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# Ward Community Water Supply

NOVEMBER 2020

CONFIDENTIAL

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# Contents



## Appendices

# 1 Introduction

WSP is working with the Flaxbourne Settlers' Association, through the Marlborough Research Centre Trust, to investigate the sustainability and resilience of the Ward Community water supply. The existing community supply is sourced from an unconfined gravel aquifer near the Flaxbourne River Bridge on State Highway 1 (SH1) via a shallow well (Figure 1.1).

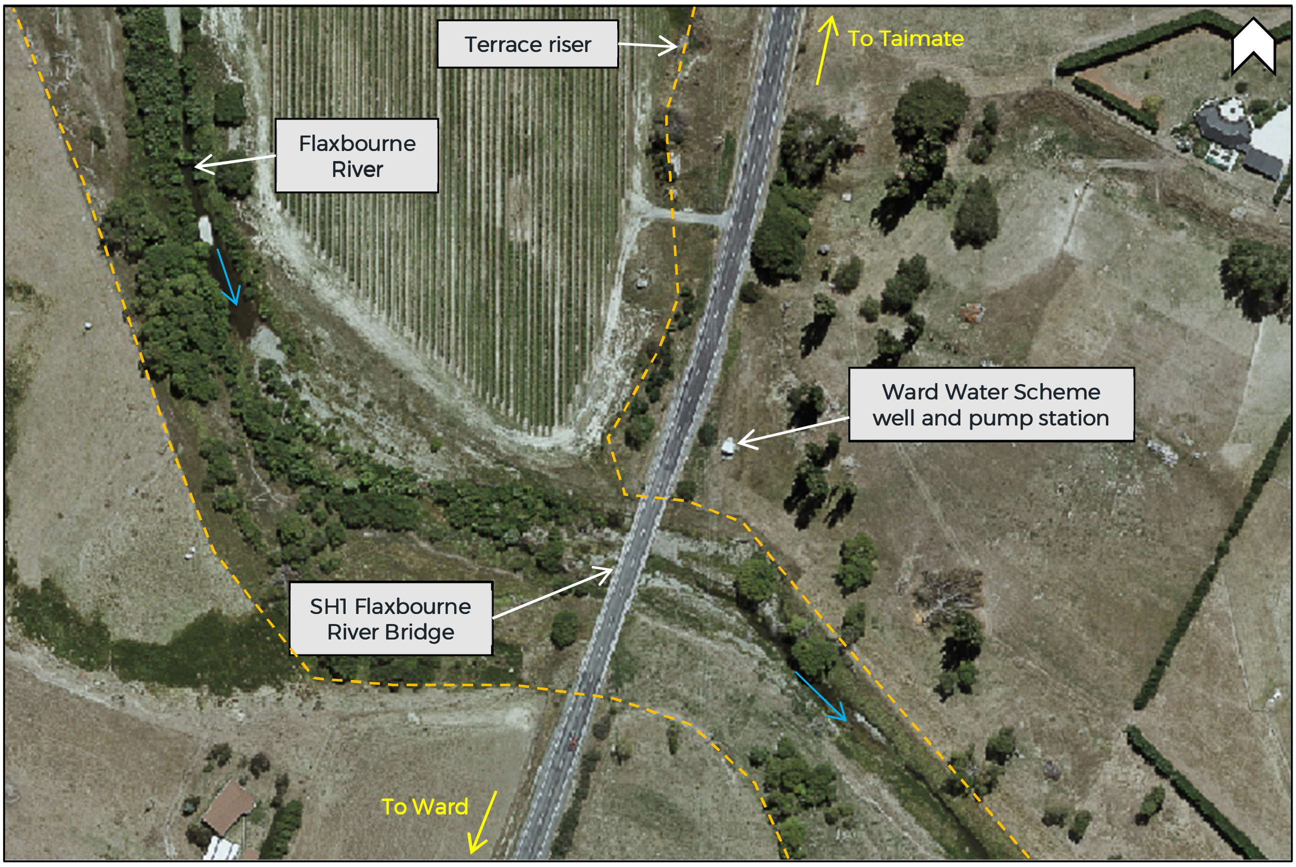


*Figure 1.1: The Ward Community water supply well abstracts water from an unconfined gravel aquifer adjacent to the Flaxbourne River.*

This report provides a summary of the sustainability and performance of the existing supply and investigations undertaken to locate an alternative supply.

# 2 Local Setting

## 2.1 Geological setting

The SH1 Flaxbourne River Bridge is in southern Marlborough, approximately 2km north of the Ward township. The area adjacent to the bridge is underlain by recent river gravel and sand which has been eroded to form a suite of degradational terraces (Figure 1.1). Local outcrops of Starborough Formation bedrock have also been mapped, which consists of poorly bedded sandstone and siltstone (Rattenbury *et al.*, 2006).

Investigations have been undertaken previously near the SH1 Flaxbourne River Bridge. These include a borehole at each bridge abutment, and a trench which was excavated to install an infiltration gallery. These investigations confirm the local geology of:

- Minor upper layer (<2m thick) of surficial silt deposits. These are likely to be overflow deposits from the river, or fill deposits associated with the construction of the bridge and road infrastructure;
- 3-6m of gravel with a sand and silt matrix. These deposits are recent alluvium and host a shallow unconfined aquifer;
- At the northern abutment, approximately 10m of silt was identified beneath the alluvial gravel. A similar layer, but significantly thinner (~2m), was also encountered at the southern abutment; and
- Basement siltstone of the Starborough Formation.

## 2.2 Hydrological setting

All known groundwater in the Flaxbourne catchment is restricted to shallow alluvial gravel deposits associated with the Flaxbourne River; or its tributaries Tachell and Needles Creeks (Figure 2.1). Very little information is available to quantify any permanent groundwater system in the catchment; however, it is thought that the relatively thin alluvial gravel deposits are recharged from rainfall and percolation from the Flaxbourne River. The gravel deposits act as unconfined riparian aquifers. The gravel deposits are generally thin i.e. less than 10m thick, and the storage capacity of the aquifers is likely to be limited (Davidson & Wilson, 2011).

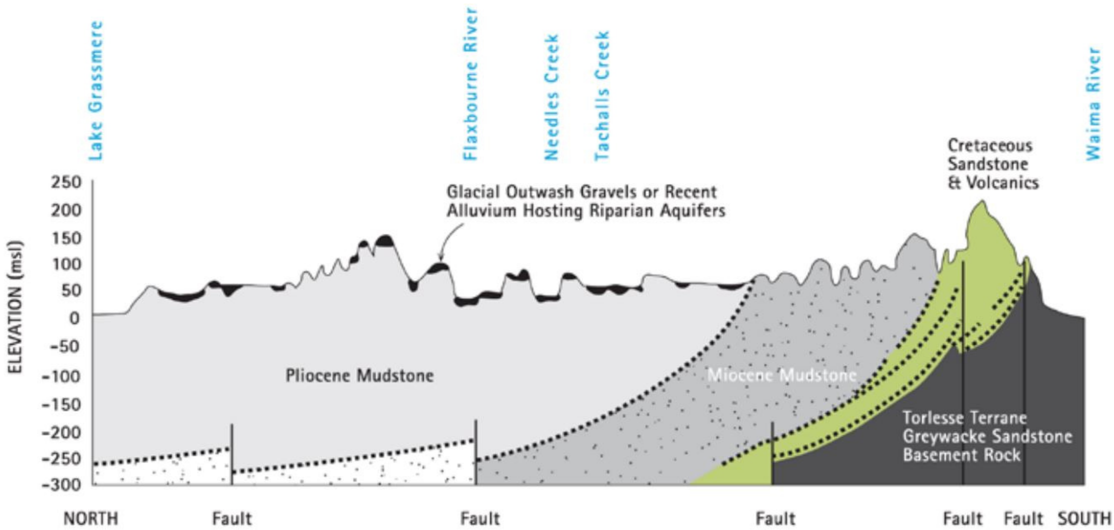


*Figure 2.1: Cross-section through the Ward Syncline indicating the limited nature of alluvial deposits near the Flaxbourne River (Davidson & Wilson, 2011).*

# 3 Existing Supply

## 3.1 Bore performance

### *Data*

Since 2016, pump flow (L/s), volume ($m^3$) and water level (m) associated with the Ward Community water supply bore have been recorded. The data available for each of these aspects is provided in Figure 3.1 through Figure 3.3.

Each measurement series have periods of missing and erroneous data. This includes the pump flow and volume measurements which were reinstated in late January 2020; after being unavailable for ~8-months (Figure 3.1 & Figure 3.2). This also applies to water level, the instrumentation for which was replaced in March 2020 following damage during the 2016 Kaikoura Earthquake (Figure 3.3). The reliability of the record between the earthquake and the installation of new equipment is unknown.

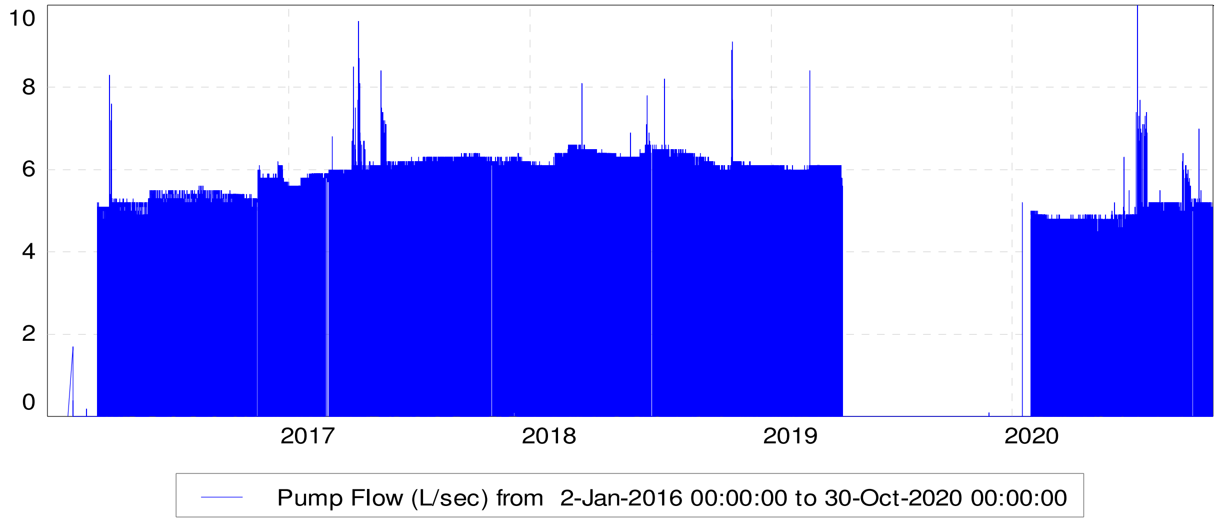


*Figure 3.1: Ward community water supply - pump flow (L/s).*

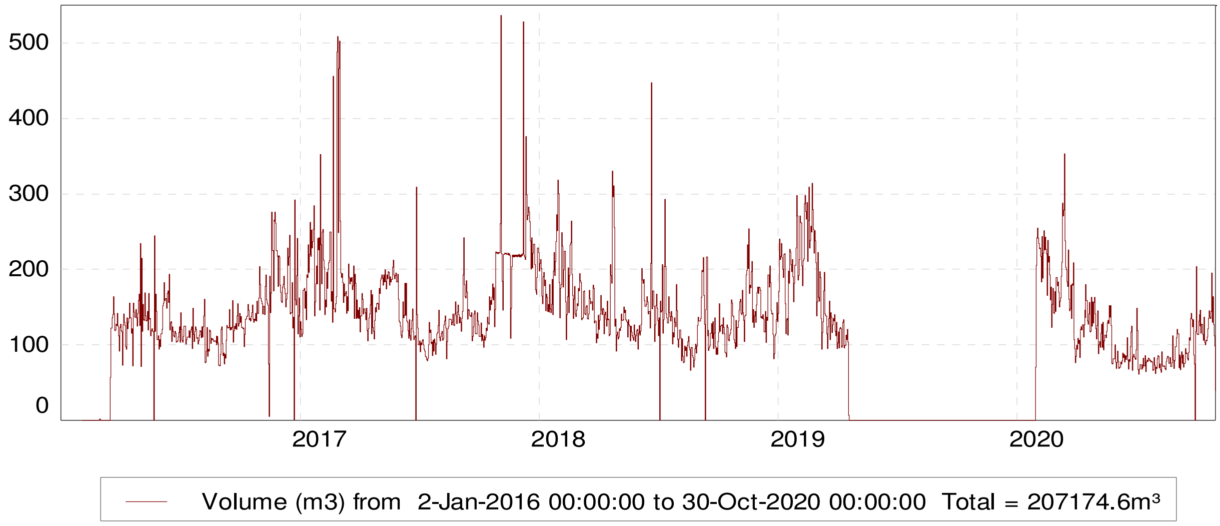


*Figure 3.2: Ward community water supply – daily pump volume (m$^3$).*

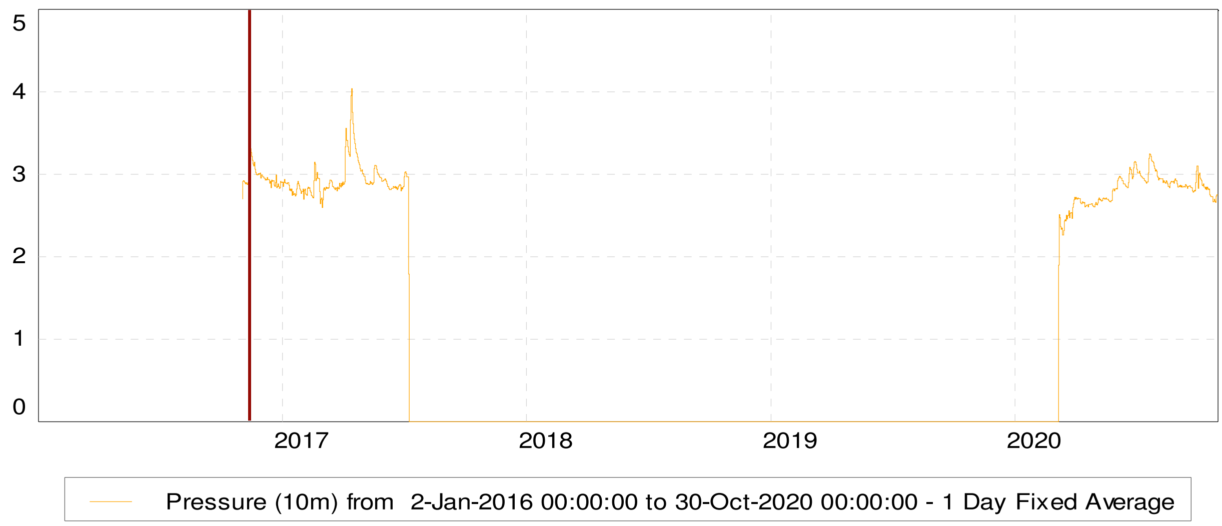


*Figure 3.3: Ward community water supply – water level (m). Kaikoura Earthquake is shown by brown vertical line.*

### *Pumping rate*

Prior to 2019, the maximum sustained flow rate was ~6L/s, with infrequent occurrences of higher pumping rates (<6.6L/s). During 2020, the flow rate is generally lower; between 4.5–5.2L/s. The lower pumping rates recorded in 2020 may be associated with the pump setting, or limitations of the pump, bore or available water supply over this period. However, the lower rates may also be attributed to the change in instrumentation or instrument calibration.

While there appear to be two periods where pumping rates increase to 6.0–7.7L/s; throughout July and late September (Figure 3.4), these values represent the instantaneous maximum pumping rate which is higher than the sustained pumping rate and may not be representative of the actual rate of take. There is also an erroneous measurement of ~40L/s which is not considered to be accurate. These 'spikes' of an apparently higher pumping rate may be errors associated with an irregular time step throughout the monitoring data.

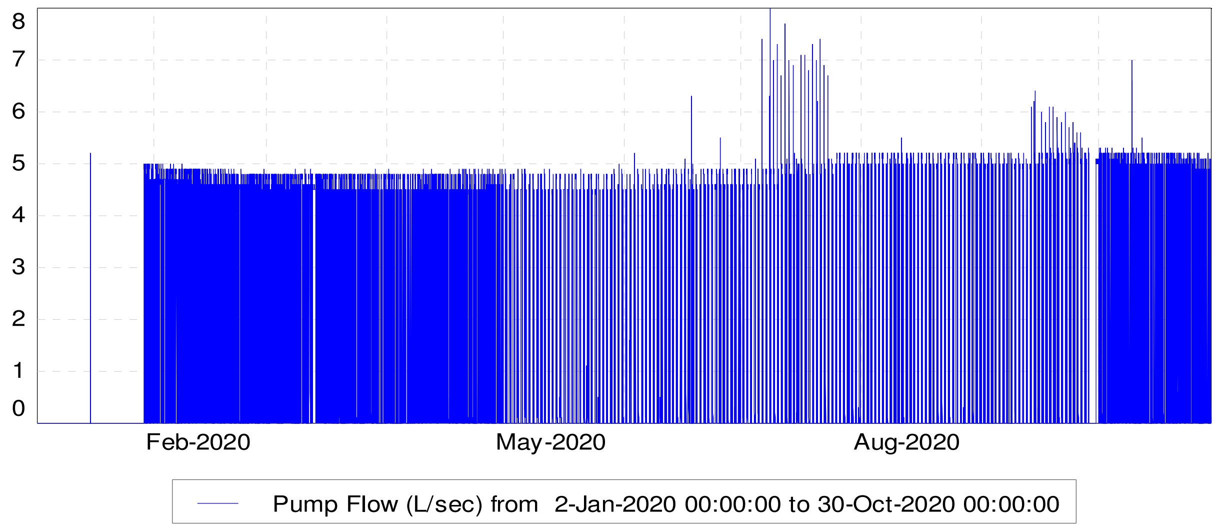


*Figure 3.4: Ward community water supply 2020 pump flow (L/s).*

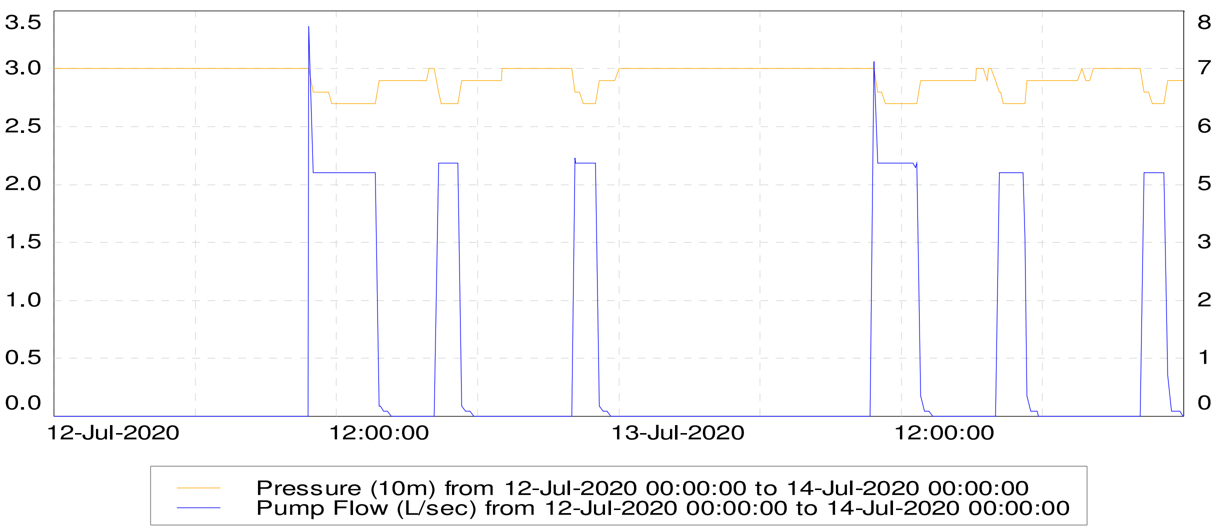


*Figure 3.5: Instantaneous pumping rate of ~7L/s before dropping to a sustained rate of ~5.2L/s (blue trace) and water level (orange trace).*

### *Drawdown*

The pumping and associated water level drawdown 'cycle' is characterised by an abrupt, but small, (200mm) drop in water level when the pump starts, and a similar but reverse recovery of the water level once pumping ceases (Figure 3.6). Once pumping ceases, the bore water level immediately recovers to the pre-pumping level. Drawdown of the water level within the bore is between 0.3–0.4m when pumping at ~5.2L/s. When pumping at a higher rate of ~6.0L/s, the drawdown remains in this range, indicating that this is a sustainable pumping regime.

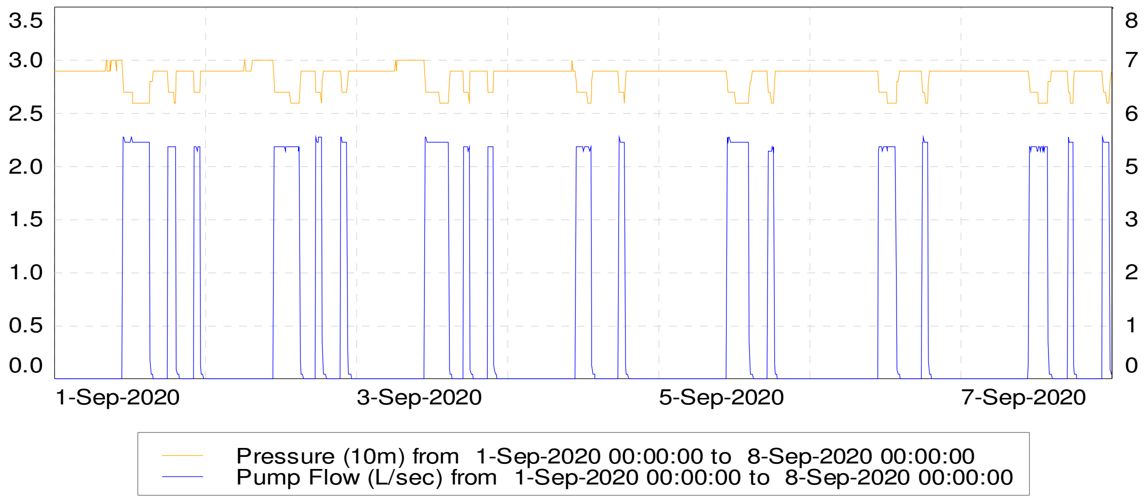


*Figure 3.6: Water level (orange trace and left axis(m)) and pump flow (blue trace and right axis (L/s) for 1-8 September 2020.*

## Volume

Figure 3.2 shows the daily pump volume since records began. As expected, pump volumes increase during spring, are highest over summer, and lowest in winter. Figure 3.7 illustrates the same pattern of demand and abstraction using the monthly pump volume by year. Monthly pump volumes range from around 3,000m$^3$ to 4,000m$^3$ over the winter months, up to more than 7000m$^3$ over the summer. The pump volumes for May and June 2020 are lower than recorded for previous years.

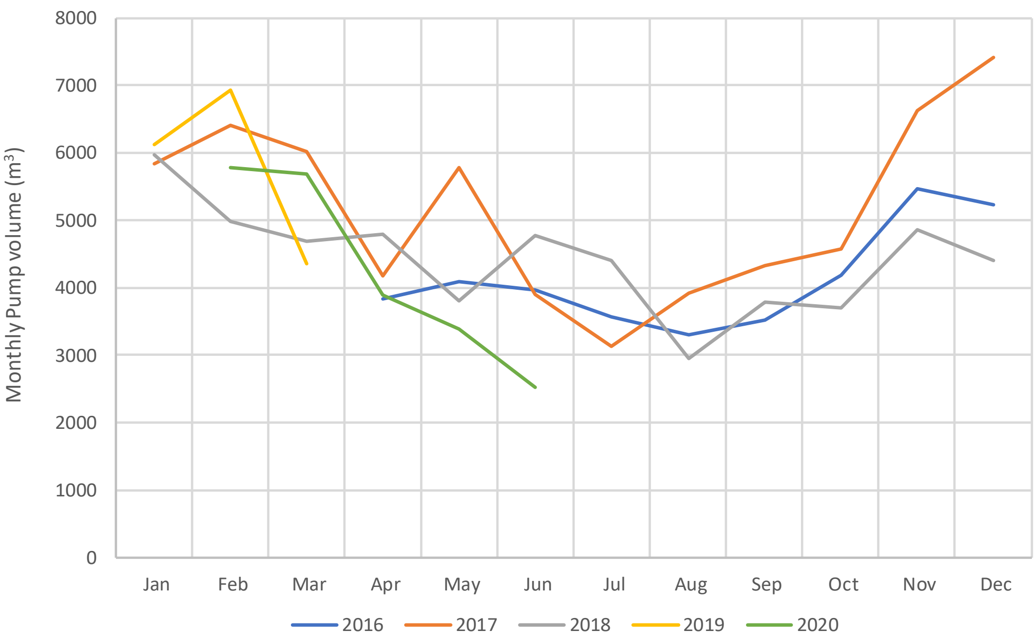


*Figure 3.7: Monthly pump volume by year.*

The flow distributions for the two periods of pump flow records; from 2016 to April 2019 and February to July 2020, highlight the lower flow rates during 2020 (Figure 3.8). The distributions also indicate that the pump is operating about 50% of the time, and is at or near maximum output for ~25% of the time. Mean flow statistics for the two periods are 1.8L/s from 2016 to 2019, and 1.6L/s for the short period of record available for 2020. However, the reliability of these data should be reviewed given the inconsistent time step, and the occasional potentially artificially high flow rates.

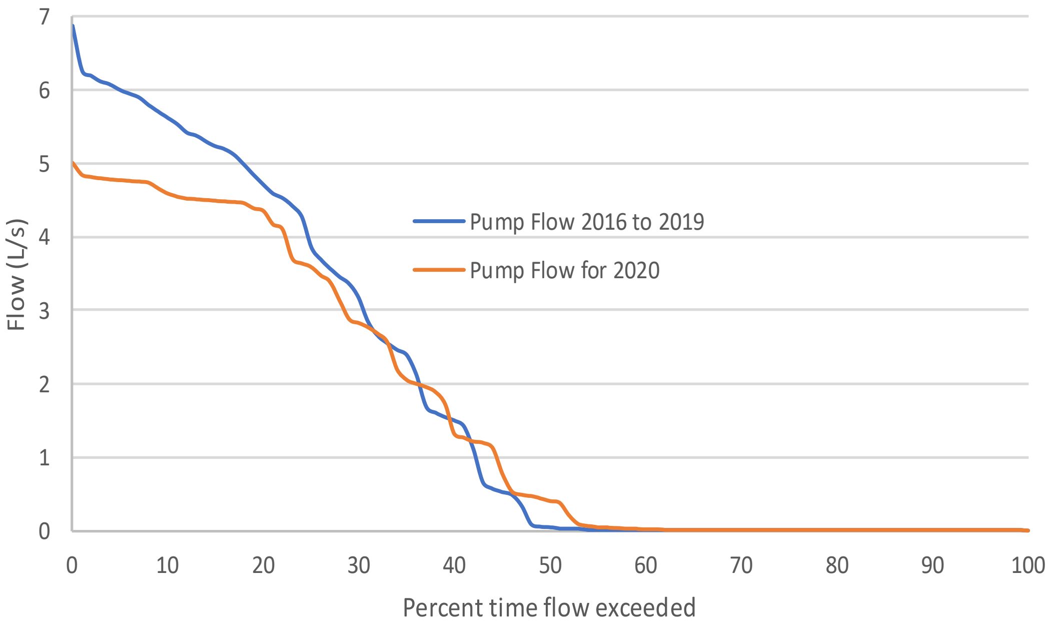


*Figure 3.8: Flow distribution of hourly data for the pump record to April 2019, and February to July 2020.*

## 3.2 Limitations of existing supply

The data available for the Ward Community water supply bore indicates that the current pumping regime is sustainable. Water is being abstracted at a rate of up to 5.2L/s over a period of an hour, ~6 times a day. However, there are several limitations associated with the existing supply:

- Groundwater sourced for the supply is from surficial alluvial gravel deposits, hydraulically-connected to the Flaxbourne River.
- While the alluvial deposits are a known groundwater resource, at a catchment level these deposits are limited. The deposits are constrained to the contemporary floodplain of the Flaxbourne River.
- The limited extent of these deposits suggests a restricted storage capacity, and a reliance on ongoing recharge from the Flaxbourne River to support the groundwater system.
- Surface flows within the Flaxbourne River are ephemeral and so there is limited groundwater recharge during dry summer periods. Any groundwater resource hydraulically-connected to the river is likely to experience low levels during prolonged dry periods.
- The nature and limited availability of groundwater in the shallow unconfined aquifer adjacent to the Flaxbourne River has implications for water resource management. These include:
  - A direct hydraulic connection between the Flaxbourne River and the groundwater resource;
  - Limited availability of groundwater;
  - Rapid recharge during periods of higher flow in the Flaxbourne River;
  - Limited groundwater storage to buffer periods of prolonged low flow in the Flaxbourne River; and
  - No aquitard to prevent contamination of the groundwater from the ground surface.

- These constraints relating to the nature of the groundwater resource impact the potable water supply for the Ward Community, Taimate, and any other abstractions in this area

# 4 Alternative Water Supply

Given the limitations of the existing water supply, a series of investigations were undertaken with the aim of improving the resilience and security of the potable water supply for the Ward Community.

These investigations, and their outcomes, are summarised below.

## 4.1 Phase 1 – electrical resistivity profiles

The full details of this investigation are provided in WSP Opus (2019).

During the initial phase of investigating potential water resources in the wider area, three electrical resistivity profiles (W1, W2 and W3) were measured on a river terrace near the SH1 Flaxbourne River Bridge (Figure 4.1). The profiles were aligned to allow interpretation of the sub-surface geology in both north-to-south and west-to-east directions.

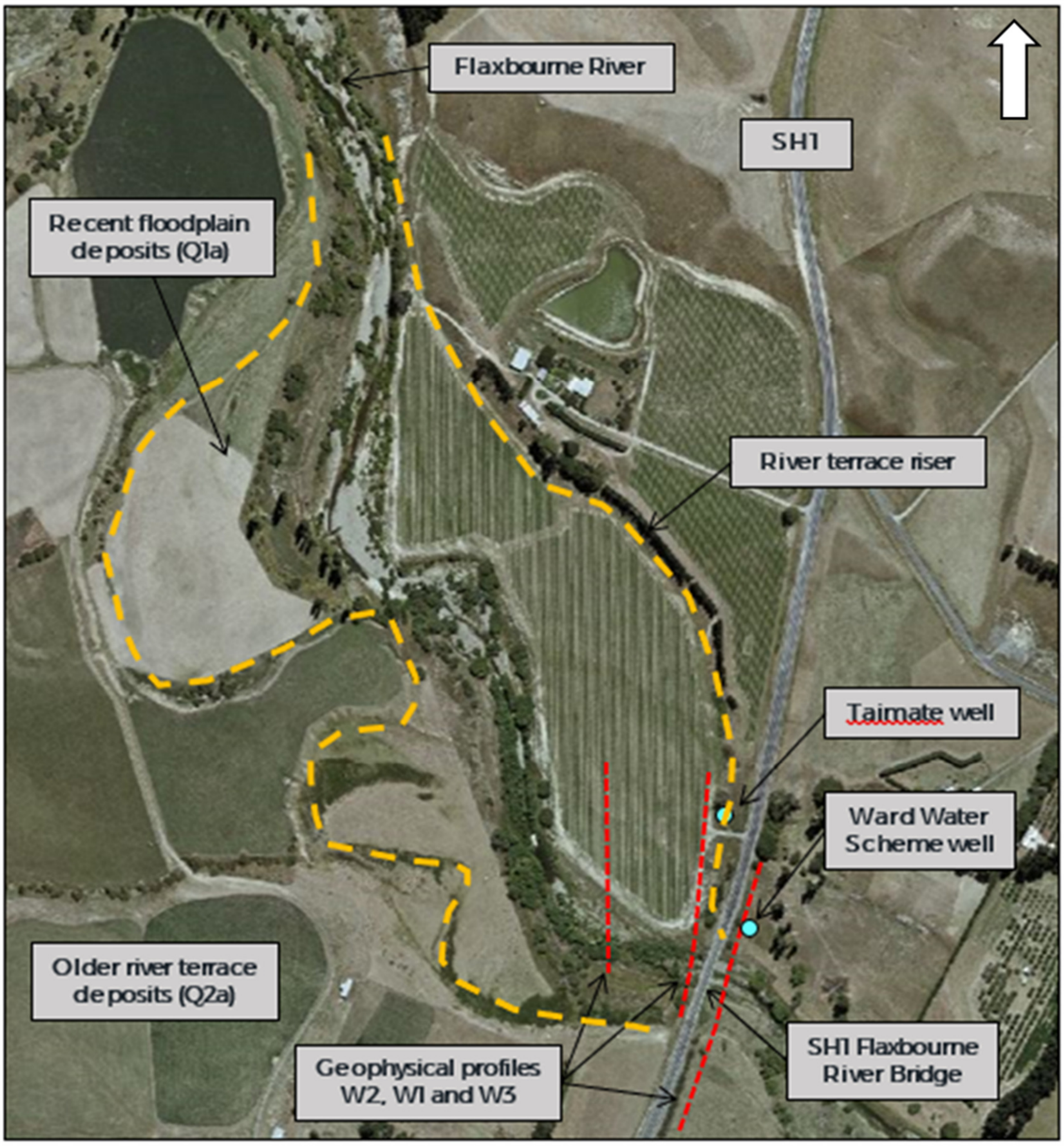


*Figure 4.1: Location of SH1 Flaxbourne River Bridge, geophysical and geotechnical investigations, and existing Ward Community and Taimate water supply bores.*

These initial investigations allowed the following conclusions:

- There are three sub-surface layers, as defined by their resistivity (Figure 4.2).

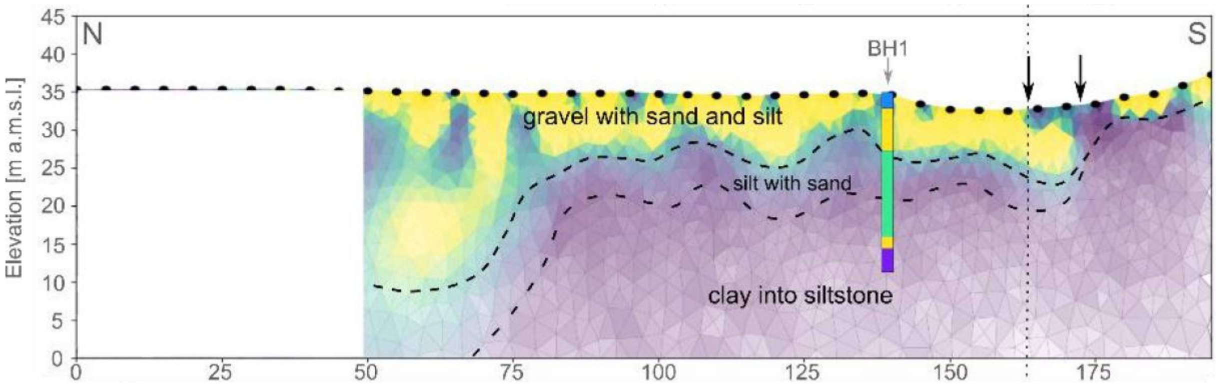


*Figure 4.2: Profile of W1 (Phase 1) with interpreted geology from bore (BH1) drilled on the northern abutment of the SH1 Flaxbourne River Bridge (Sutter, 2019a).*

- The surficial layer (yellow) is the most resistive. This layer is laterally extensive and represents the alluvial floodplain gravel. The resistivity value of these gravels is lower than normal for gravel. This may be because of the sand and silt within the gravel matrix or the presence of groundwater.

- The floodplain gravel deposit is generally less than 8m thick and extends laterally both north and south of the river. This water-bearing unit is associated with the youngest river terrace of the Flaxbourne River, and extends significantly further on the north side of the river than the south.

- There is generally little variation in thickness of the alluvial deposits, except for an area approximately 100m north of the river within the adjacent alluvial terrace, where the gravel appears to be up to 25m thick. The increased thickness of gravel is thought to be a paleochannel of the Flaxbourne River. Historic (and current) aerial images indicate the presence of a paleochannel at this location. The resistivity of this material is similar to that of the Flaxbourne River, which may indicate a larger groundwater resource.

- Historic aerial photographs of the area show several paleochannels across the river terrace on the north side of the river. The largest channel can be seen immediately north of profiles W1 and W2; which aligns with the thicker gravel deposit identified in the survey profiles (Figure 4.2).

- The static groundwater level (i.e. top of the saturated zone) could not be distinguished in the results, but the alluvial gravel deposit hosts a shallow unconfined aquifer.

- The resistivity of the stratigraphic layers underlying the surficial alluvial deposits decreases rapidly with depth. These layers are expected to consist of clay and silt deposits and then basement siltstone. These units are likely to be relatively impermeable and contain little, if any, groundwater.

The results of these investigations led to the following conclusions regarding water resources in the area:

- The surficial alluvial gravel deposits (from which the existing supply is sourced) are the only potential source of groundwater near the SH1 Bridge. Therefore, the constraints associated with the existing supply are likely to be applicable to any new bore in this area.

- These constraints could potentially be mitigated if a new bore was drilled within the paleochannel identified on the river terrace on the north side of the river. The paleochannel is likely to be hydraulically-connected to the Flaxbourne River and therefore act as a preferential flow path for shallow groundwater flow. A bore in this location would therefore potentially provide a more reliable, higher yielding, and more resilient groundwater source. It would, however, still be affected by low flows in the Flaxbourne River.

It was therefore recommended that the potential of the identified paleochannel, and the associated gravel deposit, to provide a resilient groundwater supply be investigated further.

## 4.2 Phase 2 - geophysical investigations

Given the positive results from the initial survey, a more detailed geophysical survey was undertaken to investigate:

- The gravel deposits near the existing Taimate well;

- The presence of paleochannels across the river terrace, and their implication for a potential groundwater resource; and

- The groundwater level across the site.

The second phase of investigation used a range of geophysical methods, including: electrical resistivity tomography, seismic refraction, and multi-channel analysis of surface waves (Figure 4.3).

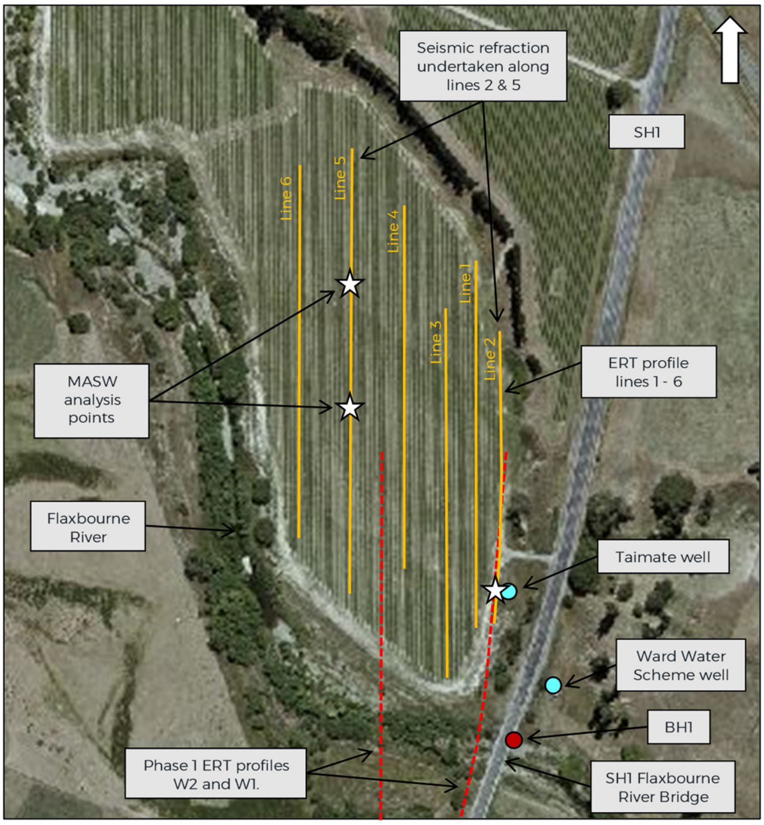


*Figure 4.3: Approximate locations of geophysical investigations along the river terrace north of Flaxbourne River. Further detail is provided in Sutter (2019a & 2019b).*

These techniques were used to investigate different aspects of the stratigraphy and hydrogeological sub-surface conditions. The different methodologies, and the full results of the investigations, are detailed in Sutter (2019b) and WSP (2020). These investigations were to provide further detail about the hydrogeology of the river terrace to the north of the Flaxbourne River, and to build on the results of the initial phase of geophysical surveys outlined in Section 4.1.

The results of this second phase of investigation indicated that:

- There are four sub-surface layers, defined by their resistivity (Figure 4.4);
    - Unit A (yellow) – Most resistive unit (100 - >120Ωm), comprised of floodplain gravel with sand and silt.
    - Unit B (blue) – Lower resistivity values (40 - 80Ωm). Predominantly comprised of silt with sand.
    - Unit C (green) – Second highest resistivity values (80 – 100Ωm). Likely to comprise gravel and sand, with lesser deposits of silt.
    - Unit D (purple) – Lowest resistivity values (20 - 40Ωm). Interpreted to mark the transition from clay to siltstone.
- The general stratigraphic profile comprises floodplain gravels (A) overlying variable deposits of gravel, sand and silt (B & C). These layers are underlain at depth by low resistivity bedrock and clay (D).
- Units A and C (floodplain gravels with minor fine sediment) are considered potential water-bearing units. Unit B (silt and sand) may contain water but is likely to have a lower hydraulic conductivity or transmissivity because of a higher percentage of fine sediment.
- The profiles along the western side of the river terrace indicate homogenous stratigraphic layers, where resistivity generally increases with depth (Figure 4.4). While there are zones of more resistive deposits at depth (Units A & C), these are isolated and well-defined.
- The profiles along the eastern side of the river terrace indicate more variability in both the surficial floodplain gravels and the underlying gravel, sand and silt deposits (Figure 4.4). These profiles indicate lenses of higher resistivity material which appear discontinuous.
- An example of this is along the eastern edge of the terrace (Line 2), where a feature is present between 80–130m, at 10–30m depth (Figure 4.4). While there is a similar zone along the adjacent Line 1, the features do not match along the profile, indicating the zone along Line 2 is isolated.
- There are differences between profiles undertaken during each of the two surveys. Areas where the profiles overlap (or are situated very close) between the two surveys (i.e. W1 & Line 2 and W2 & Line 4) indicate different resistivities and features. This may be because the profiles have been acquired at slightly different angles, or because of higher ground saturation during winter. This is indicated by the generally lower resistivities measured during the second phase of investigations, which were undertaken during spring.
- Along the eastern side of the river terrace, the groundwater interface is generally at a depth of less than 2m depth at the northern end of the line and increases to 3–4m at the southern end, closer to the Flaxbourne River.

 

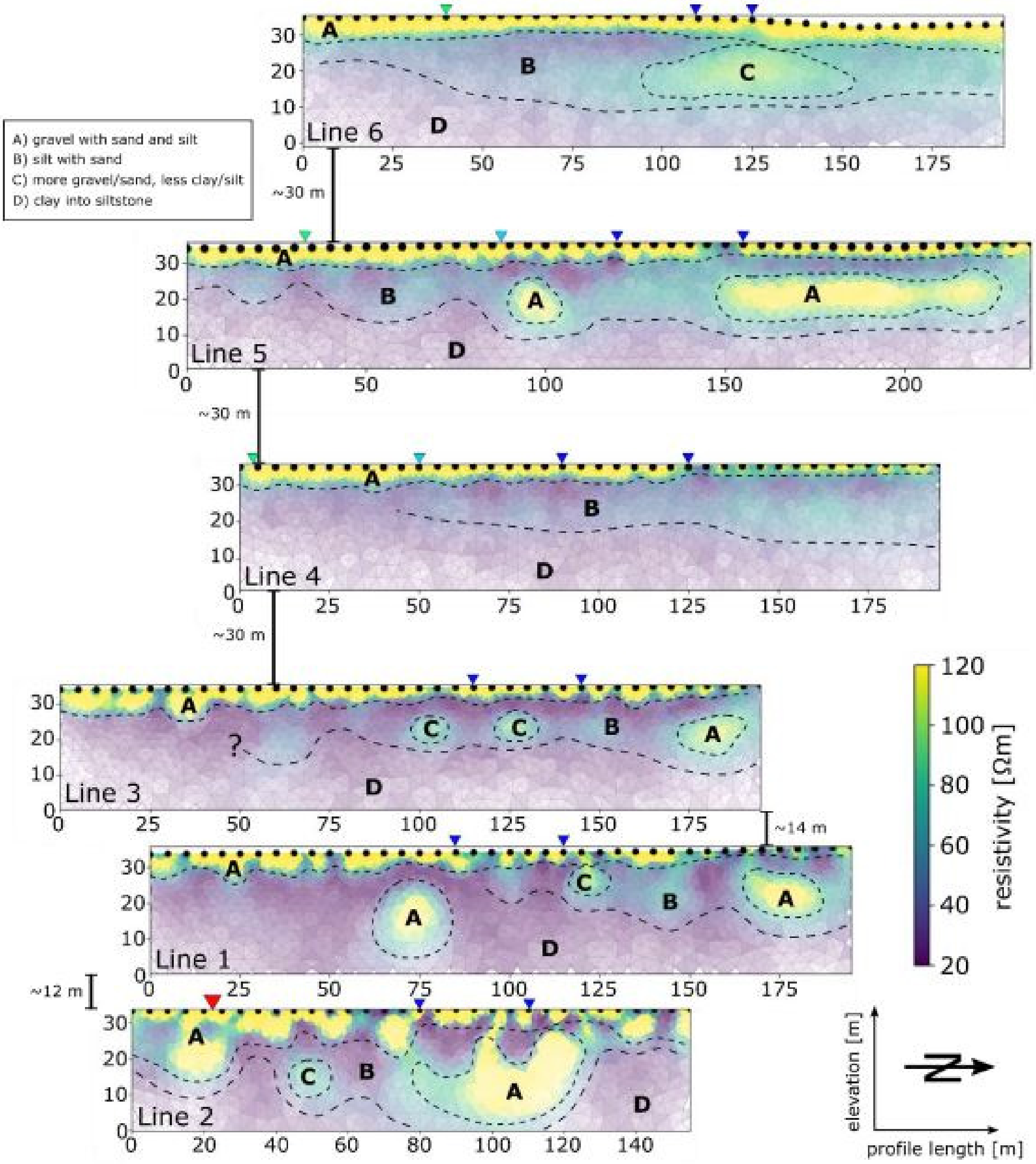


*Figure 4.4: 2D ERT profiles with interpreted units. The Taimate well is marked by the red arrow and approximate locations of paleochannels (observed in surface topography) are marked by the blue and green arrows (Sutter, 2019b).*

- Along the western side of the terrace, the interface is approximately 1–2m deep and consistent along the length of the terrace.
- These profiles indicate that groundwater is shallower in the north-west of the terrace than at the eastern edge near the Taimate well. The interpreted groundwater levels are consistent with topography. This suggests that water is flowing from the north-west to the south-east, which aligns with the flow of the Flaxbourne River, as expected.

The results of these investigations led to the following conclusions regarding water resources in the area:

- The depth to groundwater is generally <2m from the ground surface along the western side of the terrace, and slightly deeper along the eastern side i.e. 2–4m. This is consistent with the topography.

- The resistivity of the stratigraphic layers underlying the alluvial gravel can be variable, but resistivity generally decreases with depth. This is likely to be associated with the silt and clay deposits identified from drilling, as well as the siltstone bedrock. Neither of these layers is likely to provide a viable groundwater resource.

- Although the surficial gravel is the most resistive layer encountered, its resistivity is considered lower than normal for gravel. This may be because of the sand and silt within the gravel matrix and the presence of groundwater. The gravel units with the lowest proportion of fine-grained material, and highest resistivities, are expected to have the greatest potential to support a water resource.

- The sub-surface profiles tend to be more homogenous at the western side of the terrace. However, most profiles indicate localised zones of more resistive material. These zones are more likely to have higher conductivity and transmissivity and either represent paleochannels or localised, discontinuous water-bearing lenses.

- The nature of these zones can vary between seasons. Generally, lower resistivity was measured during the second phase of investigations, following winter when ground conditions were wetter. Therefore, any further investigation should target large zones of higher resistivity during drier months.

The potential of these zones, and their associated deposits, to provide a more resilient water supply was further investigated. It was suggested that this could comprise exploratory drilling and, if results were favourable, pump testing of the aquifer. From the results of the investigations to date (Sutter, 2019b), the following locations appeared promising to support a water resource (Figure 4.5).

- Line 2, between 100 – 120m, to a depth of up to 25m; and

- Line 5, between 160 – 200m, to a depth of up to 25m.

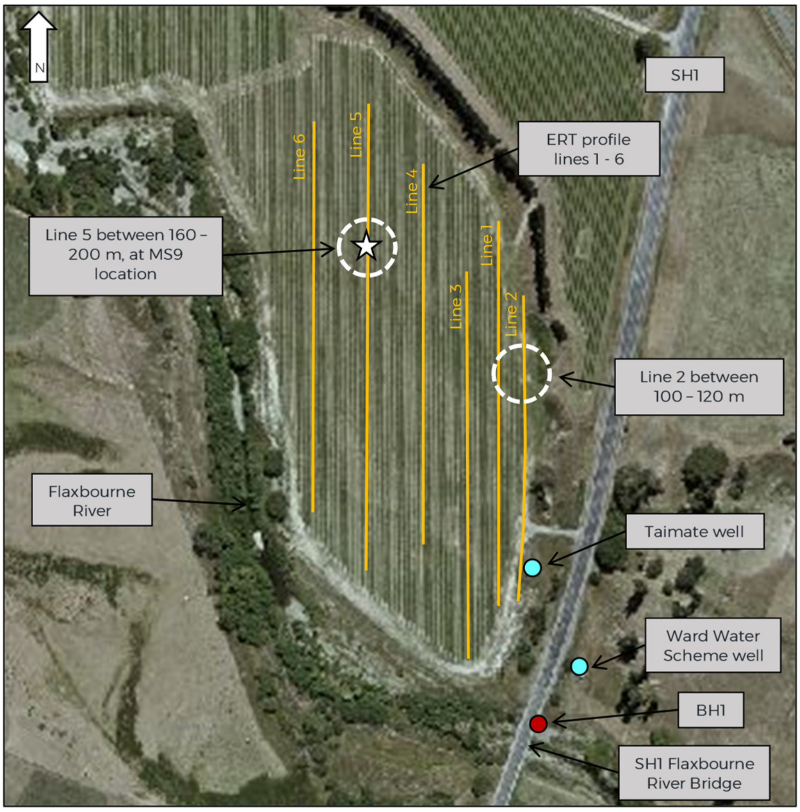


*Figure 4.5: Approximate locations identified for further investigations (white-dashed circles).*

## 4.3 Phase 3 – exploratory drilling

The results of the geophysical surveys indicated two potential sites for further investigation (Figure 4.5). Both locations are on a river terrace currently under viticulture. Given the well-established nature of the vines, and associated infrastructure across the terrace, the site nearer the edge of the vineyard was chosen for further investigation to minimise any disruption to the landowner.

Two exploratory bores were drilled by Butt Drilling in early September 2020. The logs and characteristics of these bores are presented in Appendix A. These bores were drilled in the area identified from the geophysical survey as having a greater water-bearing potential. However, neither bore identified water-bearing layers sufficient to support a potable supply.

A comparison of the geophysical results with the stratigraphy of the bores indicated the following (pers. comm. E. Sutter, 2020):

- The fit between the resistivity model and the borehole logs is relatively poor (Figure 4.6), however, there is a reasonable fit with the electrical resistivity tomography ERT section.

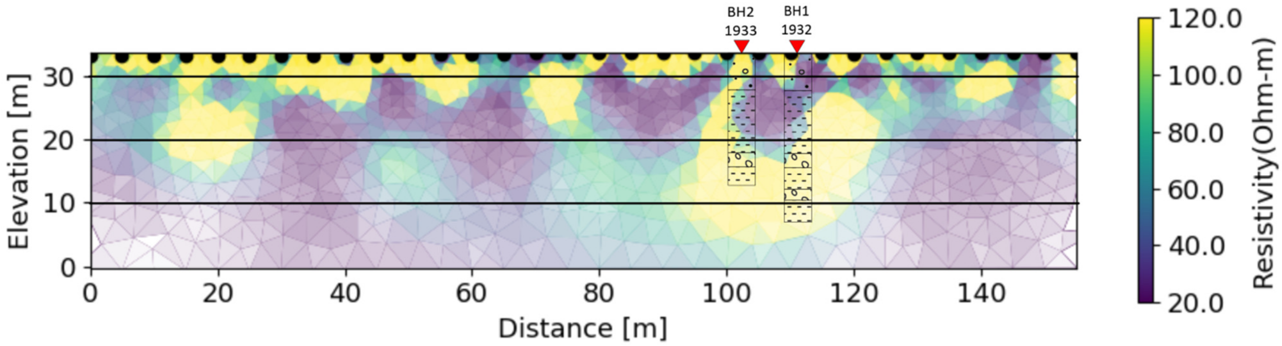


*Figure 4.6: ERT profile with bore logs superimposed.*

- The upper 16m of sediment can be split into two portions; a resistive ~6m thick top layer underlain by a ~10m thick conductive layer. Both these layers correspond well to the resistivity model. The identified resistivity ranges are industry standard for these materials, but do correlate with what is observed in the ERT model for the corresponding borehole layers.

- At depths greater than 16m, where a potential groundwater resource was identified, the bore logs indicate interlayered clayey gravel and clay deposits, rather than more permeable sediments. These materials may conservatively align with the resistivity range identified for these layers.

- Geophysical material properties show a range of values depending on many different factors; such as clay & water content, fluid salinity, porosity or temperature. This affects the ability to interpret the features with great certainty. It is therefore important to have confirmed stratigraphic information to compare with the geophysical survey results.

- The depth of the material also influences the measured resistivity, where material at greater depths is influenced by the volume of the sediment above and around identified features. This may be further influenced by the heterogeneity of the alluvial deposits, resulting in higher resistive lenses which impact the results. At greater depths, the sensitivity of the measurements is also decreased.

# 5 Conclusions

This review of the existing Ward Community water supply allows the following conclusions:

- The Ward Community water supply is sourced from surficial alluvial gravel deposits; hydraulically-connected to the Flaxbourne River.
- Since 2016, pump flow (L/s), volume of water abstracted ($m^3$), and water level (m) associated with the supply bore have been recorded. The quality of the data recorded for each of these aspects is unknown.
- Prior to 2019, the maximum sustained rate of flow from the bore was ~6L/s, with infrequent occurrences of higher rates (<6.6L/s). During 2020, the flow rate is generally lower; between 4.5 – 5.2L/s. The lower pumping rates recorded in 2020 may be associated with the pump setting, or limitations of the pump, bore or river flows occurring over this period. However, the lower rates may also be attributed to the change in instrumentation or instrument calibration.
- There are a series of erroneous instantaneous pumping rates which are not representative of the actual rate of abstraction. These 'spikes' of higher pumping rates may be errors associated with an irregular time step throughout the monitoring data.
- The pumping and associated water level drawdown 'cycle' is characterised by an instantaneous drop in water level, and a reverse increase in water level once pumping ceases (Figure 3.6). Once pumping ceases the water level immediately recovers to the pre-pumping level. Drawdown of the water level within the bore is between 0.3 – 0.4m when pumping at ~5.2L/s. When pumping at a higher rate of ~6.0L/s, the drawdown remains in this range, indicating that this is a sustainable pumping regime.
- The volume of water pumped is greater during spring and summer, and lowest in winter. The monthly pump volumes range from around 3,000$m^3$ to 4,000$m^3$ over winter, up to more than 7000$m^3$ during summer.
- The flow distribution over the recorded period indicates that the pump is operating about 50% of the time, and is at, or near, maximum output for ~25% of the time.
- Although the existing supply is meeting the needs of the Ward Community, there are several constraints associated with the existing groundwater source.
- While the alluvial deposits are a known groundwater resource, at a catchment level these deposits are limited. The deposits are constrained to the contemporary floodplain of the Flaxbourne River.
- The limited extent of these deposits suggests restricted storage capacity, and a reliance on ongoing recharge from the Flaxbourne River to support the groundwater system.
- Surface flows within the Flaxbourne River are ephemeral and so there is limited groundwater recharge during dry summer periods. Any groundwater resource hydraulically-connected to the river is likely to experience low levels during prolonged dry periods.
- The nature and limited availability of groundwater in the shallow unconfined aquifer adjacent to the Flaxbourne River has implications for water resource management. These include:
    - A direct hydraulic connection between the Flaxbourne River and the groundwater resource;

- Limited availability of groundwater;
- Rapid recharge during periods of higher flow in the Flaxbourne River;
- Limited groundwater storage to buffer periods of sustained low flow in the Flaxbourne River; and
- No aquitard to prevent contamination of the groundwater from the ground surface.

- Given the limitations of the existing water supply, a series of hydrogeological investigations were undertaken to investigate the potential to increase the resilience and security of the existing groundwater source.
- A series of geophysical investigations were undertaken to determine areas with potential groundwater resource. These investigations identified paleochannels across a recent river terrace north-west of the existing supply bore. While several constraints of the existing supply would also apply to this alternative resource, some other constraints could potentially be mitigated if a new bore was drilled within the paleochannel identified. Paleochannels are likely to be hydraulically-connected to the Flaxbourne River and act as a preferential flow path for shallow groundwater flow.
- Exploratory drilling was undertaken within those areas identified as having groundwater resource potential. However, neither bore identified water-bearing layers sufficient to support a potable supply.

# 6 Recommendations

The following recommendations are made for the Ward Community water supply:

- Regular review of the data relating to the rate and volume of abstraction and water level;
- Potentially, establishing triggers to recognise increasing risk to the sustainability and reliability of supply;
- Installation of a variable speed pump to place less stress on the aquifer during start up; and
- Investigate the potential for obtaining a secure, sustainable and resilient water supply from outside of the Flaxbourne catchment.

# 7 References

Davidson, P. and Wilson, S., 2011: Groundwaters of Marlborough. Edited by Hamill, P. Marlborough District Council.

Sutter, E., 2019a: Geophysical Assessment Report – Flaxbourne Gravel Thickness Assessment. Report prepared by Cook Costello for the Marlborough Research Centre Trust. 19p.

Sutter, E., 2019b: Geophysical Assessment Report – Flaxbourne Groundwater Resources Investigation. Report prepared by Cook Costello for the Marlborough Research Centre Trust. 27p.

Rattenbury, M.S., Townsend, D.B., Johnstone, M.R. (compilers) 2006: Geology of the Kaikōura area. Institute of Geological and Nuclear Sciences 1:250000 geological map 13. 1 sheet + 70p. Lower Hutt, New Zealand: GNS Science.

WSP Opus, 2019: Implications of the geophysical investigation for water resources – Flaxbourne River, Marlborough. Report prepared by Boam, E and McConchie, J. for the Flaxbourne Settlers' Association through the Marlborough Research Centre Trust. 7p.

# Appendix A

## Exploratory Bore Logs

*Ward Community Supply Investigations*

BUTT DRILLING

4 Springswood Grove
BLENHEIM
Telephone 021-343 089
After hours 0-3-578 8270
Facsimile 0-3-578 8166

MEMBER OF: NZDF NEW ZEALAND DRILLERS FEDERATION INC

WATER WELL ENGINEERS TO MARLBOROUGH

**Log No** 1932

**Well Owner** Ward Water Scheme
C/o WSP
Level 9 Majestic Center
100 Willis Wellington 60

**Contact Name** Jack McConchie

**Driller** Rick Line

**Map Sheet No**

**Altitude (m):**

**Drilling Date** 04/09/2020

**Grid Ref East:**

**South**

**Locality** Flaxbourne River Grid 1695182-5371057

| Depth To Strata Top (m) | Depth To Strata Bottom (m) | Strata Thickness (m) | Static Level (m) | Strata Description | Strata Picture |
|---|---|---|---|---|---|
| 0.00 | 0.80 | 0.80 | | Brown topsoil | |
| 0.80 | 2.40 | 1.60 | | Brown fine gravels and brown silt | |
| 2.40 | 5.70 | 3.30 | | Grey clay some sand | |
| 5.70 | 15.90 | 10.20 | | Grey clay (Papa) | |
| 15.90 | 17.40 | 1.50 | | Grey fine gravels, grey clay poor water bearing | |
| 17.40 | 21.50 | 4.10 | | Grey clay (Papa) | |
| 21.50 | 22.60 | 1.10 | | Grey fine gravels, grey clay poor water bearing | |
| 22.60 | 26.10 | 3.50 | | Grey clay (Papa) | |

BUTT DRILLING

4 Springswood Grove
BLENHEIM
Telephone 021-343 089
After hours 0-3-578 8270
Facsimile 0-3-578 8166

MEMBER OF: NZDF NEW ZEALAND DRILLERS FEDERATION INC

## WATER WELL ENGINEERS TO MARLBOROUGH

**Casing above ground (mm):** 0

**Casing NB Dia (mm):** 100

**Finished Static Water Level:** 0.00

**Ground Level**

**Test Pumping:** 0.00 **Hours**

**Screen NB Dia (mm):** 0

**Draw Down (m):** 0.00 **Below Static Water Level**

**Leader Length (m):** 0.00

**Flow Rate:** 0.00 **cubic mph**

**Top of Screen Leader (m):** 0.00

**Casing Length (m):** 0.00

**Step Test By:**

**Top Of Screen (m):** 0.00

*From:* *To:* *Slot Size* *Length*

**Bottom Of Screen (m):** 0.00

**Length of Sump (m):** 0.00

**Total Screen Length (m):** 0.00

**Finished Depth of Well (m):** 26.10

**Remarks:**

Well abandoned and casing removed , static water level expected to be approx 1.1 mtrs above ground similar to well 2 . Hole sealed with cement and bentonite .

**PLEASE NOTE:**
**Test pumping flow rates, static levels, and water level draw down are as recorded at the time of test pumping. These figures could change at a later time due to influences beyond our control (e.g. seasonal variations).**

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# WATER WELL ENGINEERS TO MARLBOROUGH

**Log No** 1933

**Well Owner** Ward Water Scheme
C/o WSP
Level 9 Majestic Center
100 Willis Wellington 60

**Contact Name** Jack McConchie

**Driller** Rick Line

**Map Sheet No**

**Altitude (m):**

**Drilling Date** 07/09/2020

**Grid Ref East:**

**South**

**Locality** Flaxbourne River Grid ref 1695180-5371048

| Depth To Strata Top (m) | Depth To Strata Bottom (m) | Strata Thickness (m) | Static Level (m) | Strata Description | Strata Picture |
|---|---|---|---|---|---|
| 0.00 | 1.10 | 1.10 | | Brown topsoil | |
| 1.10 | 2.80 | 1.70 | | Brown fine gravels and brown silt | |
| 2.80 | 3.10 | 0.30 | | Grey medium gravels and grey clay | |
| 3.10 | 5.80 | 2.70 | | Grey clay, some sand | |
| 5.80 | 15.90 | 10.10 | | Grey clay (Papa) | |
| 15.90 | 17.50 | 1.60 | | Grey fine gravels, grey clay poor water bearing | |
| 17.50 | 20.00 | 2.50 | | Grey clay (Papa) | |

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WATER WELL ENGINEERS TO MARLBOROUGH

Casing above ground (mm): 0

Casing NB Dia (mm): 100

Finished Static Water Level: 0.00

Ground Level

Test Pumping: 0.00 Hours

Screen NB Dia (mm): 0

Draw Down (m): 0.00 Below Static Water Level

Leader Length (m): 0.00

Flow Rate: 0.00 cubic mph

Top of Screen Leader (m): 0.00

Casing Length (m): 0.00

Step Test By:

Top Of Screen (m): 0.00

| From: | To: | Slot Size | Length |
|---|---|---|---|

Bottom Of Screen (m): 0.00

Length of Sump (m): 0.00

Total Screen Length (m): 0.00

Finished Depth of Well (m): 0.00

**Remarks:**

Well abandoned and casing removed . Part of casing removed and left over night , static water level 1.15 above ground level in the morning . Hole sealed with cement and bentonite.

**PLEASE NOTE:**
**Test pumping flow rates, static levels, and water level draw down are as recorded at the time of test pumping. These figures could change at a later time due to influences beyond our control (e.g. seasonal variations).**

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