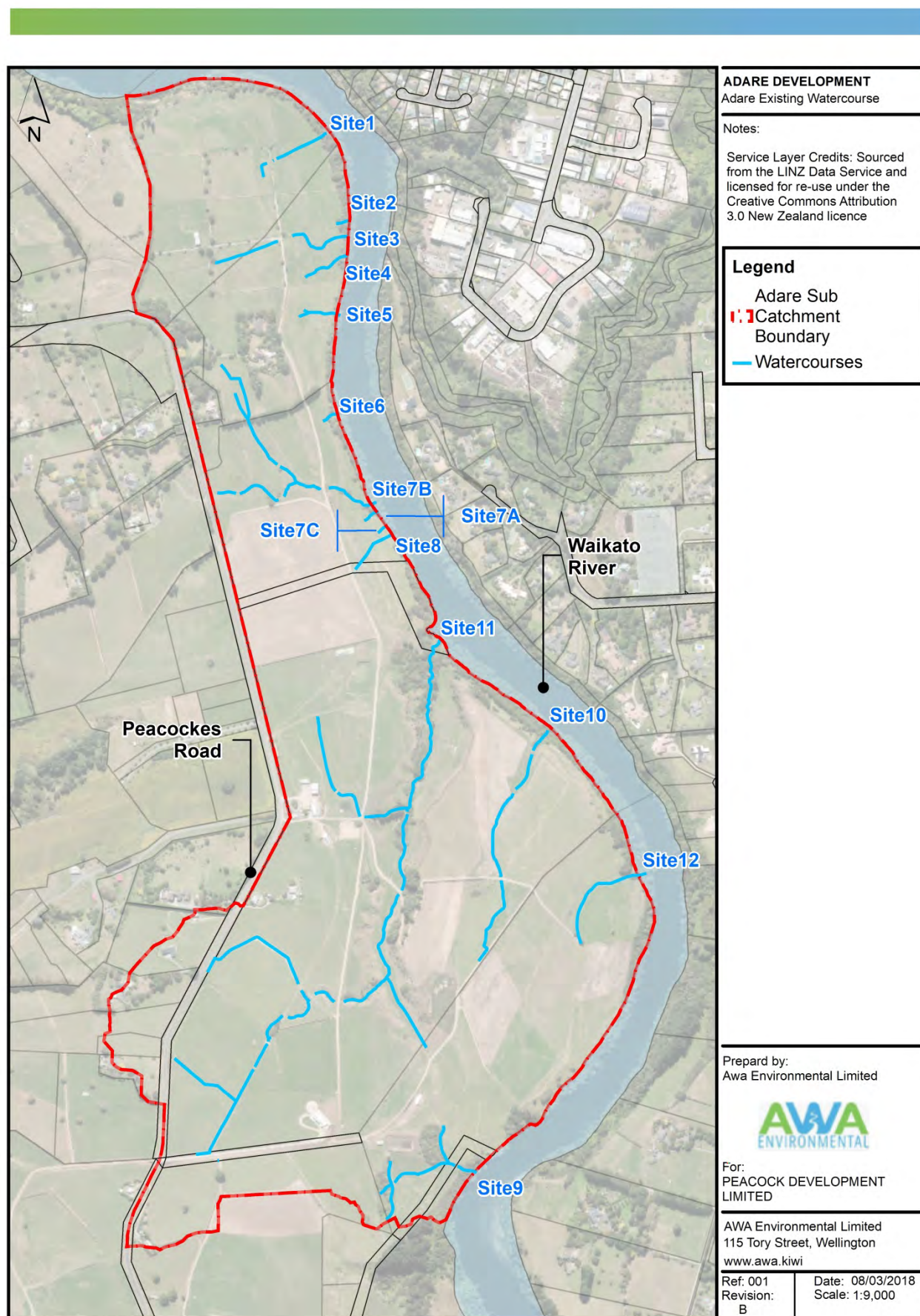


Figure 3.1: Drainage plan showing location of watercourses on the Peacocke Farm site



Plate 2: Watercourse S7B ‘western’ branch ephemeral (upper left) and intermittent channel (upper middle & right); northern branch ephemeral (middle left & middle) and fenced farm drain (middle right); and lower permanent reach (bottom left) and substrate (bottom right).

Beyond this point the watercourse becomes intermittent with a well-defined channel (0.5-0.7m wide) for approximately 80m until it meets the permanent reach of Watercourse 7. A farm crossing is present across the intermittent watercourse the downstream portion of which is fenced and has different stream characteristics (i.e., riparian vegetation spread across and poorly defined channel).

On the ‘northern branch’, beyond the two ephemeral drains that originate in the paddock south of several farmhouses (approximately 113m and 132 m respectively), a 105m fenced farm drain extends downstream to a large farm crossing with culvert. Downstream of this

crossing the mid-reaches of this watercourse are permanent with stream widths ranging from 0.4-0.6m. The streambed substrate is silt and weathered clay providing unstable benthic habitat for invertebrates up until the main race crossing and culvert.

The permanent stream is more incised as it drops down to the Waikato River and for the last 50m, has permanent riparian cover. The substrate at this point provides better quality benthic habitat for invertebrates with an increase in particle size and woody debris, shallow runs and pools and a small waterfall (approximately 5m).

The proposed development footprint will extend across the upper reaches of this watercourse requiring reclamation of approximately 362m of ephemeral watercourse; 110m of farm drain; 29 m of intermittent watercourse (including the farm crossings) and 15 m of permanent stream (see Figure 3.3).

3.2.3 Watercourse S11

Watercourse S11 originates from three areas drained by farm drains in paddocks adjacent to Peacockes Road (totalling 782m in length) (see Plate 3). Beyond the 'north western' and 'south eastern' farm drains are two 1st order intermittent watercourses (approximately 67 & 23 m in length respectively), accessible by stock, which contain mud and silt which provides poor quality habitat for macroinvertebrates.

These two 1st order watercourses join prior to a large crossing and culvert to create a more incised and fenced 2nd order intermittent stream for approximately 54 m up to the main race crossing and culvert. Although a deeply incised channel in parts, a better quality macroinvertebrate habitat (gravels, etc) is present in this section of stream.

Beyond the crossing, the stream drops off the old River terrace into the gully where it meets the 'southern' intermittent watercourse (96m in length) and a pond (approximately 110m further downstream) created by a raised farm crossing and elevated culvert. The watercourse at this point contains mud and silt providing poor quality habitat for macroinvertebrates.

Beyond the pond the lower reaches of Watercourse 11 consists of 512m of permanent watercourse with riparian vegetation and better quality benthic habitat for invertebrates with an increase in particle size and woody debris, shallow runs and pools.

A third farm drain (the 'western branch') is located behind a perched culvert which discharges into an ephemeral watercourse (approximately 170m long) and into the permanent watercourse in the gully (see Plate 4).

The proposed development footprint will extend across the upper reaches of Watercourse 11 requiring reclamation of approximately 962m of farm drain (and crossings); and 91 and 62 m of 1st and 2nd order intermittent watercourse (and farm crossings) (see Figure 3.3).



Plate 3: Watercourse S11 'south eastern' branch (upper left & middle) and north western branch (top right) farm drains; and intermittent channel 1st order (middle) and 2nd order (bottom) channels.



Plate 4: Watercourse S11 'southern' branch intermittent/ephemeral channel (upper & middle left); intermittent pond (middle right); and permanent watercourse downstream of pond (bottom left) and prior to discharge to the Waikato River (bottom right).

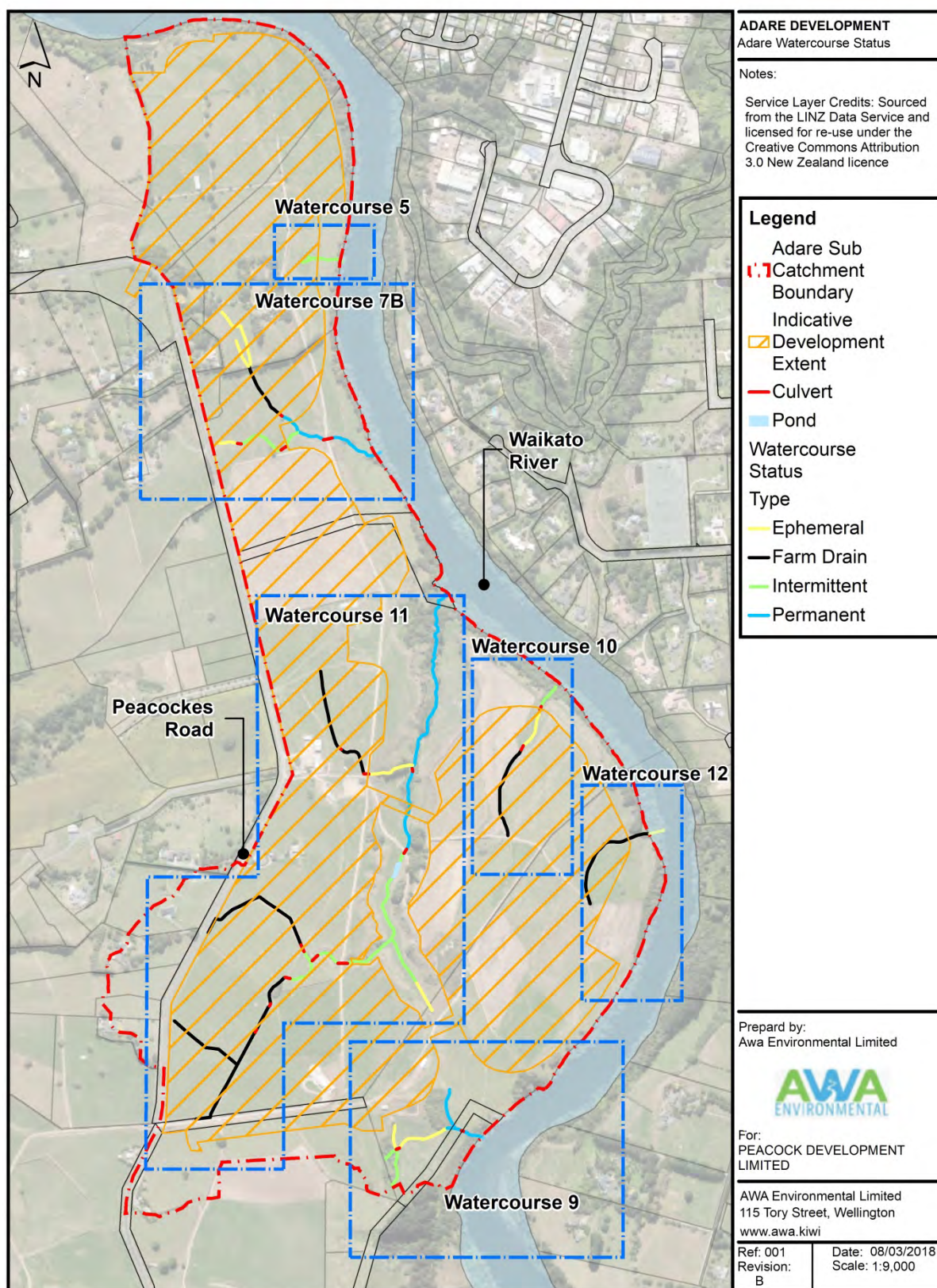


Figure 3.2: Proposed development overlay with key watercourses on site.

3.2.4 Other Watercourses

Several other watercourses, potentially affected by the development footprint, are present on the site (see Figure 3.3). These are as described below.

Watercourse S9

Watercourse S9 consists of ephemeral (166 m), intermittent (100 m) and permanent (135 m) reaches. The proposed development footprint does not require reclamation of any of the watercourse at S9.

Watercourse S10

Watercourse S10 consists of farm drain (375m), ephemeral watercourse (80 m) and intermittent (62m) watercourse located within the riparian vegetation adjacent to the Waikato River (see Plate 5).

The proposed development footprint will require reclamation of the farm drain (and crossings) and the ephemeral watercourse. The intermittent reach will be unaffected by reclamation.

Watercourse S12

Watercourse S12 consists of farm drain (186m) and ephemeral watercourse (39m) located within the riparian vegetation adjacent to the Waikato River. The proposed development footprint will require reclamation of the farm drain. The ephemeral reach will be unaffected by reclamation.



Plate 5: Watercourse S10 farm drain (upper left); ephemeral (upper middle) and intermittent (upper right) reaches and Watercourse S12 farm drain (lower left & middle); and ephemeral reach (lower right).

3.3 Macroinvertebrates

Table 3.1 a summary of macroinvertebrate data showing key metrics for key watercourses (Sites S5, S7 and S11) on site. The key points to note are:

- Taxa richness is low - moderate ranging from 8 (S5) to 25 (S11 (intermittent) 2°).
- Taxa are dominated by water quality and habitat tolerant dipterans (Figure 3.3).

- The proportion of water and habitat sensitive EPT (mayflies, stoneflies, caddisflies) taxa is low with EPT taxa most prevalent in the 2° intermittent and permanent reaches of S11 where better quality habitat is present.
- MCI-sb scores range from 71 (1° reach on S11) indicating 'probable severe organic enrichment' to 105 (2° reach on S11) indicating 'possible mild organic enrichment' (see Figure 3.4).
- Freshwater crayfish (kōura) were not recorded from any of the streams.

Table 3.1: Summary of macroinvertebrate data showing key metrics

Type	S5	S7B (inter)	S7B (perm)	S11 (inter) 1°	S11 (inter) 2°	S11 (perm)	S11 (inter) 1°
No of Taxa	8	17	14	14	25	23	15
MCI	92.8	80.9	81.4	76.3	104.6	87.8	71.3
% EPT	12.5	0	7.1	0	36	30.4	0

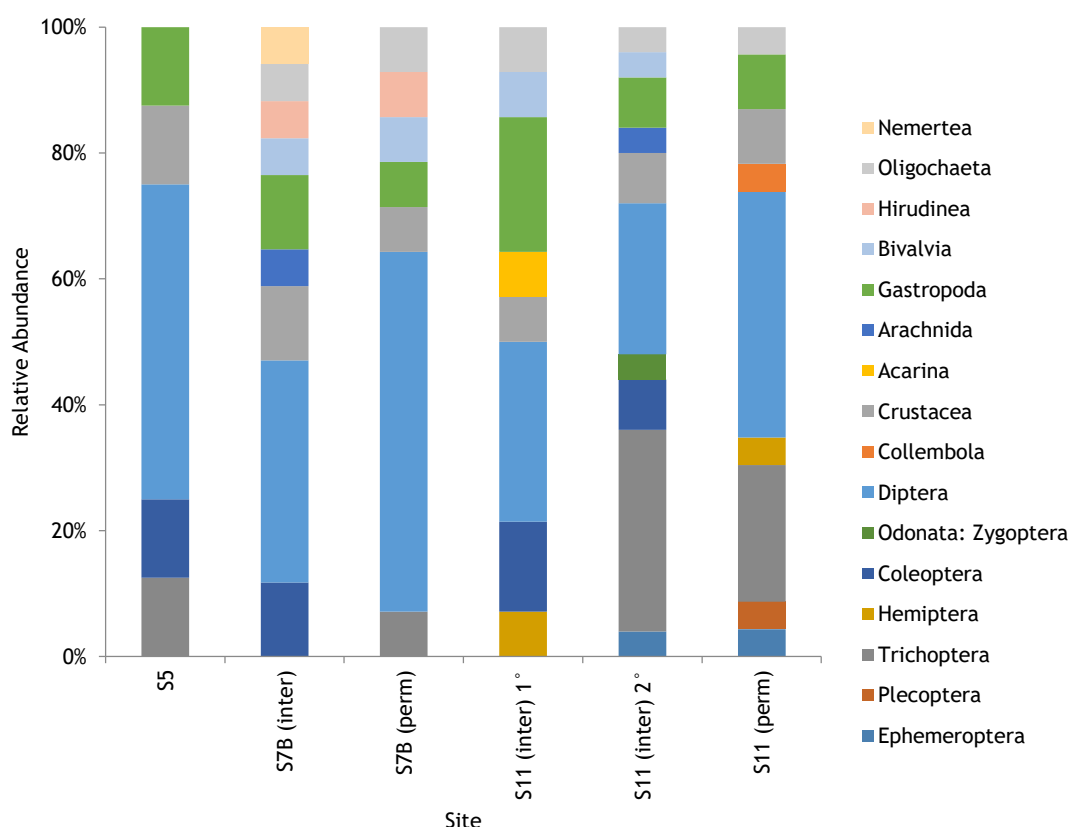


Figure 3.3: Relative taxonomic abundance

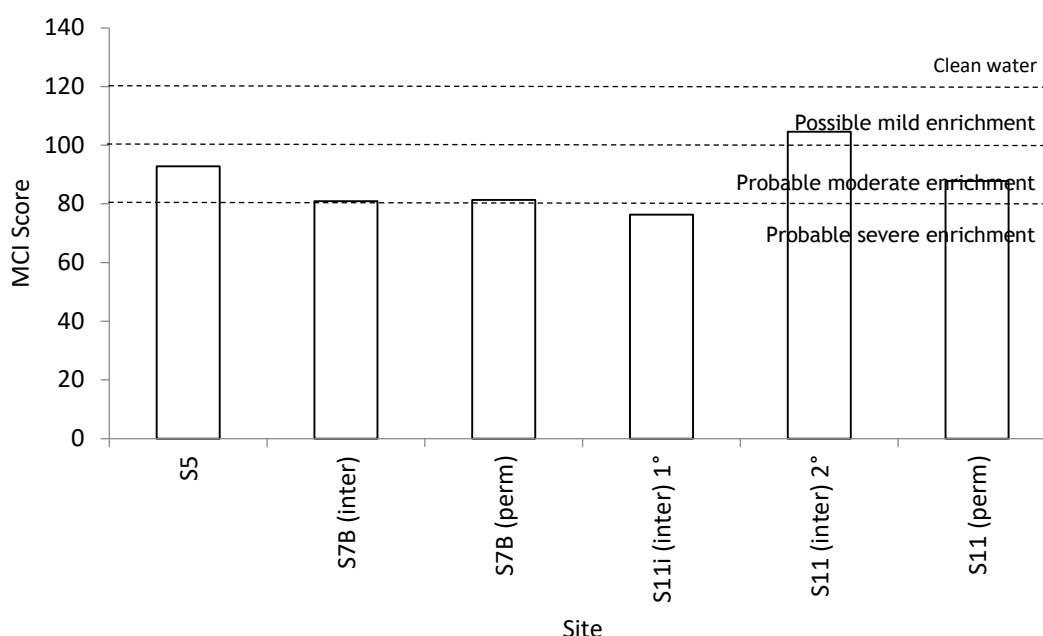


Figure 3.4: MCI scores

3.4 Fish fauna

The assessment of the presence of fish on the site is based on results from a recent survey and NZFFD records. Figure 3.5 identifies sites that were surveyed using nets (Fyke and g-minnows) and electric fishing of the key watercourses (S7, S9 and S11) and the Pond on S11 which had water at the time of the survey.

The only species identified in the site survey was short finned eel with a single individual being observed in the pool below the waterfall on Watercourse 7 and a single individual captured in a fyke net in the pond on Watercourse 11.

Figure 3.6 presents the New Zealand Freshwater Fish database records (NZFFD) located in close proximity to the site. There are 41 records of fish held in the NZFFD for five sites for surveys conducted between 1985 and 2007. Ten fish species (including freshwater mussel and koura) are listed in the NZFFD for the Waikato River and tributary sites including six native species (common smelt, longfin & shortfin eel, koaro, giant kokopu, banded kokopu, common bully, Inanga and grey mullet) and several of introduced species (rainbow trout, brown trout and Koi carp).

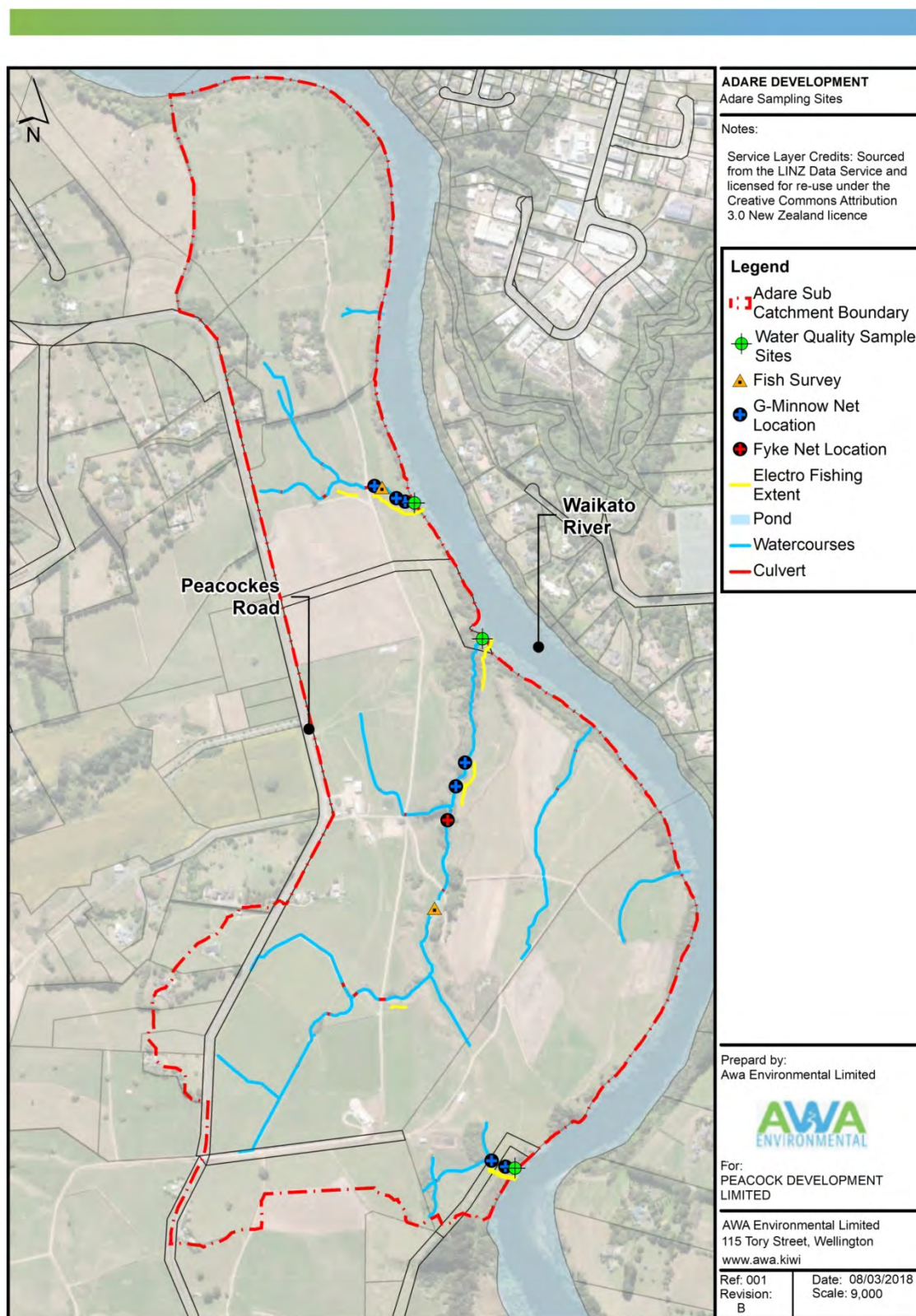


Figure 3.5: Sampling sites used during recent surveys of Peacocke Farm

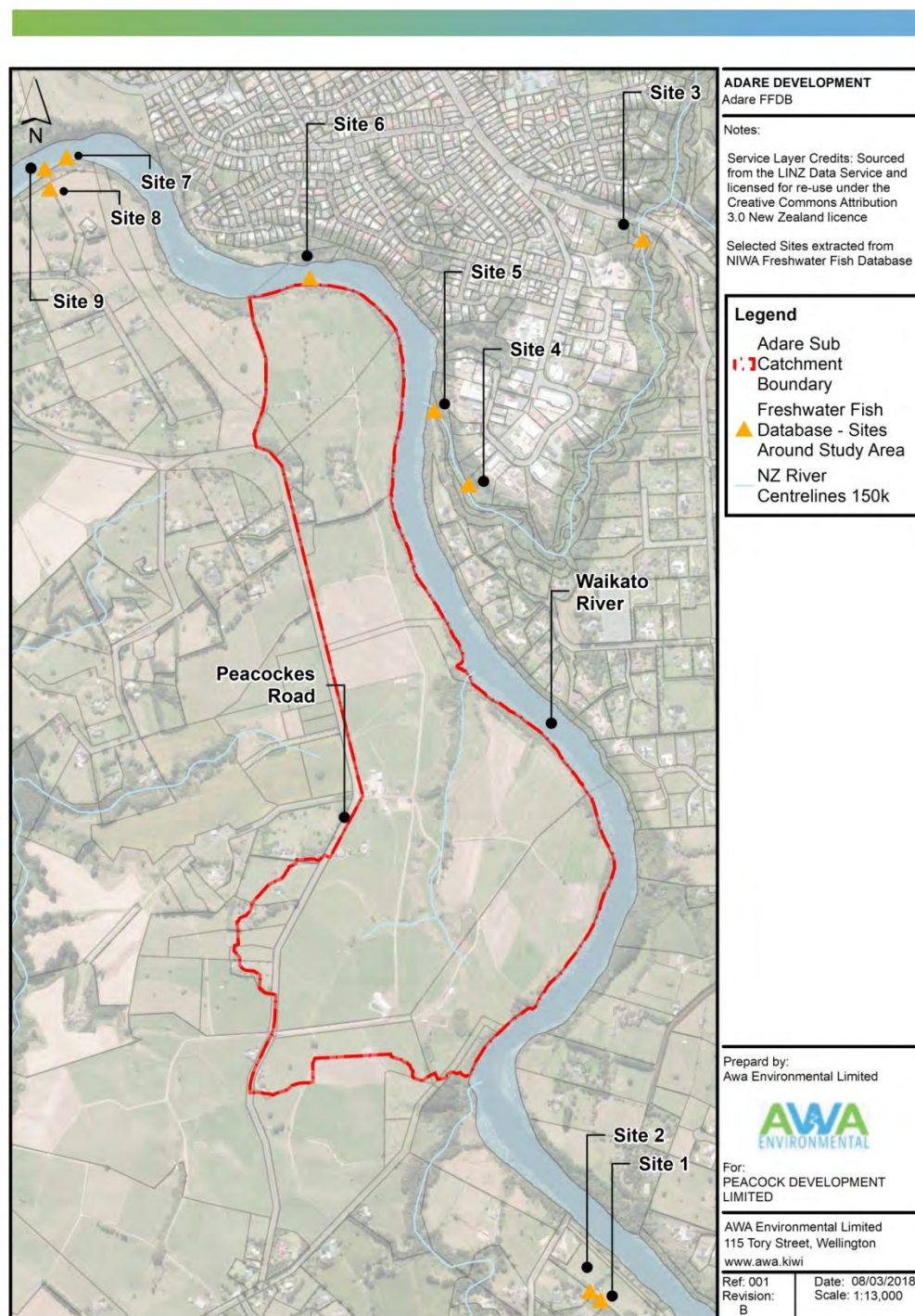


Figure 3.6: NZFFD sites located in close proximity to Peacocke Farm

Overall, it appears fish use of the key watercourses on site is limited. This is likely to be due to a combination of the perched nature at some of the discharge points of the watercourses to the River, the perched nature of the numerous culverts present and the limited upstream habitat available.

3.5 Water Quality

A comparison of water quality data collected from sites in the current survey with ANZECC (2000) trigger values for lowland Rivers (see Table 3.2). Appendix C presents the laboratory report.

Table 3.2: A comparison of water quality data for Peacocke Farm sites with accepted guidelines (all results g/m³ unless specified)

Parameter	Waikato River	Site			Guidelines ¹
		S7	S9	S11	
pH (pH units)	7.85	7.98	7.43	7.45	7.2 - 7.8
Temperature (°C)	11.2	13.2	16.3	15.1	-
Conductivity (µS/cm)	133.3	6.6	465	250	-
DO	10.1	10.3	9.3	10.1	-
DO (%)	103.4	98.3	94.8	100.3	98 - 105
Turbidity (NTU)	2.3	3.4	2.7	5.0	5.6
TSS	5.6	6.4	7.2	12.0	-
TN	0.53	2.2	8.4	5.3	0.614
Nitrate	0.36	1.7	8.5	4.9	0.7 ²
TON	0.37	1.7	8.5	4.9	0.444
Total Ammonia	0.02	0.011	0.022	0.022	0.9 ²
DRP	0.021	0.048	0.037	0.07	0.01
TP	0.048	0.082	0.05	0.1	0.033

Note: all results mg / L unless stated. ¹ANZECC (2000) default trigger values for slightly disturbed lowland Rivers in New Zealand. ²for protection of 95% of species in slightly-moderately disturbed systems.

The key points to note are as follows:

- pHs recorded at all sites are within or just outside the ANZECC (2000) default trigger value range of pH 7.2-7.8.
- Water temperatures ranging from 11.2-16.3 °C reflect the time of day the samples were collected and the flows in the watercourses. Conductivities at all sites range from 6.6 - 465 µS/cm.
- Dissolved oxygen saturations (94.8-103.4%) at all sites are within or just outside the ANZECC (2000) trigger range of 90-105%. Dissolved oxygen concentrations are high ranging from 9.3 -10.3 mg/L for all sites.
- Turbidities (5.6 - 12.0 NTU) at all sites are at or exceed the ANZECC (2000) default trigger value range of 5.6 NTU. TSS concentrations (2.4-5 g/m³) are low.
- Total nitrogen concentrations in the watercourses on the farm site (2.2 - 8.4 mg/L) exceed the ANZECC (2000) default trigger value range of 0.614 mg/L. The Waikato River sample concentration (0.53 mg/L) is below the trigger value.
- Nitrate concentrations in the watercourses on the farm site (1.7 - 8.5 mg/L) exceed the ANZECC (2000) default trigger value range of 0.7 mg/L. The Waikato River sample concentration (0.36 mg/L) is below the trigger value.
- Total oxidised nitrogen concentrations in the watercourses on the farm site (1.7 - 8.5 mg/L) exceed the ANZECC (2000) default trigger value range of 0.444 mg/L. The Waikato River sample concentration (0.37 mg/L) is below the trigger value.
- Total ammonia concentrations at all sites (0.11 - 0.22 mg/L) are below the ANZECC (2000) default trigger value range of 0.9 mg/L.
- Dissolved reactive phosphorus concentrations at all sites (0.021 - 0.07 mg/L) exceed the ANZECC (2000) default trigger value range of 0.01 mg/L.
- Total phosphorus concentrations at all sites (0.048-0.1 mg/L) exceed the ANZECC (2000) default trigger value range of 0.033 mg/L.

The results indicate that the watercourses on Peacocke Farm are typical of those that drain catchments dominated by pasture.

4. Summary

This report presents the results of a study of the freshwater ecological resources present on the Peacocke Farm site. The information presented in this report will be used to determine the effects of land development on the resources present.

In summary, the following key points can be made:

- An evaluation of the Peacocke farm site has determined that the site is dominated by seeps, farm drains and ephemeral watercourses that have little or no ecological merit.
- Three watercourses potential impacted by the proposed development have been classed as a combination of intermittent and permanent based on field investigations undertaken in November 2017 and February 2018.
- Macroinvertebrate taxa richness is low-moderate ranging with taxa dominated by water quality and habitat tolerant dipterans. MCI-sb scores indicate severe to mild organic enrichment.
- Overall, it appears use of the key watercourses on site by fish is limited. This is likely to be due to a combination of the perched nature at some of the discharge points of the watercourses to the River, the perched nature of the numerous culverts present preventing upstream movement of fish, and the limited habitat available.

5. References

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ). 2000. Australian and New Zealand Guidelines for Fresh and Marine Waters.

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Appendices

Received
PLANNING GUIDANCE
15 June 2018

Appendix A Habitat Assessment Sheet

Field Assessment Cover Form

Wadeable Hard-Bottomed and Soft-Bottomed Streams

STREAM NAME:		ASSESSOR:																									
SITE NUMBER:	SAMPLE NUMBER:	DATE:	TIME (NZST):																								
GPS COORDINATES: Downstream end of reach - Easting –		Northing –																									
Upstream end of reach - Easting –		Northing –																									
CHANNEL AND RIPARIAN FEATURES Canopy Cover: ☐ Open ☐ Partly shaded ☐ Significantly shaded Fencing: ☐ None or ineffective ☐ One side or partial ☐ Complete both sides Dominant Riparian Vegetation: ☐ Crops etc ☐ Pasture ☐ Exotic trees ☐ Retired vege. ☐ Native shrub ☐ Native trees		INSTREAM HYDRAULIC CONDITIONS Estimated or measured reach average: Stream width (active channel) _____ m Stream width (water) _____ m Stream depth _____ m Surface velocity _____ m/sec																									
WATER QUALITY Temperature: _____ °C Conductivity: _____ µS/cm @ 25°C Dissolved Oxygen: _____ % _____ mg/L Turbidity: ☐ Clear ☐ Slightly turbid ☐ Highly turbid ☐ Stained ☐ Other _____																											
STREAM-BOTTOM SUBSTRATA Compaction (inorganic substrata): ☐ assorted sizes tightly packed &/or overlapping ☐ moderately packed with some overlap ☐ mostly a loose assortment with little overlap ☐ no packing / loose assortment easily moved. Embeddedness: (% gravel-boulder particles covered by fine sediment) ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% ORGANIC MATERIAL (% cover) Large wood (>10 cm diameter): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Coarse Detritus (small wood, sticks, leaves etc >1 mm): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Fine (<1 mm) Organic Deposits (edges and backwaters): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75%																											
		% surficial inorganic substratum size composition (should sum to 100%)																									
		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Substratum type</th> <th>Dimension (middle axis)</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Bedrock</td> <td>-</td> <td></td> </tr> <tr> <td>Boulder</td> <td>> 256mm</td> <td></td> </tr> <tr> <td>Cobble</td> <td>>64-256mm</td> <td></td> </tr> <tr> <td>Gravel</td> <td>>2-64mm</td> <td></td> </tr> <tr> <td>Sand</td> <td>>0.06-2mm</td> <td></td> </tr> <tr> <td>Silt</td> <td>0.004-0.06mm</td> <td></td> </tr> <tr> <td>Clay</td> <td><0.004mm</td> <td></td> </tr> </tbody> </table>		Substratum type	Dimension (middle axis)	Percentage	Bedrock	-		Boulder	> 256mm		Cobble	>64-256mm		Gravel	>2-64mm		Sand	>0.06-2mm		Silt	0.004-0.06mm		Clay	<0.004mm	
Substratum type	Dimension (middle axis)	Percentage																									
Bedrock	-																										
Boulder	> 256mm																										
Cobble	>64-256mm																										
Gravel	>2-64mm																										
Sand	>0.06-2mm																										
Silt	0.004-0.06mm																										
Clay	<0.004mm																										
INSTREAM PLANT COVER (% of streambed area) Filamentous Algae (>2mm long) & Mats (>3 mm thick): ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Macrophytes: ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75% Mosses/Liverworts: ☐ <5% ☐ 5-25% ☐ 26-50% ☐ 51-75% ☐ >75%		HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%) <table style="width: 100%;"> <tr> <td>Stones: _____ %</td> <td>Riffles: _____ %</td> </tr> <tr> <td>Wood: _____ %</td> <td>Runs: _____ %</td> </tr> <tr> <td>Macrophytes: _____ %</td> <td></td> </tr> <tr> <td>Edges: _____ %</td> <td></td> </tr> </table>		Stones: _____ %	Riffles: _____ %	Wood: _____ %	Runs: _____ %	Macrophytes: _____ %		Edges: _____ %																	
Stones: _____ %	Riffles: _____ %																										
Wood: _____ %	Runs: _____ %																										
Macrophytes: _____ %																											
Edges: _____ %																											
COMMENTS 		NO. INVERTEBRATES RETURNED: Koura: _____ Shrimps: _____ Crabs: _____ Mussels: _____ Others (specify) _____ Species of mussel (tick) <table style="width: 100%;"> <tr> <td style="text-align: center;"><i>Hyridella</i></td> <td style="text-align: center;"><i>Cucumerunio</i></td> </tr> <tr> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> <tr> <td style="text-align: center;"> Shell smooth; up to 100mm long; variable shell shape </td> <td style="text-align: center;"> Nodules and ridges on upper part of shell; up to 90mm long </td> </tr> </table>		<i>Hyridella</i>	<i>Cucumerunio</i>			Shell smooth; up to 100mm long; variable shell shape	Nodules and ridges on upper part of shell; up to 90mm long																		
<i>Hyridella</i>	<i>Cucumerunio</i>																										
																											
Shell smooth; up to 100mm long; variable shell shape	Nodules and ridges on upper part of shell; up to 90mm long																										

Wadeable Soft-Bottomed Streams

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:					SITE NUMBER:															
SAMPLE NUMBER:					ASSESSOR:					DATE:										
Habitat Parameter	Category																			
	Optimal					Suboptimal					Marginal					Poor				
1. Riparian Vegetative Zone Width (score each bank; determine left or right side by facing downstream)	- Bankside vegetation buffer is >10m - Continuous and dense					- Bankside vegetation buffer is <10m - Mostly continuous					- Pathways present and/or stock access to stream - Mostly healed over					- Breaks frequent - Human activity obvious				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
2. Vegetative Protection (score each bank; determine left or right side by facing downstream)	- Bank surfaces and immediate riparian zones covered by native vegetation - Trees, understorey shrubs, or non-woody plants present - Vegetative disruption minimal					- Bank surfaces covered mainly by native vegetation - Disruption evident - Banks may be covered by exotic forestry					- Bank surfaces covered by a mixture of grasses/shrubs, blackberry, willow and introduced trees - Vegetation disruption obvious - Bare soil/closely cropped vegetation common					- Bank surfaces covered by grasses and shrubs - Disruption of streambank vegetation very high - Grass heavily grazed - Significant stock damage to the bank				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
3. Bank Stability (score each bank; determine left of right side by facing downstream)	- Banks stable - Erosion/bank failure absent or minimal <5% of bank affected					- Moderately stable - Infrequent, small areas of erosion mostly healed over 5-30% of bank eroded					- Moderately unstable 30-60% of bank in reach has areas of erosion - High erosion potential during floods					- Unstable - Many eroded areas 60-100% of bank has erosional scars				
Left bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Right bank	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Mean LB&RB _____																				
4. Channel sinuosity	Bends increase stream length 3-4 times longer than if it was in a straight line					Bends increase the stream length 2-3 times longer than if it was in a straight line					Bends increase the stream length 1-2 times longer than if it was in a straight line					Channel straight				
SCORE _____	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

SUBTOTAL : _____

Soft bottomed continued

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
5. Channel Alteration	- Changes to channel/dredging absent or minimal - Stream with normal pattern	- Some changes to channel/dredging - Evidence of past channel/dredging - Recent channel/dredging not present	- Channel changes/dredging extensive - Embankments or shoring structures present on both banks 40 to 80% of reach channelised and disrupted	- Banks shored with gabion or cement >80% of the stream reach channelised and disrupted. - Instream habitat altered or absent
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	- Little/no islands or point bars present <20% of the bottom affected by sediment deposition	- New increase in bar formation, mostly from gravel, sand or fine sediment 20-50% of the bottom affected; - Slight deposition in pools	- Some deposition of new gravel, sand or fine sediment on old and new bars 50-80% of the bottom affected - Sediment deposits at obstructions, constrictions, and bends	- Heavy deposits of fine material - Increased bar development >80% of the bottom changing frequently - Pools almost absent due to sediment deposition
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Pool Variability	- Pools evenly mixed - Large/shallow, Large/deep, Small/shallow, Small/deep	- Majority of pools large/deep - Very few shallow pools	Prevalence shallow pools	Majority of pools small/shallow
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	>50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats - Snags/ submerged logs/ undercut banks/ cobbles provides abundant fish cover - Must not be new or transient	30-50% substrate favourable for invertebrate colonisation - Snags/submerged logs/undercut banks/cobbles - Fish cover common - Moderate variety of habitat types. Can consist of some new material	10-30% substrate favourable for invertebrate colonisation - Fish cover patchy 60-90% substrate easily moved by foot - Woody debris rare or may be smothered by sediment	<10% substrate favourable for invertebrate colonisation - Fish cover rare or absent - Substrate unstable or lacking - Stable habitats lacking or limited to macrophytes
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	Periphyton not evident on hand held substrates (macrophytes, wood etc) or fine sediments	Periphyton not visible on substrates but obvious to touch	- Periphyton visible <20% cover of available substrates	- Periphyton obvious and prolific >20% cover of available substrates
SCORE ____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score ____	NB: Use only means of LB and RB values			

Appendix B Macroinvertebrate Data

Table B1: Macroinvertebrate data (presence / absence data)

						Sites			
			S5	S7B (inter)	S7B (perm)	11i (inter) 1°	11m (inter) 1°	S11 (inter) 2°	S11 (perm)
Ephemeroptera	Leptophlebiidae	Zephlebia						1	1
Plecoptera	Gripopterygidae	Acroperla							1
Trichoptera	Conoesucidae	Pycnocentria						1	
		Pycnocentrodes						1	
	Hydrobiosidae	Costachorema							
		Hydrobiosis	1					1	1
		Psilochorema						1	1
	Hydropsychidae	Aoteapsyche						1	
		Orthopsyche			1			1	1
	Leptoceridae	Triplectides						1	1
	Oeconesidae	Oeconesidae							1
	Polycentropodidae	Plectrocnemia						1	
Hemiptera	Corixidae	Sigara							1
	Veliidae	Microvelia				1			
Coleoptera	Dytiscidae	Liodessus				1	1		
		Rhantus					1		
	Elmidae							1	
	Hydrophilidae	other	1	1		1	1	1	
	Scirtidae			1					
Odonata: Zygoptera		Austrolestes					1		
		Xanthocnemis						1	
Diptera	Chironomidae	Chironomus		1	1		1	1	1
		Corynoneura					1		
		Lobodiamesa		1					
		Orthocladiinae			1		1	1	1
		Polypedilum			1				1
		Tanypodinae	1	1	1		1	1	
						Sites			

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			S5	S7B (inter)	S7B (perm)	11i (inter) 1°	11m (inter) 1°	S11 (inter) 2°	S11 (perm)
	Culicidae			1		1	1		
	Dixidae	Paradixa				1	1	1	1
	Empididae								1
	Ephyridae						1		
	Muscidae		1		1	1			1
	Psychodidae						1		1
	Sciomyzidae	Neolimnia						1	
	Simuliidae	Austrosimulium			1				1
	Syrphidae			1					
	Tipulidae	Hexatomini	1						
	Tipulidae	Paralimnophila		1	1	1		1	
	Tipulidae	Zelandotipula	1		1				1
Crustacea	Amphipoda	Talitridae		1					1
	Decapoda	Paratya						1	
	Ostracoda		1	1	1	1	1	1	1
Acarina						1			
Arachnida		Dolomedes		1				1	
Mollusca	Gastropoda	Lymnaeidae		1		1			
		Physa = Physella				1		1	1
		Potamopyrgus	1	1	1	1		1	1
Mollusca: Bivalvia	Sphaeriidae			1	1	1		1	
Hirudinea				1	1		1		
Oligochaeta				1	1	1	1	1	1
Nemertea				1					

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Appendix C Laboratory Report

Certificate of Analysis

Laboratory Reference:171110-079

Attention: Luke Gowing
 Client: **ARGO ENVIRONMENTAL**
 Address: **101 Customs Street East, Auckland Central, 1010**
 Client Reference: **Freshwater Samples (Adair Farm, Hamilton)**
 Purchase Order: **ADAIR FARM**

Final Report: **250150-0**
 Report Issue Date: **28-Nov-2017**
 Received Date: **10-Nov-2017**
 Quote Reference : **6536**

Sample Details

	WATERS	WATERS	WATERS	WATERS
Lab Sample ID:	171110-079-1	171110-079-2	171110-079-3	171110-079-4
Client Sample ID:				
Sample Date/Time:	09/11/2017 10:00	09/11/2017 12:00	09/11/2017 14:00	09/11/2017
Description:	Site 7	Site 9	Site 11	Waikato River

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Nitrate (as N)	mg/L	1.7	8.5	4.9	0.36
Nitrite (as N)	mg/L	0.0042	0.0077	0.012	0.0053
Total Oxidised Nitrogen (as N) by Calculation	mg/L	1.7 *	8.5 *	4.9 *	0.37 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	0.011	0.022	0.022	0.020
Dissolved Reactive Phosphorus (as P)	mg/L	0.048	0.037	0.070	0.021
Total Kjeldahl Nitrogen (as N)	mg/L	0.61	0.29	0.25	0.17
Total Nitrogen (as N)	mg/L	2.2	8.4	5.3	0.53
Total Phosphorus (as P)	mg/L	0.082	0.050	0.10	0.048
Total Suspended Solids	mg/L	6.4	7.2	12	5.6
Turbidity	NTU	3.4	2.7	5.0	2.3

Results marked with * are not accredited to International Accreditation New Zealand

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Dissolved Reactive Phosphorus (as P) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-P F	0.002 mg/L	All	Auckland
Total Kjeldahl Nitrogen (as N) by Sulphuric Acid Digestion (with mercury catalyst) and Colorimetry/Discrete Analyser	APHA (online edition) 4500-N org	0.1 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Preparations				

Preparations		Received		
Membrane Filtration (0.45 µm)	APH (for detection of 450 B (preliminary filtration)	PLANNING GUIDANCE 15 June 2018	All	Auckland
<i>The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.</i> <i>For more information please contact the Operations Manager</i>				

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 28/11/2017

A handwritten signature in blue ink, appearing to read 'Zum Nguyen'.

Zum Nguyen
KTP Signatory