Targeted Dry Weather Monitoring Plan for Addington Brook

Prepared for

Christchurch City Council

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Limitations:

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Executive Summary

Christchurch City Council (CCC) undertakes monitoring of water quality in Christchurch and Banks Peninsula. This is a requirement of the Comprehensive Stormwater Network Discharge Consent (CSNDC; CRC231955) and the associated Environmental Monitoring Programme (EMP). Annual reporting on this monitoring has identified sites where water quality does not meet the targets set out in the CSNDC. Targeted wet and dry weather surface water monitoring shall be undertaken at these sites, which will aid in determining sources of stormwater contaminants.

Pattle Delamore Partners Limited (PDP) has been engaged by CCC to prepare a dry weather monitoring plan for Addington Brook. This report aims to present a monitoring plan that will aid in identifying sources of dry weather (i.e., not associated with stormwater) contaminants within Addington Catchment, as required by the CSNDC.

PDP has identified eight monitoring locations in the Addington Catchment, which have been selected to enable individual catchments with potential sources of dry weather contaminants to be located. The selected monitoring locations have been assigned a priority level, to give CCC flexibility in the number of in-situ monitoring devices they wish to obtain.

At each location, one years' worth of continuous dry weather monitoring data is recommended to be recorded using in-situ probes, at 5-minute intervals. PDP recommend that the probes monitor for the following parameters:

- Conductivity;
- Temperature;
- Water level; and potentially
- Turbidity.

While measuring turbidity is preferable, the high cost of turbidity probes may exclude this as an option. A cost breakdown of the recommended options for probes and sites to be monitored is included below in Table 1.

Table 1: Costings for the recommended in-situ monitoring devices, based on the number of sites to be monitored.

Sites Sampled	Levelogger 5 LTC	Levelogger 5 LTC & Greenspan TS-1000L Turbidity Sensor	AquaTROLL
Priority 1 Sites – four sites	$16,520	$47,317	$72,611
Priority 1 & 2 Sites – seven sites	$28,716	$82,610	$127,069
Priority 1, 2, & 3 Sites – eight sites	$32,780	$94,375	$145,222

Based on the lower cost and the ability to monitor three of the four parameters listed above, the Levelogger 5 LTC is PDP's recommended monitoring probe. Monitoring for turbidity using the Greenspan TS-1000L sensor would provide additional information regarding the nature of dry weather discharges, but is not essential.

After one years' worth of dry weather data has been collected, PDP recommends the data be analysed and reported on. If there are no major trends, the monitoring plan can be adjusted, and probes can be redeployed for a further six months of continuous monitoring. If there are clear trends, monitoring locations and methodologies can be adjusted as required to narrow-down the contributing catchment to the potential dry-weather discharge. This process should be iterative and will ultimately be at the discretion of the contractor/consultant undertaking the monitoring.

PDP recommends that CCC considers the monitoring locations presented in this report in terms of their priority level and accessibility, and provides information to PDP or the contractor undertaking the monitoring works regarding site accessibility and preferences as necessary.

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1.0 Introduction

The Christchurch City Council (CCC) undertakes monitoring of water quality in Christchurch and Banks Peninsula. Primarily, this is done to meet the requirements of the Comprehensive Stormwater Network Discharge Consent (CSNDC; CRC231955) and the associated Environmental Monitoring Programme (EMP). Annual reporting on this monitoring has identified sites where water quality does not meet the targets set out in the CSNDC. These sites have been selected for Targeted Wet Weather Monitoring (TWWM) of surface water in accordance with Schedule 3 (k) of the consent:

> *"Carry out targeted wet weather monitoring of surface water in selected receiving environments, to improve knowledge of the state of the receiving environment, contaminant inputs and treatment efficiency, and to inform mitigation options under the SMPs. Selected areas may include new stormwater developments and retrofits and known existing hotspots of contaminants."*

Pattle Delamore Partners (PDP) has been engaged by CCC to prepare a wet weather monitoring plan for the lower Ōpāwaho/Heathcote River near Ferrymead and Te Tauawa-a-Maka/Nottingham Stream in Halswell and a dry weather monitoring plan for Addington Brook. This report contains the dry weather monitoring plan for Addington Brook. The TWWM plans are presented in a separate report.

1.1 Objective

This report aims to present a monitoring plan that will aid in identifying sources of dry weather (i.e., not associated with stormwater) contaminants within Addington Brook that may be affecting Council compliance with the CSNDC.

The monitoring plan and contaminant source identification are required to address Condition 59 of the CSNDC and the recommendations in the 'Condition 59 responses to monitoring report 2022 - surface water' (Margetts, et al., 2022).

1.2 Scope of Works

This deliverable consists of a concise monitoring report covering dry weather monitoring. It includes:

- consideration of industrial/commercial/high traffic areas, roofing sources, and the Condition 59 high-risk sites assessment (AECOM, 2023),
- the sites to be monitored and the equipment to be used;
- the recommended in situ monitoring instruments for each site, to assess potential dry weather discharges;

- the intended protocols for installation, maintenance, and quality assurance of the dry weather in situ monitoring instruments; and
- estimated costs for the recommended dry weather in situ monitoring instruments (including different options where possible).

2.0 Background

This monitoring plan will address Addington Brook, and its corresponding Catchment (Addington Catchment). Addington Brook is an urban spring-fed stream that meanders through Southern Christchurch before joining with Ōtākaro/Avon River, at the Botanic Gardens (Reuben, et al., 2019). Addington Catchment is shown in Appendix A.

This monitoring plan aims to aid in identifying sources of dry weather (i.e., not associated with stormwater) contaminants within Addington Brook that may be affecting Council compliance with the CSNDC.

AECOM (2023) has provided a high-level desktop assessment of high-risk sites within the lower Ōpāwaho/Heathcote, Curletts, Addington and Te Tauawa-a-Maka/Nottingham Catchments. A 'high risk' site was defined as "A site that has the potential to discharge contaminants to stormwater at concentrations that could exceed Attribute Target Levels (ATLs)". There was a specific focus on sites that could contribute copper and/or zinc – as these contaminants exceeded the ATLs. Twenty-six high-risk sites were highlighted in the Addington Catchment (AECOM, 2023).

While these sites were considered in the selection of water monitoring locations, ultimately, the key decision factors included existing water quality data, proximity to industrial/commercial/high traffic areas and roofing sources, and the ability to delineate sections of the stormwater network to aid in further investigations.

2.1.1 Water Quality

A high portion of the Addington Catchment is classified as contaminated or potentially contaminated by ECan, and its water quality has historically been poor. Previous CCC monthly water quality sampling has returned exceedances of the assigned ATLs for dissolved copper and dissolved zinc on multiple occasions. Only one sample exceeded the ATL for copper during dry weather, whereas approximately a quarter of the samples that exceeded the zinc ATL were associated with dry weather. This has led CCC to believe that there are both dry weather and stormwater sources of heavy metals in the catchment (Margetts, et al., 2022).

A significant amount of water quality monitoring has been undertaken in the Addington Catchment. ECan has been undertaking dry weather (baseline) and wet weather water quality monitoring for this catchment since 2014. Sampled locations are displayed in Figure 1. Copper and zinc concentrations were elevated above baseline levels during wet weather events (Margetts, et al., 2022).

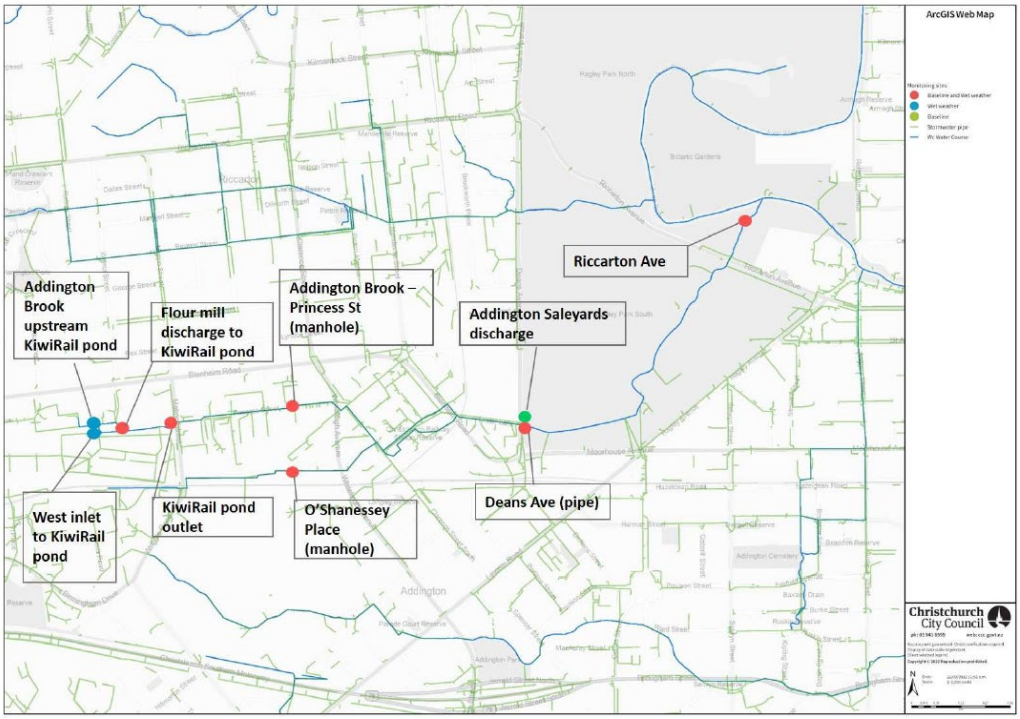

Figure 1. ECan monthly monitoring grab sampling locations in Addington Catchment (Margetts, et al., 2022).

The highest concentrations of dissolved zinc and copper were recorded at the O'Shanessey Place manhole site. Concentrations at this sampling location remained elevated during dry-weather monitoring, while other locations saw larger decreases (Margetts, et al., 2022). This is shown in Figure 2.

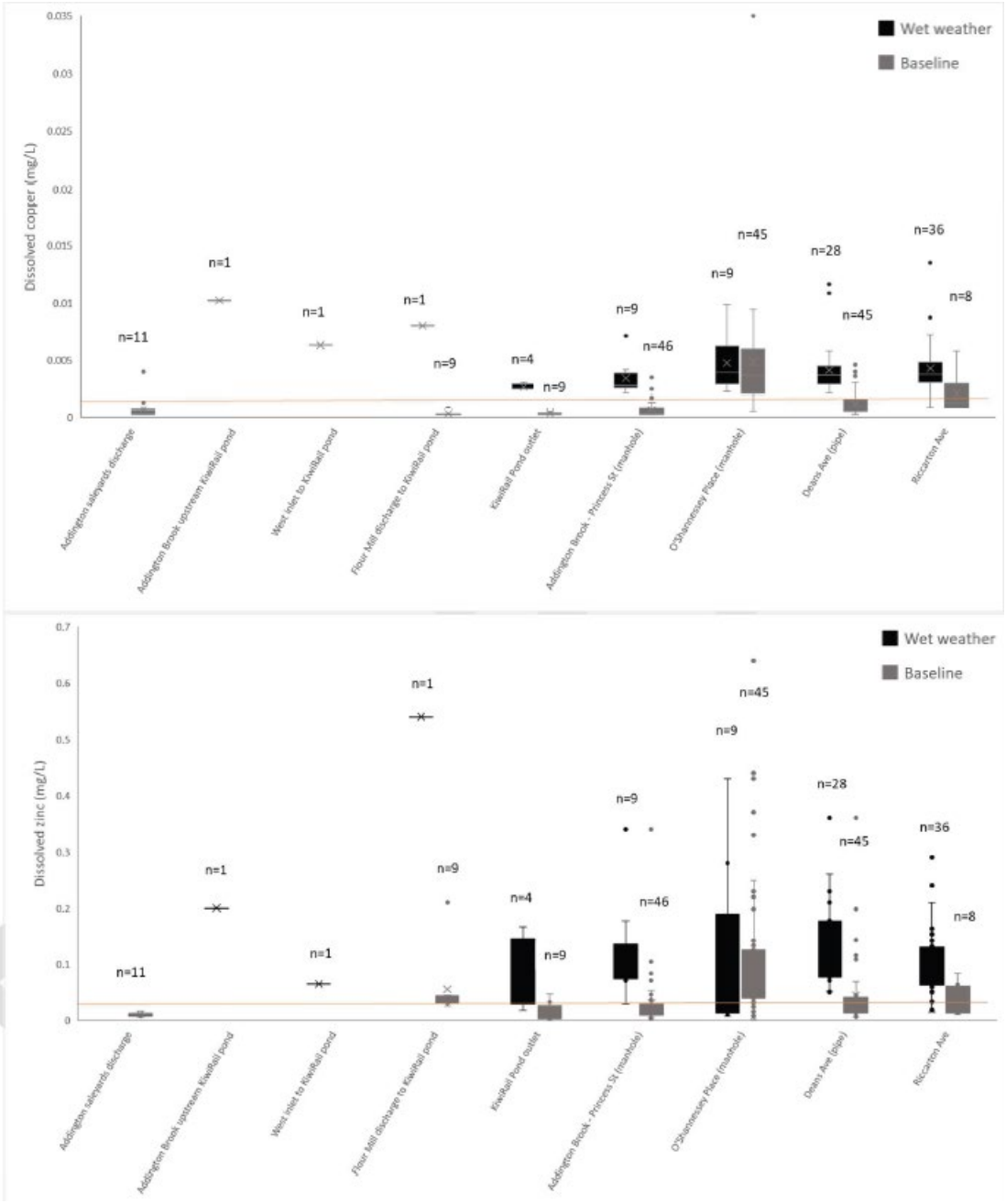

Figure 2. Dissolved zinc and copper concentrations from ECan sampling (Margetts, et al., 2022).

3.0 Dry Weather Monitoring Sites

Monitoring within the Addington Catchment shall be undertaken using in-situ continuous monitoring instruments. PDP has provided recommendations in relation to the instruments deployed in Section 4.4.

PDP has recommended a total of eight monitoring sites. Details of the selected sites are outlined in the following sections. A priority of 1, 2, or 3 has been assigned to each site, 1 being high priority and 3 being low priority:

- Priority 1 sites are locations of high importance that take precedence over other sites. In PDP's opinion, they must be sampled;
- Priority 2 sites are locations of importance. It is highly recommended they are sampled; and
- Priority 3 sites are non-essential but should be sampled where possible.

PDP recommend in-situ monitoring instruments for all sites where possible. Where this is not possible due to cost or availability of equipment, PDP recommend that lower-priority sites are sampled at a later date.

The sites selected for monitoring in this monitoring plan were selected based on the following criteria:

- Existing knowledge of issues in the catchment, as outlined in Section 2.1.1
- Catchment land uses and building/roading infrastructure density
- High-risk sites, as identified by AECOM (AECOM, 2023)
- Findings of the PDP site walkovers, including but not limited to:
  - Accessibility issues;
  - safety issues; and
  - verification of network layout.
- Key network sub-catchments and tributaries
- Existing monthly monitoring locations (Margetts, et al., 2022)

Proposed monitoring locations for Addington Catchment are outlined in Table 2. The following locations are situated in waterways:

- AB1 – Addington Brook at Deans Avenue; and
- AB2 – Addington Brook at the botanic gardens.

The remaining monitoring sites are situated within manholes. A figure showing these potential locations is appended in Appendix A.

Table 2: Addington Brook monitoring locations

Site ID	Description	Reasoning	Monitoring Method	Water Level Monitoring	Priority
AB1	Addington Brook at Deans Avenue	Site located downstream of the western catchment inlet	In-situ monitoring device	In-situ monitoring device	1
AB2	Addington Brook at the Botanic Garden	Will distinguish any increase in contaminants generated from eastern stormwater influent and Hagley Park (High-Risk Site).	In-situ monitoring device	In-situ monitoring device	2
AB3	O'Shanessey Place manhole	Previous Ecan monitoring showed high dry weather contaminant concentrations (Margetts, et al., 2022).	In-situ monitoring device	In-situ monitoring device	1
AB4	Princess Street Manhole	Isolate the water quality of this branch of the SW Network from the O'Shanessey Place branch	In-situ monitoring device	In-situ monitoring device	1
AB5	Matipo Street Manhole	Will distinguish any increase in contaminants generated from the showgrounds.	In-situ monitoring device	In-situ monitoring device	3
AB6	Carpark off Wrights Road Manhole	Ecan monitoring showed high contaminant levels downstream, which may stem from 'High-risk areas' upstream of this site (ID: 559) (AECOM, 2023).	In-situ monitoring device	In-situ monitoring device	1
AB7	Wrights Road Manhole	Ecan monitoring showed high contaminant levels downstream, which may stem from heavy industry land use areas upstream of this site.	In-situ monitoring device	In-situ monitoring device	2
AB8	Detroit Corner Manhole	Will help identify any dry weather discharges from high-risk sites in the east of the catchment, as advised by Borne and Gadd (2023)	In-situ monitoring device	In-situ monitoring device	2

4.0 Dry Weather Monitoring Protocols

Dry weather monitoring using in situ monitoring instruments will be carried out in the Addington catchment. PDP recommend that continuous data loggers are utilised for this monitoring. It is recommended that the following parameters are logged at 5-minute intervals, continuously, over at least one year's worth of data:

- Conductivity – as a proxy for total dissolved solids (TDS) and salinity;
- Temperature – to identify changes in temperature that may result from discharges;
- Turbidity – as a proxy for total suspended solids (TSS); and
- Water level – to identify spikes in stormwater flows that are unrelated to rainfall.

Continuous dry weather data on these parameters should help to identify discharges, discharge types (continuous flow vs pulse), and the frequency and duration of those discharges (Borne, 2023). A shorter logging interval of 1-2 minutes would allow for more accurate characterisations of peak flows. However, PDP advises a slightly larger logging interval should be utilized for the following reasons:

- A shorter logging interval would mean the duration of continuous dry weather monitoring will be significantly reduced due to memory limitations. This means the monitoring will be disrupted more frequently for collection;
- More frequent data collection which would increase monitoring operational costs and impact H&S requirements; and
- Anomalous dry weather discharge events (e.g. one 20 – 30 minute discharge over three months) will not be critical to capture. The focus is more on longer-term and repeated dry weather discharge events (e.g. 20 – 30 min discharges, weekly) so minute by minute resolution is not critical.

After one year's worth of dry weather data has been collected, results should be analysed and reported on. The analysis and reporting can be defined and undertaken after the monitoring has been completed, as it will depend on the amount and type of data collected as well as the number of discharges detected and characterised. If there are no identifiable trends or discharges, PDP recommends that the dry weather monitoring plan is adjusted, and the probes are redeployed for a further 6 months. If trends are identified, a more targeted dry weather monitoring plan can be implemented. This process should be iterative.

4.1 Dry Weather Criteria

In-situ continuous monitoring will be carried out during all weather. Once the monitoring data has been collected, it will be compared to rainfall data and filtered to contain only dry-day data.

For this report, a "dry day" will count as a day preceded by two antecedent dry days. 'Antecedent dry days' are days with less than 2 mm of rainfall over 24 hrs (Gadd et al., 2014). However, it is anticipated that a "baseline" for each site will be established and used to assist in determining the dry weather criteria.

4.2 In-situ Monitoring Device Options

PDP reviewed the capabilities and costs of the following probes:

- EXO1 and EXO3 probes;
- RiverWatch Waka Package V4.0;
- Leveloggers to be installed in conjunction with turbidity probes;
- Hobologger U24 to be installed in conjunction with turbidity probes; and
- AquaTROLLs;

PDP have provided cost estimates for various dry weather in situ monitoring instruments in Table 3, and full pricing information is included in Appendix B. The parameters measured by each instrument are outlined in Table 4.

Table 3: Costings for different in situ Instruments

Name	Parameters	Quantity Recommended	Cost per unit[1]	Total (incl GST)
EXO1	Temperature, water level, and conductivity	6[3]	$13,560	$76,903
EXO3	Temperature, water level, turbidity, and conductivity	6[3]	$21,833	$145,523
Levelogger 5 LTC	Water level, temperature, and conductivity	8	$4,324	$32,781
Levelogger 5 LTC with Telemetry	Water level, temperature and conductivity	8	$8,771	$61,378
HOBO U20L-Ox Water Level Logger	Water level	8	$3,767	$30,139
HOBO Conductivity/Salinity Bluetooth Data Logger	Conductivity, Temperature, Specific Conductance	8	$2,382	$19,053
Aquistar Turbo Turbidity Sensor[2]	Turbidity	8	$8,780[2]	$70,242
Greenspan TS-1000L Turbidity Sensor	Turbidity	8	$7,699	$61,594
AquaTROLL 600	Conductivity, Temperature, water level and turbidity	8	$18,153	$145,222
RiverWatch Waka Package V4.0	DO, Temperature, Conductivity, Turbidity, and pH	8	$6,422	$50,884

Notes:

1. *Cost is all-inclusive (includes cable, software, probe, sensors etc)*
2. *Probe requires external Power Source*
3. *Pricing is for 6 EXO series loggers, as the CCC have indicated they have two existing EXO series loggers.*

The RiverWatch Waka Package V4.0 has the following additional capabilities:

- Telemetry and wireless capabilities (manual download required if loggers are installed in manholes);
- Advanced user interface for real-time data visualisation; and
- Dissolved oxygen and pH monitoring capabilities.

This device was not included in the complete analysis, as the following drawbacks prevent it from being applicable to dry weather stormwater network monitoring:

- It does not have water level monitoring capabilities; and
- It does not work in depths less than 40 cm.

Due to the high pricing of telemetry, and issues around manhole lids blocking signals, the option of telemetry was discarded. Details on the different options are outlined in Table 4. In addition to these details, it is worth noting that the following probes have Bluetooth and/or wireless capabilities:

- EXO3;
- AquaTROLL 600;
- HOBO conductivity/salinity logger;
- Levelogger 5 LTC;

If this technology works through manhole lids, this will remove hazards surrounding access to monitoring locations in carriageways.

It should be noted that the Turbo Turbidity Sensor requires an external power supply. In contrast, the Greenspan TS-1000L has an optional internal battery pack that lasts up to 6 months, and all other devices have internal batteries that last more than one year. Additionally, some probes require minimum deployment water depths. As noted by Niwa (2023), this is an important criterion to consider in stormwater networks, as there will often be little to no water in the pipeline. This criteria is included in the water level range in Table 3 where it could be found, and as part of the “Range” criteria in Table 4. Niwa advises that some probes may require a weir to be installed, to ensure minimum deployment depths are met and probes are kept submerged where necessary (2023).

Table 4: In-situ monitoring device capability comparison

Parameters		EXO3	Aquistar Turbo Turbidity Sensor	HOBO U24 Conductivity Logger	HOBO U20L-Ox Water Level Logger	Levelogger 5 LTC	Greenspan TS-1000L Turbidity Sensor	AquaTroll 600
Temperature (°C)	Range	-5 – 50 °C	-	5 - 35 °C	-	0 - 50 °C	0 - 50 °C	-5 – 50 °C
	Accuracy	± 0.01% - 0.05% RD[2]	-	± 0.1 °C[3]	-	± 0.05 °C[3]	-	± 0.1 °C[3]
Conductivity (µS/cm)	Range	0 – 100,000 µS/cm	-	Low Range: 0 - 1,000 µS/cm Full range 0 - 10,000 µS/cm	-	Full Range: 0 - 100,000 µS/cm Calibrated range: 50 - 80,000 µS/cm	-	0 - 350,000 µS/cm
	Accuracy	± 0.2 -1% RD[2]	-	Low Range: 3% RD[2] or 5 µS/cm, Full range: 3% RD[2] or 20 µS/cm	-	± 1 - 2% RD[2] or 15 µS/cm	-	± 0.5 - 1.0 % RD[2]
Turbidity (NTU)	Range	0 - 4,000 NTU	0 - 3,000 NTU	-	-	-	0 - 1,000 NTU	0 - 4,000 NTU
	Accuracy	± 2 - 5% RD[2]	± 2% RD[2] or ± 2 NTU	-	-	-	± 1 - 3% FS[1]	± 2% RD[2] or ±0.5 NTU
Level (m)	Range	0 - 10 m	-	-	0 - 30.6 m	0 - 200 m	0.05- 100 m	0 - 30 m
	Accuracy	± 0.04 - 0.03% FS[1]	-	-	± 0.2 % FS[1]	± 0.003 - 0.10 m FS[1]	-	± 0.1% FS[1]
Memory (logs)		1,000,000	260,000	11,500	21,700	150,000	250,000	100,000
Memory (days at 5 minute intervals)		3472.2	902.8	39.9	75.3	520.8	868.1	347.2

Notes:

1. *Accuracy expressed as % of the full scale (FS).*
2. *Accuracy expressed as % of the reading (RD).*
3. *Technical specification does not specific whether accuracy is expressed in FS or RD.*

4.3 Multi-Criteria Analysis

To compare the alternative in-situ monitoring devices, a Multi-criteria analysis (MCA) was carried out. This MCA is based on the above information: cost, accuracy, range, memory, and additional features. Lead times were not factored into this analysis, due to lack of available information. The criteria were each given a weighting, from 1 – 5, 5 being the most important. Then, each probe was scored against these criteria, on a scale of 1 -5, 5 being the best performing as shown in Table 5.

Table 5: Multi-Criteria Analysis

Parameter	Weight	EXO3	HOBO Loggers[1]	Aquistar Turbo Turbidity Sensor[1]	Greenspan TS-1000L Turbidity Sensor[1]	Levelogger 5 LTC[1]	AquaTROLL 600
Cost[1]	5	2	4	4	5	5	3
Accuracy	4	4	3	4	4	5	5
Range	4	4	2	1	3	3	5
Memory	2	5	2	5	5	5	5
Utility[2]	1	5	3	1	2	4	5
Totals		**57**	**47**	**51**	**65**	**71**	**70**

Notes:

1. *Loggers without the capability to log all three required parameters were paired with the cheapest compatible probes to give a relative price. The cheapest turbidity probe is the Greenspan TS-1000L Turbidity Sensor, and the cheapest conductivity probe and water level logger was the Levelogger 5 LTC without telemetry.*
2. *"Utility" refers to additional useful features possessed by each device, including wireless/Wi-Fi capabilities, battery source/life, and ease of installation.*

4.4 Recommendations

As indicated by Table 5, PDP recommends CCC adopt one of the following options for in-situ monitoring:

- AquaTROLL 600 ($18,153 per site); or
- Levelogger 5 LTC in conjunction with the Greenspan TS-1000L Turbidity Sensor ($12,023 per site);

While the AquaTROLL provides more versatility, utility, and a greater range and accuracy in readings, it is the more expensive option. The Levelogger/Greenspan combo adequately meets the project's needs and provides a good range and accuracy in measurements – at a lower cost.

While measuring turbidity would be preferable, the high cost of turbidity probes may exclude this as an option. For a reduced cost option, PDP recommends that the Levelogger 5 LTC be deployed at all dry weather monitoring sites, to measure temperature, conductivity, and water level. A breakdown of the capital cost for the recommended options for loggers and site selection is outlined below in Table 6.

Table 6: Cost break down for the recommended in-situ monitoring devices.

Sites Samples	Levelogger 5 LTC	Levelogger 5 LTC & Greenspan TS-1000L Turbidity Sensor	AquaTROLL
Priority 1 Sites – four sites	$16,520	$47,317	$72,611
Priority 1 & 2 Sites – seven sites	$28,716	$82,610	$127,069
Priority 1, 2 & 3 Sites – eight sites	$32,780	$94,375	$145,222

4.5 Quality Assurance

In-situ monitoring devices will be calibrated prior to deployment. Recalibration frequency will be dependent on the in-situ monitoring device selected by the council. Therefore, recalibration will occur as required.

5.0 Installation & Maintenance

5.1 Installation

5.1.1 In situ monitoring devices

In-situ monitoring devices will be installed securely in manholes and drains. The installation method will be devised in conjunction with the contractors engaged to install the devices. Small weirs may need to be installed in conjunction with loggers to meet minimum deployment depth requirements; however, this will depend on the logger chosen. Consideration will need to be given to confined space entry.

5.1.2 Location Access

Locations AB5 and AB6 will require stakeholder engagement and access requests prior to installation. AB5 is located on Rating Unit 36227. This is an accessway that appears to be frequently used by heavy vehicles. AB6 is in a shared car park on rating unit 33147. The building situated on this lot appears to be uninhabited. Above mentioned locations are pictured in Figure 3.

Figure 3. In-situ monitoring sites located on private property, pictured from left to right: AB6 and AB5.

Locations AB3, AB4, AB7, and AB8 are situated in or around carriageways. AB7 is the highest risk location, situated in the middle of the heavily trafficked Wrights Road. Installation and maintenance on this street would require traffic management planning and carriageway closures. As an alternative to this location, a double sump (ID: 9669) was identified at the intersection between Moncur Place and Wrights Road. This sump is situated off the main carriageway, but is still connected to the main network. This will provide safer access if required. AB4 and AB3 are situated on Princess Street and O'Shanessey Place, respectively. They are situated off the main carriageway, on more quiet back streets. They have both been previously grab sampled by CCC, as per Figure 1. The above-mentioned locations are pictured below in Figure 4. AB8 is not pictured, as this site was selected via a desktop assessment after Borne and Gadd completed a peer review (2023). A site visit should be conducted prior to deployment in AB8, to assess access and health and safety constraints.

Figure 4. In situ monitoring sites located on carriageways, pictured from left to right: AB7, AB3, and AB4.

5.2 Maintenance

To ensure in-situ instruments are adequately maintained prior to monitoring, the following routine maintenance checks should be undertaken:

- Ensure in-situ monitoring devices are fully charged prior to deployment.
- Ensure any pre-recorded data is downloaded and deleted from the loggers' memory

- Ensure in-situ monitoring devices are calibrated prior to deployment and recalibrated as required.
- Carry out regular inspections to ensure in-situ monitoring devices are working as required, once deployed.

5.3 Security

Installation of in-stream in-situ monitoring devices introduces risk of vandalism. The proposed in-stream monitoring devices are small in size and the options for reducing the risk of vandalism include:

- Locking the devices to a structure such as a bridge, culvert, or waratah.
- Concealing devices within structures or behind vegetation.
- Installing devices in the centre of a waterway to reduce access.

The option selected for each site will depend on the type of device to be used, ease of public access, visibility, and existing structures. The effect of vegetation or structures on the measurements will also need to be considered if using these to conceal the device.

6.0 Reporting

PDP recommends that upon completion of all monitoring, results should be analysed and reported. PDP recommend that the following analysis is undertaken:

- In-situ monitoring device data should be cleaned to remove rainfall events, and this data should be presented and analysed.
- Discharge occurrence, duration and frequency should be identified.
- Recommendations on future in-situ monitoring within the Addington Brook Catchment should be suggested.

This information can be used to inform future monitoring plans.

7.0 Conclusion and Recommendations

PDP has completed a dry weather monitoring plan for Addington Catchment. This monitoring plan includes details on:

- Previous catchment monitoring undertaken by CCC, the University of Canterbury, and ECan;
- Catchment information, including limitations and complicating factors;
- Monitoring locations, with assigned priority levels;
- Dry weather event criteria;

- Installation methodology; and
- Recommendations on in-situ monitoring devices, and their potential costs.

In summary, there are eight monitoring locations that have been identified by PDP to characterise catchments that may be sources of dry-weather discharges of contaminants. The selected monitoring locations have been assigned a priority level, to give CCC flexibility in the number of monitoring devices they wish to obtain.

At each location, one years' worth of continuous dry weather monitoring data shall be collected using in-situ probes. PDP recommend probes log the following parameters:

- Conductivity;
- Temperature;
- Water level; and potentially,
- Turbidity.

While measuring turbidity is preferable, the high cost of turbidity probes may exclude this as an option. A costing breakdown of the recommended options is included below in Table 7.

Table 7: Cost break down for the recommended in-situ monitoring devices.

Sites Samples	Levelogger 5 LTC	Levelogger 5 LTC & Greenspan TS-1000L Turbidity Sensor	AquaTROLL
Priority 1 Sites – four sites	$16,520	$47,317	$72,611
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Priority 1, 2 & 3 Sites – eight sites	$32,780	$94,375	$145,222

After one years' worth of dry weather data has been collected, PDP recommends the data be analysed and reported on. If there are no major trends, the monitoring plan can be adjusted, and probes can be redeployed for a further six months of continuous monitoring. If there are clear trends, monitoring locations and methodologies can be adjusted as required. This process should be iterative.

PDP recommends that CCC considers the monitoring locations presented in this report in terms of their priority level and accessibility, and provides information to PDP or the contractor undertaking the monitoring works regarding site accessibility and preferences as necessary.

8.0 References

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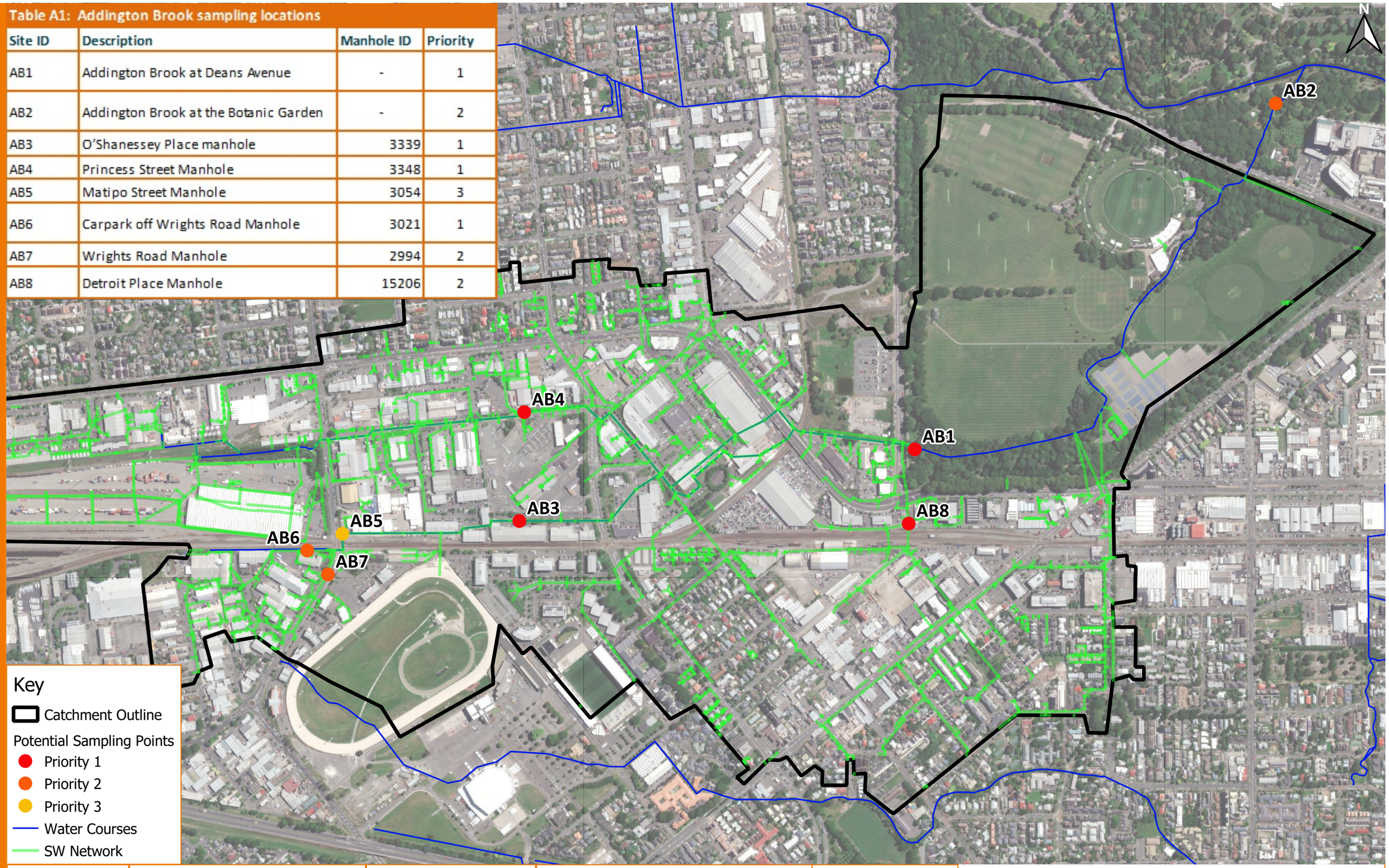
Appendix A: Addington Catchment Monitoring Map

Table A1: Addington Brook sampling locations

Site ID	Description	Manhole ID	Priority
AB1	Addington Brook at Deans Avenue	-	1
AB2	Addington Brook at the Botanic Garden	-	2
AB3	O'Shanessey Place manhole	3339	1
AB4	Princess Street Manhole	3348	1
AB5	Matipo Street Manhole	3054	3
AB6	Carpark off Wrights Road Manhole	3021	1
AB7	Wrights Road Manhole	2994	2
AB8	Detroit Place Manhole	15206	2



METRES (A4)
SCALE : 1:7,500

REVISION: 4
DATE: 15/03/2024
BY: ELLA HARRIS

NOTES

1. AERIAL IMAGERY SOURCED FROM THE LINZ DATA SERVICE [https://data.linz.govt.nz] AND LICENCED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENCE.

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Addington Catchment: Proposed Water Quality Sampling Locations

Targeted wet weather monitoring plan

Appendix B: Cost Analysis for In-Situ Monitoring Devices

Priorty 1, 2 & 3				
Item	**Description**	**Qty**	**Cost**	**Total**
EXO1				
YSI-599501-01	EXO1 Sonde, 10 meter Depth, 4 Sensor Ports, Depth range: 0-10 meters, Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 2 Port Plugs, USB drive loaded with Manual and KOR Software	6	9,324.00	55,944.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	6	1,692.00	10,152.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**11,792.00**	**66,872.00**
Tax			**1,768.80**	**10,030.80**
Total (inc Tax)			**13,560.80**	**76,902.80**
EXO3				
YSI-599503-01	EXO3 Sonde, 10 meter depth, 4 Sensor Ports, 1 Wiper Port, Depth range: 0-10 metres, No AUX Port, native SDi-12, Compact Battery Compartment. Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 3 port plugs, USB drive loaded with User Manual and KOR Software	6	10,814.00	64,884.00
YSI-599090-01	EXO Central Wiper, EXO2 & EXO3, Installs in center wiper port on EXO2 and EXO3 sondes only, Includes two wiper brushes and installation tool, Used in unattended monitoring deployments to reduce bio-fouling.	6	2,305.00	13,830.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	6	1,692.00	10,152.00
YSI-599101-01	EXO Turbidity Sensor, Compatible with any EXO sonde, Wide range Sensor reads from 0-4000 FNU, Incorporates wet-mate connector and welded titanium housing	6	3,399.00	20,394.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**18,986.00**	**126,541.40**
Tax			**2,847.90**	**18,981.21**
Total (inc Tax)			**21,833.90**	**145,522.61**
LevelLogger				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	8	2,837.00	22,696.00
SOL-114608	3001 Barologger 5	8	698.00	5,584.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
Total			**3,760.00**	**28,505.00**
Tax			**564.00**	**4,275.75**
Total (inc Tax)			**4,324.00**	**32,780.75**
HOBO Water Level Logger Delux (U20L-0x)				
U20-001-02	HOBO Logger (100' range)	8	3,276	26,208
U20-001-04	HOBO Logger (13' range) for Baraometric Pressure	1		
U20-DTW-1	HOBO waterproof shuttle	1		
U20-CASE-1	carrying case	1		
BHW-PRO-USB	HOBOware Pro software	1		
Total			**3,276**	**26,208**
Tax			**491**	**3,931**
Total (inc Tax)			**3,767**	**30,139**
HOBO U24 - Conductivity/Salinity (Fresh Water)				
Hobo U24		8	2,071.00	16,568.00
Total			**2,071.00**	**16,568.00**
Tax			**310.65**	**2,485.20**
Total (inc Tax)			**2,381.65**	**19,053.20**
LevelLogger with telemetry				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	8	2,837.00	22,696.00
SOL-114608	3001 Barologger 5	8	698.00	5,584.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
SOL-115711	3001 L5 Direct Read Cable (34ft) for the Levelogger 5	1	257.00	257.00
SOL-115133	3001 SDI-12 Interface Cable for the Levelogger (15ft length) w/Ferrules	1	610.00	610.00
IRS 150FXC	iRIS 150C Data Logger, 8MB flash memory, two analogue and two digital inputs, SDI-12 support, single digital output, switched 12V output, communications via RS232.	8	885.00	7,080.00
iRIS ICE4GT	iCE4 GT Modem	8	700.00	5,600.00
Telemetry	Telemetry - One year data hosting and online portal. Unlimitied email and sms notification	8	720.00	5,760.00
Enclosure	Enclosure and Mounting of Equipment	8	695.00	5,560.00
			7,627.00	**53,372.00**
Tax			**1,144.05**	**8,005.80**
Total (inc Tax)			**8,771.05**	**61,377.80**
Aquistar Turbo Turbidity Sensor				
INW 2N11130	Aquistar Turbo Turbidity Sensor, ISO 7027, 0 - 3,000 NTU with 10 m cable	8	7,635.00	61,080.00
Tax			**1,145.25**	**9,162.00**
Total (inc Tax)			**8,780.25**	**70,242.00**
Greenspan TS-1000A/L Turbidity Sensor				
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	8	6,695.00	53,560.00

Tax				**1,004.25**	**8,034.00**
Total (inc Tax)				**7,699.25**	**61,594.00**
Aquatroll 600					
00-74050	AquaTroll 600 Non-Vented - 0 - 30 m water quality sonde	8		8,350	66,800
0063480	Aqua Troll 500 and 600 Turbidity Sensor	8		2,275	18,200
0063460	Aqua Troll 500 and 600 Temperature/Conductivity	8		1,865	14,920
0063510	Aqua Troll 500 and 600 sensor port plug	8		105	840
0051480	Twist-Lock Backshell/Hanger - Used to sea off quatroll if is just used for a logging/spot check unit	8		300	2,400
006350	Dual-sided active anti fouling measure for snesor face and seidment build up onrestrictor	8		2,350	18,800
0064630	Aquatroll 500 and 600 wiper port plug	8		145	1,160
5200-03-01-R025	Rugged twistlock poly non-vented 5 m cable	8		395	3,160
Total			**15,785**		**126,280**
Tax			**2,368**		**18,942**
Total (inc Tax)			**18,153**		**145,222**
Greenspan TS-1000A/L Turbidity Sensor and LevelLogger					
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	8	6695		53560
SOL-114615	3001 Levelogger 5 LTC, M5/C80	8	2837		22696
SOL-114608	3001 Barologger 5	8	698		5584
SOL-114403	3001 Field Reader 5 USB Assembly	1	225		225
Total			**10455**		**82065**
Tax			**1568.25**		**12309.75**
Total (inc Tax)			**12023.25**		**94374.75**

Priorty 1 & 2 Sites

Item	Description	Qty	Cost	Total
EXO1				
YSI-599501-01	EXO1 Sonde, 10 meter Depth, 4 Sensor Ports, Depth range: 0-10 meters, Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 2 Port Plugs, USB drive loaded with Manual and KOR Software	5	9,324.00	46,620.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	5	1,692.00	8,460.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**11,792.00**	**55,856.00**
Tax			**1,768.80**	**8,378.40**
Total (inc Tax)			**13,560.80**	**64,234.40**
EXO3				
YSI-599503-01	EXO3 Sonde, 10 meter depth, 4 Sensor Ports, 1 Wiper Port, Depth range: 0-10 metres, No AUX Port, native SDi-12, Compact Battery Compartment. Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 3 port plugs, USB drive loaded with User Manual and KOR Software	5	10,814.00	54,070.00
YSI-599090-01	EXO Central Wiper, EXO2 & EXO3, Installs in center wiper port on EXO2 and EXO3 sondes only, Includes two wiper brushes and installation tool, Used in unattended monitoring deployments to reduce bio-fouling.	5	2,305.00	11,525.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	5	1,692.00	8,460.00
YSI-599101-01	EXO Turbidity Sensor, Compatible with any EXO sonde, Wide range Sensor reads from 0-4000 FNU, Incorporates wet-mate connector and welded titanium housing	5	3,399.00	16,995.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**18,986.00**	**105,599.90**
Tax			**2,847.90**	**15,839.99**
Total (inc Tax)			**21,833.90**	**121,439.89**
LevelLogger				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	7	2,837.00	19,859.00
SOL-114608	3001 Barologger 5	7	698.00	4,886.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
Total			**3,760.00**	**24,970.00**
Tax			**564.00**	**3,745.50**
Total (inc Tax)			**4,324.00**	**28,715.50**
HOBO Water Level Logger Delux (U20L-0x)				
U20-001-02	HOBO Logger (100' range)	7	3,276	22,932
U20-001-04	HOBO Logger (13' range) for Baraometric Pressure	1		
U20-DTW-1	HOBO waterproof shuttle	1		
U20-CASE-1	carrying case	1		
BHW-PRO-USB	HOBOware Pro software	1		
Total			**3,276**	**22,932**
Tax			**491**	**3,440**
Total (inc Tax)			**3,767**	**26,372**
HOBO U24 - Conductivity/Salinity (Fresh Water)				
Hobo U24		7	2,071.00	14,497.00
Total			**2,071.00**	**14,497.00**
Tax			**310.65**	**2,174.55**
Total (inc Tax)			**2,381.65**	**16,671.55**

LevelLogger with telemetry				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	7	2,837.00	19,859.00
SOL-114608	3001 Barologger 5	7	698.00	4,886.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
SOL-115711	3001 L5 Direct Read Cable (34ft) for the Levelogger 5	1	257.00	257.00
SOL-115133	3001 SDI-12 Interface Cable for the Levelogger (15ft length) w/Ferrules	1	610.00	610.00
IRS 150FXC	iRIS 150C Data Logger, 8MB flash memory, two analogue and two digital inputs, SDI-12 support, single digital output, switched 12V output, communications via RS232.	7	885.00	6,195.00
iRIS ICE4GT	iCE4 GT Modem	7	700.00	4,900.00
Telemetry	Telemetry - One year data hosting and online portal. Unlimitied email and sms notification	7	720.00	5,040.00
Enclosure	Enclosure and Mounting of Equipment	7	695.00	4,865.00
			7,627.00	**46,837.00**
Tax			**1,144.05**	**7,025.55**
Total (inc Tax)			**8,771.05**	**53,862.55**
Aquistar Turbo Turbidity Sensor				
INW 2N11130	Aquistar Turbo Turbidity Sensor, ISO 7027, 0 - 3,000 NTU with 10 m cable	7	7,635.00	53,445.00
Tax			**1,145.25**	**8,016.75**
Total (inc Tax)			**8,780.25**	**61,461.75**
Greenspan TS-1000A/L Turbidity Sensor				
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	7	6,695.00	46,865.00
Tax			**1,004.25**	**7,029.75**
Total (inc Tax)			**7,699.25**	**53,894.75**
Aquatroll 600				
00-74050	AquaTroll 600 Non-Vented - 0 - 30 m water quality sonde	7	8,350	58,450
0063480	Aqua Troll 500 and 600 Turbidity Sensor	7	2,275	15,925
0063460	Aqua Troll 500 and 600 Temperature/Conductivity	7	1,865	13,055
0063510	Aqua Troll 500 and 600 sensor port plug	7	105	735
0051480	Twist-Lock Backshell/Hanger - Used to sea off quatroll if is just used for a logging/spot check unit	7	300	2,100
006350	Dual-sided active anti fouling measure for snesor face and seidment build up onrestrictor	7	2,350	16,450
0064630	Aquatroll 500 and 600 wiper port plug	7	145	1,015
5200-03-01-R025	Rugged twistlock poly non-vented 5 m cable	7	395	2,765
Total			**15,785**	**110,495**
Tax			**2,368**	**16,574**
Total (inc Tax)			**18,153**	**127,069**
Greenspan TS-1000A/L Turbidity Sensor and LevelLogger				
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	7	6695	46865
SOL-114615	3001 Levelogger 5 LTC, M5/C80	7	2837	19859
SOL-114608	3001 Barologger 5	7	698	4886
SOL-114403	3001 Field Reader 5 USB Assembly	1	225	225
Total			**10455**	**71835**
Tax			**1568.25**	**10775.25**
Total (inc Tax)			**12023.25**	**82610.25**

Priorty 1				
Item	**Description**	**Qty**	**Cost**	**Total**
EXO1				
YSI-599501-01	EXO1 Sonde, 10 meter Depth, 4 Sensor Ports, Depth range: 0-10 meters, Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 2 Port Plugs, USB drive loaded with Manual and KOR Software	2	9,324.00	18,648.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	2	1,692.00	3,384.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**11,792.00**	**22,808.00**
Tax			**1,768.80**	**3,421.20**
Total (inc Tax)			**13,560.80**	**26,229.20**
EXO3				
YSI-599503-01	EXO3 Sonde, 10 meter depth, 4 Sensor Ports, 1 Wiper Port, Depth range: 0-10 metres, No AUX Port, native SDi-12, Compact Battery Compartment. Contains: Sonde, 2 "D" Batteries, Calibration Cup, Tool Kit, 3 port plugs, USB drive loaded with User Manual and KOR Software	2	10,814.00	21,628.00
YSI-599090-01	EXO Central Wiper, EXO2 & EXO3, Installs in center wiper port on EXO2 and EXO3 sondes only, Includes two wiper brushes and installation tool, Used in unattended monitoring deployments to reduce bio-fouling.	2	2,305.00	4,610.00
YSI-599870	EXO Conductivity & Temperature Sensor, flow channel design and high accuracy fast response temperature	2	1,692.00	3,384.00
YSI-599101-01	EXO Turbidity Sensor, Compatible with any EXO sonde, Wide range Sensor reads from 0-4000 FNU, Incorporates wet-mate connector and welded titanium housing	2	3,399.00	6,798.00
YSI-599810	EXO Signal Output Adapter - USB Allows connections between EXO sonde and a PC	1	776.00	776.00
Total			**18,986.00**	**42,775.40**
Tax			**2,847.90**	**6,416.31**

Total (inc Tax)			**21,833.90**	**49,191.71**

LevelLogger				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	4	2,837.00	11,348.00
SOL-114608	3001 Barologger 5	4	698.00	2,792.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
Total			**3,760.00**	**14,365.00**
Tax			**564.00**	**2,154.75**
Total (inc Tax)			**4,324.00**	**16,519.75**

HOBO Water Level Logger Delux (U20L-0x)				
U20-001-02	HOBO Logger (100' range)	4	3,276	13,104
U20-001-04	HOBO Logger (13' range) for Baraometric Pressure	1		
U20-DTW-1	HOBO waterproof shuttle	1		
U20-CASE-1	carrying case	1		
BHW-PRO-USB	HOBOware Pro software	1		
Total			**3,276**	**13,104**
Tax			**491**	**1,966**
Total (inc Tax)			**3,767**	**15,070**

HOBO U24 - Conductivity/Salinity (Fresh Water)				
Hobo U24		4	2,071.00	8,284.00
Total			**2,071.00**	**8,284.00**
Tax			**310.65**	**1,242.60**
Total (inc Tax)			**2,381.65**	**9,526.60**

LevelLogger with telemetry				
SOL-114615	3001 Levelogger 5 LTC, M5/C80	4	2,837.00	11,348.00
SOL-114608	3001 Barologger 5	4	698.00	2,792.00
SOL-114403	3001 Field Reader 5 USB Assembly	1	225.00	225.00
SOL-115711	3001 L5 Direct Read Cable (34ft) for the Levelogger 5	1	257.00	257.00
SOL-115133	3001 SDI-12 Interface Cable for the Levelogger (15ft length) w/Ferrules	1	610.00	610.00
IRS 150FXC	iRIS 150C Data Logger, 8MB flash memory, two analogue and two digital inputs, SDI-12 support, single digital output, switched 12V output, communications via RS232.	4	885.00	3,540.00
iRIS ICE4GT	iCE4 GT Modem	4	700.00	2,800.00
Telemetry	Telemetry - One year data hosting and online portal. Unlimitied email and sms notification	4	720.00	2,880.00
Enclosure	Enclosure and Mounting of Equipment	4	695.00	2,780.00
			7,627.00	**27,232.00**
Tax			**1,144.05**	**4,084.80**
Total (inc Tax)			**8,771.05**	**31,316.80**

Aquistar Turbo Turbidity Sensor				
INW 2N11130	Aquistar Turbo Turbidity Sensor, ISO 7027, 0 - 3,000 NTU with 10 m cable	4	7,635.00	30,540.00
Tax			**1,145.25**	**4,581.00**
Total (inc Tax)			**8,780.25**	**35,121.00**

Greenspan TS-1000A/L Turbidity Sensor				
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	4	6,695.00	26,780.00
Tax			**1,004.25**	**4,017.00**
Total (inc Tax)			**7,699.25**	**30,797.00**

Aquatroll 600				
00-74050	AquaTroll 600 Non-Vented - 0 - 30 m water quality sonde	4	8,350	33,400
0063480	Aqua Troll 500 and 600 Turbidity Sensor	4	2,275	9,100
0063460	Aqua Troll 500 and 600 Temperature/Conductivity	4	1,865	7,460
0063510	Aqua Troll 500 and 600 sensor port plug	4	105	420
0051480	Twist-Lock Backshell/Hanger - Used to sea off quatroll if is just used for a logging/spot check unit	4	300	1,200
006350	Dual-sided active anti fouling measure for snesor face and seidment build up onrestrictor	4	2,350	9,400
0064630	Aquatroll 500 and 600 wiper port plug	4	145	580
5200-03-01-R025	Rugged twistlock poly non-vented 5 m cable	4	395	1,580
Total			**15,785**	**63,140**
Tax			**2,368**	**9,471**
Total (inc Tax)			**18,153**	**72,611**

Greenspan TS-1000A/L Turbidity Sensor and LevelLogger				
GRN TS-1000L	TS-1000L Logging sensor with lens Wiper, Battery pack and comms cable	4	6695	26780
SOL-114615	3001 Levelogger 5 LTC, M5/C80	4	2837	11348
SOL-114608	3001 Barologger 5	4	698	2792
SOL-114403	3001 Field Reader 5 USB Assembly	1	225	225
Total			**10455**	**41145**
Tax			**1568.25**	**6171.75**
Total (inc Tax)			**12023.25**	**47316.75**