



Otago Regional Council  
SOE Monitoring 2010:  
Instream and Riparian  
Habitat Assessment  
Summary

EOS Ecology Report No. 09024-ORC01-01 | June 2010

AQUATIC RESEARCH  
CONSULTANTS





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## REPORT

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## 1 INTRODUCTION

Between the 3rd and 10th of February 2010, EOS Ecology conducted the field component of Otago Regional Council's (ORC) 2010 State of the Environment (SOE) monitoring at 30 sites throughout the Otago region; from Oamaru west to Wanaka and south to the Catlins. This involved a habitat assessment and collection of periphyton and macroinvertebrate samples and subsequent laboratory analysis and processing. This report summarises the methodology and results of the habitat assessment component. EOS Ecology was not asked to analyse the results but only to present a summary of the methods used and tabulate the raw data.

## 2 METHODS

### 2.1 Fieldwork

At all sites habitat assessment was undertaken according to Protocol P2 (semi-quantitative) of Harding *et al.* (2009). This included the following components; P2b—Hydrological and morphological procedure, P2c—Instream habitat procedure, and P2d—Riparian procedure. The P2b procedure included measurement of wetted width, meso-habitat length, pool water and soft sediment depth, estimation of floodplain shape, bankfull channel shape, wetted width channel shape, undercutting, a discharge gauging across a transect, and completion of a plan diagram of the site. The P2c procedure involved the estimation of substrate size, embeddedness, substrate compactness, area of scouring and depositional zones, obstructions to flow, undercutting and overhanging vegetation, and cover of macrophytes, moss, algal beds, and wood and leaf packs. The P2d procedure estimated shading of waterway, riparian buffer width and intactness, riparian vegetation composition, bank stability, livestock access, riparian soil denitrification potential, land slope, groundcover, soil drainage, and the number of rills. See Harding *et al.* (2009) for full details of these procedures.

### 2.2 Data entry and analysis

The P2b data was entered into the MS Excel spreadsheet form ('P2A Input' sheet) supplied with Harding *et al.* (2009). This Excel form calculates a number of hydrological and morphological parameters and provides a diagram of the stream profile at the point where the discharge gauging was undertaken. It should be noted that an error was discovered on the 'P2A Metrics' sheet supplied with Harding *et al.* (2009) where the Gini coefficient (a measure of channel shape variability) cell was not actively linked to the calculation area of the sheet. This was corrected.

Harding *et al.* (2009) does not provide any entry sheets for P2c and P2d data thus we created custom Excel spreadsheets for the entry of this data.

## 3 RESULTS

All sites were surveyed between February 3rd and 10th, 2010 (Table 1). A full tabulation of the raw data is provided in the Appendices. The only difficulties encountered during sampling were:

- » Site 9—Waikouaiti River @ Orbells Crossing is a tidally influenced site and the stage of the tide influences a number of key hydrological parameters such as depth, width, and velocity.

- » Site 14—Waipori River @ Falls Reserve has very variable flow due to a hydro dam upstream. We were informed by a TrustPower employee that the water level in this river changes rapidly without warning (depending on power demand). There was too much flow to safely enter the water to complete the depth/velocity transect.
- » Site 16—Ida Burn @ SH85 had incorrect GPS coordinates provided by ORC. The provided coordinates were for a site on Hills Creek which is northwest of Ida Burn on SH85. EOS Ecology sampled both sites (the site co-ordinates on Hills Creek as well as Ida Burn @ SH85) to ensure the correct site was sampled and subsequent correspondence with the ORC concluded that the co-ordinates were wrong. Thus the Hills Creek data has not been presented.

The P2 method of habitat assessment gave a reasonable overview of each site. The prescribed sampling time of 45-60 minutes (Harding *et al.* 2009) was achievable at the smaller sites. Sites at larger rivers and those where access along the stream was difficult took considerably longer. Many of the habitat evaluation parameters involved subjective estimations and these were assessed by one team member for consistency between sites.

Sampling occurred during a period of stable weather with little rainfall. During the field survey period only light drizzle was encountered and it was evident at many sites from the abundance of algae that no significant scouring flows had occurred for some time.

For the smaller rivers and streams the prescribed site length of 20 times the wetted width (Harding *et al.* 2009) was easily attainable. For the larger rivers a site length of 20 times the wetted width was excessive (e.g., > 250 m) and thus a default site length 150–200 m was chosen (making sure all habitat types present were included within the site). Surveyed site lengths ranged from 50 m (Site 13—Silver Stm @ Riccarton

**TABLE 1 The 30 Otago Regional Council State of the Environment biomonitoring sites surveyed between February 3rd and 10th, 2010. Note that the site codes were assigned by EOS Ecology.**

| Site code | Site name                            | Site code | Site name                         |
|-----------|--------------------------------------|-----------|-----------------------------------|
| 1         | Kakanui River @ Clifton Falls        | 16        | Ida Burn @ SH85                   |
| 2         | Kakanui River @ McCones              | 17        | Fraser River @ Marshall Rd        |
| 3         | Kauru @ Ewings                       | 18        | Cardrona River @ Mt Barker        |
| 4         | Shag River @ Craig Rd                | 19        | Lindis River @ Ardgour Rd         |
| 5         | Shag River @ Goodwood Pump           | 20        | Luggate Ck @ SH6 bridge           |
| 6         | Trotters Ck @ Mathesons              | 21        | Mill Ck @ Fish Trap               |
| 7         | Waianakarua @ Browns Pump            | 22        | Heriot Burn @ Park Hill Rd        |
| 8         | Waiareka Ck @ Taipo Rd               | 23        | Waipahi River @ Waipahi           |
| 9         | Waikouaiti River @ Orbell's Crossing | 24        | Waitahuna @ Tweeds Bridge         |
| 10        | Kaikorai Stm @ Brighton Rd           | 25        | Waiwera River 1km US of Clutha    |
| 11        | Lindsay Ck @ North Bar Rd            | 26        | Crookston Burn @ Kelso-Tapanui Rd |
| 12        | Water of Leith @ Dundas Street       | 27        | Waikoikoi Ck @ Bailey Bridge      |
| 13        | Silver Stm @ Riccarton Rd            | 28        | Waipahi River @ Cairns            |
| 14        | Waipori River @ Falls Reserve        | 29        | Tokomairiro @ West Branch Bridge  |
| 15        | Dunstan Ck @ Beattie Rd              | 30        | Catlins River @ Houipapa          |



Rd and Site 16—Ida Burn @ SH85) to 200 m (Site 2—Kakanui River @ McCones and Site 23—Waipahi River @ Waipahi). Discharge ranged from 0.001 m<sup>3</sup>/s (Site 6—Trotters Ck @ Mathesons) to 2.3 m<sup>3</sup>/s (Site 17—Fraser River @ Marshall Rd). However, discharge was likely greatest at Site 14—Waipori River @ Falls Reserve where hydro-dam release made the river too dangerous to wade and undertake the stream discharge gauging. Full hydrological and morphological (P2b) results are shown in the Appendices (Section 5.1).

Most sites had a substratum dominated by cobbles (64-255 mm) and gravel (2-63 mm) and algal cover in excess of 50%. Full instream habitat (P2c) results are shown in the Appendices (Section 5.2). Most sites had minimal shading and only a few allowed full livestock access. Full riparian condition results are shown in the Appendices (Section 5.3).

#### 4 REFERENCES

Harding, J.S., Clapcott, J.E., Quinn, J.M., Hayes, J.W., Joy, M.K., Storey, R.G., Greig, H.S., Hay, J., James, T., Beech, M.A., Ozanne R., Meredith, A., Boothroyd, I. 2009. *Stream Habitat Assessment Protocols for Wadeable Rivers and Streams of New Zealand*. School of Biological Sciences, University of Canterbury, Christchurch, New Zealand. 133 p.

## 5 APPENDICES

### 5.1 Summary of hydrological and morphological data

**TABLE 5.1 Summary of P2b hydrological and morphological information (as per Harding *et al.* 2009) collected from 30 sites in the Otago region as part of Otago Regional Council's 2010 State of the Environment monitoring. Information was collected between February 3rd and 10th, 2010.**

| Site code                              | 1                             | 2                       | 3              | 4                     | 5                          |
|--|-------------------------------|-------------------------|----------------|-----------------------|----------------------------|
| Site name                              | Kakanui River @ Clifton Falls | Kakanui River @ McCones | Kauru @ Ewings | Shag River @ Craig Rd | Shag River @ Goodwood Pump |
| Assessor                               | AS & VB                       | AS & VB                 | AS & VB        | AS & VB               | AS & VB                    |
| Date                                   | 3/02/10                       | 4/02/10                 | 3/02/10        | 4/02/10               | 4/02/10                    |
| Wetted width (m)                       | 13.10                         | 10.00                   | 9.50           | 5.50                  | 2.50                       |
| Site length (m)                        | 120                           | 200                     | 160            | 100                   | 85                         |
| Percent rapid (%)                      | 0.00                          | 0.00                    | 0.00           | 0.00                  | 0.00                       |
| Percent run (%)                        | 18.33                         | 8.00                    | 16.88          | 35.00                 | 23.53                      |
| Percent riffle (%)                     | 24.17                         | 32.00                   | 14.38          | 32.00                 | 25.88                      |
| Percent pool (%)                       | 57.50                         | 60.00                   | 68.75          | 33.00                 | 50.59                      |
| Percent backwater (%)                  | 18.33                         | 0.00                    | 0.00           | 0.00                  | 0.00                       |
| Percent other meso habitat (%)         | 0.00                          | 0.00                    | 0.00           | 0.00                  | 0.00                       |
| Meso habitat richness                  | 4                             | 3                       | 3              | 3                     | 3                          |
| Start of reach easting                 | 2332690.426                   | 2343683.789             | 2331830.04     | 2327066.157           | 2334437.233                |
| Start of reach northing                | 5572688.851                   | 5556865.249             | 5563879.989    | 5528795.644           | 5523383.684                |
| End of reach easting                   | 2332630.351                   | 2343458.608             | 2331691.194    | 2326995.465           | 2334419.928                |
| End of reach northing                  | 5572789.443                   | 5556865.849             | 5563828.12     | 5528843.303           | 5523450.899                |
| Average pool maximum depth (m)         | 0.77                          | 0.55                    | 1.38           | 0.53                  | 1.35                       |
| Average pool sediment depth (m)        | 0.00                          | 0.00                    | 0.00           | 0.00                  | 0.01                       |
| Average pool crest depth (m)           | 0.20                          | 0.16                    | 0.20           | 0.18                  | 0.12                       |
| Residual pool depth (m)                | 0.57                          | 0.40                    | 1.18           | 0.35                  | 1.23                       |
| Floodplain shape                       | Wide                          | Wide                    | U shape        | Multi-stage           | Multi-stage                |
| Run bankfull shape                     | U shape                       | Wide                    | Multi-stage    | Wide                  | U shape                    |
| Riffle bankfull shape                  | U shape                       | Wide                    | Multi-stage    | Wide                  | Wide                       |
| Pool bankfull shape                    | U shape                       | Wide                    | U shape        | Wide                  | U shape                    |
| Run channel shape                      | Wide                          | U shape                 | Wide           | Wide                  | Wide                       |
| Riffle channel shape                   | Wide                          | Wide                    | Wide           | Wide                  | Wide                       |
| Pool channel shape                     | Wide                          | Wide                    | U shape        | Wide                  | U shape                    |
| Average bank undercut (m)              | 0.10                          | 0.00                    | 0.13           | 0.00                  | 0.00                       |
| Bank height (m)                        | 1.92                          | 1.55                    | 0.97           | 1.25                  | 1.61                       |
| Average bank slope (m/m)               | 0.20                          | 0.72                    | 0.05           | 0.27                  | 0.29                       |
| Bankfull width (m)                     | 25                            | 31.50                   | 30.00          | 13.00                 | 29.00                      |
| Thalweg depth (m)                      | 0.62                          | 0.55                    | 0.37           | 0.50                  | 0.26                       |
| Mean water depth (m)                   | 0.295                         | 0.23                    | 0.19           | 0.19                  | 0.14                       |
| Cross-sectional area (m <sup>2</sup> ) | 3.897                         | 2.20                    | 3.64           | 1.18                  | 0.73                       |
| Mean water velocity (m/s)              | 0.111                         | 0.19                    | 0.03           | 0.06                  | 0.07                       |
| Discharge (m <sup>3</sup> /s)          | 0.467                         | 0.41                    | 0.07           | 0.08                  | 0.06                       |
| Channel shape: Width/depth ratio       | 13.02                         | 20.32                   | 30.93          | 10.40                 | 18.01                      |
| Channel shape: Gini coefficient        | 0.36                          | 0.43                    | 0.46           | 0.33                  | 0.55                       |
| Channel slope (° or m/m) <sup>a</sup>  |                               |                         |                |                       |                            |
| Sinuosity <sup>a</sup>                 |                               |                         |                |                       |                            |

<sup>a</sup> Channel slope and sinuosity are external calculations in GIS: requires REACHSTART and REACHEND coordinates

| Site code                              | 6                       | 7                         | 8                      | 9                                   | 10                         |
|--|-------------------------|---------------------------|------------------------|-------------------------------------|----------------------------|
| Site name                              | Trotters Ck @ Mathesons | Waianakarua @ Browns Pump | Waiareka Ck @ Taipo Rd | Waikouaiti River @ Orbells Crossing | Kaikorai Stm @ Brighton Rd |
| Assessor                               | AS & VB                 | AS & VB                   | AS & VB                | AS & VB                             | AS & VB                    |
| Date                                   | 4/02/10                 | 4/02/10                   | 3/02/10                | 5/02/10                             | 5/02/10                    |
| Wetted width (m)                       | 3.25                    | 6.00                      | 5.80                   | 6.25                                | 6.50                       |
| Site length (m)                        | 100                     | 120                       | 100                    | 100                                 | 100                        |
| Percent rapid (%)                      | 0.00                    | 0.00                      | 0.00                   | 0.00                                | 0.00                       |
| Percent run (%)                        | 60.00                   | 2.50                      | 12.00                  | 10.00                               | 11.00                      |
| Percent riffle (%)                     | 2.00                    | 38.33                     | 0.00                   | 0.00                                | 44.00                      |
| Percent pool (%)                       | 38.00                   | 59.17                     | 88.00                  | 90.00                               | 45.00                      |
| Percent backwater (%)                  | 0.00                    | 0.00                      | 0.00                   | 0.00                                | 0.00                       |
| Percent other meso habitat (%)         | 0.00                    | 0.00                      | 0.00                   | 0.00                                | 0.00                       |
| Meso habitat richness                  | 3                       | 3                         | 2                      | 2                                   | 3                          |
| Start of reach easting                 | 2340667.501             | 2340480.561               | 2343404.177            | 2324591.143                         | 2309751.062                |
| Start of reach northing                | 5532828.821             | 5548288.23                | 5559454.642            | 5508440.431                         | 5475094.183                |
| End of reach easting                   | 2340587.841             | 2340457.59                | 2343363.049            | 2324515.053                         | 2309835.737                |
| End of reach northing                  | 5532878.921             | 5548403.439               | 5559546.496            | 5508378.449                         | 5475047.558                |
| Average pool maximum depth (m)         | 0.33                    | 1.50                      | 2.00                   | 0.60                                | 0.65                       |
| Average pool sediment depth (m)        | 0.01                    | 0.00                      | 0.50                   | 0.04                                | 0.00                       |
| Average pool crest depth (m)           | 0.04                    | 0.14                      | 0.14                   | 0.15                                | 0.10                       |
| Residual pool depth (m)                | 0.29                    | 1.37                      | 1.86                   | 0.45                                | 0.55                       |
| Floodplain shape                       | Multi-stage             | Multi-stage               | Multi-stage            | Multi-stage                         | Wide                       |
| Run bankfull shape                     | U shape                 | Wide                      | Wide                   | Multi-stage                         | U Shape                    |
| Riffle bankfull shape                  | U shape                 | Wide                      | 0                      | 0                                   | U shape                    |
| Pool bankfull shape                    | U shape                 | Wide                      | U shape                | Multi-stage                         | U shape                    |
| Run channel shape                      | Wide                    | Wide                      | U shape                | Wide                                | Wide                       |
| Riffle channel shape                   | Wide                    | Wide                      | 0                      | 0                                   | Wide                       |
| Pool channel shape                     | Wide                    | U shape                   | U shape                | Wide                                | U shape                    |
| Average bank undercut (m)              | 0.00                    | 0.00                      | 0.00                   | 0.00                                | 0.00                       |
| Bank height (m)                        | 1.42                    | 1.02                      | 2.16                   | 0.67                                | 1.00                       |
| Average bank slope (m/m)               | 0.37                    | 0.33                      | 0.12                   | 2.51                                | 0.78                       |
| Bankfull width (m)                     | 12.00                   | 23.00                     | 16.90                  | 23.49                               | 8.00                       |
| Thalweg depth (m)                      | 0.07                    | 0.17                      | 0.16                   | 0.22                                | 0.30                       |
| Mean water depth (m)                   | 0.04                    | 0.09                      | 0.17                   | 0.13 <sup>b</sup>                   | 0.16                       |
| Cross-sectional area (m <sup>2</sup> ) | 0.03                    | 0.37                      | 1.20                   | 0.54 <sup>b</sup>                   | 0.99                       |
| Mean water velocity (m/s)              | 0.03                    | 0.51                      | 0.15                   | 0.04 <sup>b</sup>                   | 0.17                       |
| Discharge (m <sup>3</sup> /s)          | 0.00                    | 0.22                      | 0.10                   | 0.03 <sup>b</sup>                   | 0.19                       |
| Channel shape: Width/depth ratio       | 8.45                    | 22.55                     | 7.82                   | 35.06                               | 8.00                       |
| Channel shape: Gini coefficient        | 0.85                    | 0.50                      | 0.54                   | 0.46                                | 0.43                       |
| Channel slope (° or m/m)               |                         |                           |                        |                                     |                            |
| Sinuosity                              |                         |                           |                        |                                     |                            |

<sup>b</sup> Tidally influenced thus depth, width and velocity measurements are unreliable.

| Site code                              | 11                        | 12                             | 13                        | 14                            | 15                      |
|--|---------------------------|--------------------------------|---------------------------|-------------------------------|-------------------------|
| Site name                              | Lindsay Ck @ North Bar Rd | Water of Leith @ Dundas Street | Silver Stm @ Riccarton Rd | Waipori River @ Falls Reserve | Dunstan Ck @ Beattie Rd |
| Assessor                               | AS & VB                   | AS & VB                        | AS & VB                   | AS & VB                       | AS & VB                 |
| Date                                   | 5/02/10                   | 5/02/10                        | 5/02/10                   | 6/02/10                       | 10/02/10                |
| Wetted width (m)                       | 3.00                      | 8.30                           | 3.50                      | 20.00                         | 5.00                    |
| Site length (m)                        | 60                        | 120                            | 50                        | 75                            | 115                     |
| Percent rapid (%)                      | 0.00                      | 0.00                           | 0.00                      | 54.67                         | 0.00                    |
| Percent run (%)                        | 18.33                     | 67.50                          | 70.00                     | 100.00                        | 54.78                   |
| Percent riffle (%)                     | 53.33                     | 32.50                          | 30.00                     | 0.00                          | 35.65                   |
| Percent pool (%)                       | 28.33                     | 0.00                           | 0.00                      | 0.00                          | 9.57                    |
| Percent backwater (%)                  | 0.00                      | 7.50                           | 0.00                      | 20.00                         | 0.00                    |
| Percent other meso habitat (%)         | 0.00                      | 0.00                           | 0.00                      | 0.00                          | 0.00                    |
| Meso habitat richness                  | 3                         | 3                              | 2                         | 3                             | 3                       |
| Start of reach easting                 | 2317525.452               | 2317105.065                    | 2301998.773               | 2282348.967                   | 2254705.891             |
| Start of reach northing                | 5481147.323               | 5479932.611                    | 5478274.107               | 5471257.498                   | 5580368.19              |
| End of reach easting                   | 2317482.395               | 2317146.39                     | 2302045.491               | 2282333.259                   | 2254697.289             |
| End of reach northing                  | 5481194.291               | 5480045.199                    | 5478293.542               | 5471195.985                   | 5580468.905             |
| Average pool maximum depth (m)         | 1.20                      | 0.35                           | 0.25                      | 2.00                          | 0.75                    |
| Average pool sediment depth (m)        | 0.00                      | 0.00                           | 0.00                      | c                             | 0.00                    |
| Average pool crest depth (m)           | 0.01                      | 0.13                           | 0.12                      | c                             | 0.15                    |
| Residual pool depth (m)                | 1.19                      | 0.22                           | 0.13                      | c                             | 0.60                    |
| Floodplain shape                       | U shape                   | Multi-stage                    | Multi-stage               | U shape                       | Wide                    |
| Run bankfull shape                     | U Shape                   | U shape                        | U shape                   | Wide                          | Wide                    |
| Riffle bankfull shape                  | U shape                   | U shape                        | U shape                   | Wide                          | Wide                    |
| Pool bankfull shape                    | U shape                   | U shape                        | 0                         | 0                             | Wide                    |
| Run channel shape                      | U Shape                   | Wide                           | Wide                      | Wide                          | Wide                    |
| Riffle channel shape                   | Wide                      | Wide                           | Wide                      | Wide                          | Wide                    |
| Pool channel shape                     | U shape                   | Wide                           | 0                         | U shape                       | U shape                 |
| Average bank undercut (m)              | 0.00                      | 0.00                           | 0.00                      | 0.00                          | 0.07                    |
| Bank height (m)                        | 0.80                      | 1.31                           | 0.54                      | c                             | 1.71                    |
| Average bank slope (m/m)               | 0.83                      | 1.40                           | 0.44                      | c                             | 0.40                    |
| Bankfull width (m)                     | 6.80                      | 11.20                          | 4.40                      | c                             | 16.00                   |
| Thalweg depth (m)                      | 0.20                      | 0.41                           | 0.19                      | c                             | 0.51                    |
| Mean water depth (m)                   | 0.11                      | 0.21                           | 0.13                      | c                             | 0.31                    |
| Cross-sectional area (m <sup>2</sup> ) | 0.30                      | 2.13                           | 0.38                      | c                             | 1.67                    |
| Mean water velocity (m/s)              | 0.11                      | 0.05                           | 0.10                      | c                             | 0.14                    |
| Discharge (m <sup>3</sup> /s)          | 0.04                      | 0.12                           | 0.04                      | c                             | 0.31                    |
| Channel shape: Width/depth ratio       | 8.50                      | 8.55                           | 8.15                      | c                             | 9.36                    |
| Channel shape: Gini coefficient        | 0.46                      | 0.41                           | 0.44                      | c                             | 0.46                    |
| Channel slope (° or m/m)               |                           |                                |                           |                               |                         |
| Sinuosity                              |                           |                                |                           |                               |                         |

<sup>c</sup> Not wadeable thus some variables unable to be measured.

| Site code                              | 16              | 17                         | 18                         | 19                        | 20                      |
|--|-----------------|----------------------------|----------------------------|---------------------------|-------------------------|
| Site name                              | Ida Burn @ SH85 | Fraser River @ Marshall Rd | Cardrona River @ Mt Barker | Lindis River @ Ardgour Rd | Luggate Ck @ SH6 bridge |
| Assessor                               | AS & VB         | AS & VB                    | AS & VB                    | AS & VB                   | AS & VB                 |
| Date                                   | 10/02/10        | 8/02/10                    | 9/02/10                    | 9/02/10                   | 9/02/10                 |
| Wetted width (m)                       | 2.50            | 7.00                       | 7.00                       | 5.50                      | 6.00                    |
| Site length (m)                        | 50              | 110                        | 140                        | 160                       | 120                     |
| Percent rapid (%)                      | 0.00            | 0.00                       | 0.00                       | 0.00                      | 0.00                    |
| Percent run (%)                        | 14.00           | 70.91                      | 50.71                      | 18.75                     | 28.33                   |
| Percent riffle (%)                     | 86.00           | 29.09                      | 38.57                      | 35.00                     | 50.00                   |
| Percent pool (%)                       | 0.00            | 0.00                       | 10.71                      | 46.25                     | 21.67                   |
| Percent backwater (%)                  | 0.00            | 13.64                      | 0.00                       | 0.00                      | 5.83                    |
| Percent other meso habitat (%)         | 0.00            | 0.00                       | 0.00                       | 0.00                      | 0.00                    |
| Meso habitat richness                  | 2               | 3                          | 3                          | 3                         | 4                       |
| Start of reach easting                 | 2272314.632     | 2223964.214                | 2202776.944                | 2228725.546               | 2214526.229             |
| Start of reach northing                | 5574682.925     | 5544852.496                | 5599172.03                 | 5589172.852               | 5599898.618             |
| End of reach easting                   | 2272359.656     | 2223878.685                | 2202661.919                | 2228810.883               | 2214422.267             |
| End of reach northing                  | 5574659.542     | 5544861.236                | 5599105.134                | 5589302.161               | 5599936.451             |
| Average pool maximum depth (m)         | 0.15            | 0.60                       | 1.50                       | 0.90                      | 0.90                    |
| Average pool sediment depth (m)        | 0.00            | 0.00                       | 0.10                       | 0.00                      | 0.00                    |
| Average pool crest depth (m)           | 0.10            | 0.30                       | 0.25                       | 0.18                      | 0.25                    |
| Residual pool depth (m)                | 0.05            | 0.30                       | 1.25                       | 0.73                      | 0.65                    |
| Floodplain shape                       | U shape         | Wide                       | Wide                       | Wide                      | Wide                    |
| Run bankfull shape                     | U shape         | Wide                       | Wide                       | Wide                      | U shape                 |
| Riffle bankfull shape                  | U shape         | Wide                       | Wide                       | Wide                      | U shape                 |
| Pool bankfull shape                    | 0               | U shape                    | U shape                    | Wide                      | U shape                 |
| Run channel shape                      | Wide            | Wide                       | Wide                       | Wide                      | Wide                    |
| Riffle channel shape                   | Wide            | Wide                       | Wide                       | Wide                      | Wide                    |
| Pool channel shape                     | 0               | Wide                       | U shape                    | U shape                   | U shape                 |
| Average bank undercut (m)              | 0.00            | 0.00                       | 0.07                       | 0.07                      | 0.07                    |
| Bank height (m)                        | 0.45            | 1.30                       | 1.57                       | 1.19                      | 1.52                    |
| Average bank slope (m/m)               | 0.54            | 0.66                       | 0.37                       | 0.21                      | 0.51                    |
| Bankfull width (m)                     | 4.00            | 8.80                       | 16.90                      | 27.70                     | 13.50                   |
| Thalweg depth (m)                      | 0.10            | 0.65                       | 0.42                       | 0.14                      | 0.27                    |
| Mean water depth (m)                   | 0.06            | 0.36                       | 0.27                       | 0.07                      | 0.14                    |
| Cross-sectional area (m <sup>2</sup> ) | 0.13            | 2.64                       | 2.22                       | 0.67                      | 1.17                    |
| Mean water velocity (m/s)              | 0.15            | 0.75                       | 0.26                       | 0.07                      | 0.19                    |
| Discharge (m <sup>3</sup> /s)          | 0.03            | 2.28                       | 0.76                       | 0.07                      | 0.24                    |
| Channel shape: Width/depth ratio       | 8.89            | 6.77                       | 10.76                      | 23.28                     | 8.88                    |
| Channel shape: Gini coefficient        | 0.50            | 0.39                       | 0.50                       | 0.51                      | 0.48                    |
| Channel slope (° or m/m)               |                 |                            |                            |                           |                         |
| Sinuosity                              |                 |                            |                            |                           |                         |

| Site code                              | 21                  | 22                         | 23                      | 24                        | 25                              |
|--|---------------------|----------------------------|-------------------------|---------------------------|---------------------------------|
| Site name                              | Mill Ck @ Fish Trap | Heriot Burn @ Park Hill Rd | Waipahi River @ Waipahi | Waitahuna @ Tweeds Bridge | Waiwera River 1 km US of Clutha |
| Assessor                               | AS & VB             | AS & VB                    | AS & VB                 | AS & VB                   | AS & VB                         |
| Date                                   | 9/02/10             | 8/02/10                    | 8/02/10                 | 6/02/10                   | 7/02/10                         |
| Wetted width (m)                       | 2.80                | 3.75                       | 20.00                   | 6.00                      | 8.00                            |
| Site length (m)                        | 60                  | 80                         | 200                     | 120                       | 160                             |
| Percent rapid (%)                      | 0.00                | 0.00                       | 0.00                    | 0.00                      | 5.00                            |
| Percent run (%)                        | 81.67               | 50.00                      | 94.00                   | 42.50                     | 68.13                           |
| Percent riffle (%)                     | 11.67               | 28.75                      | 0.00                    | 17.50                     | 26.88                           |
| Percent pool (%)                       | 6.67                | 21.25                      | 6.00                    | 40.00                     | 15.63                           |
| Percent backwater (%)                  | 5.00                | 0.00                       | 0.00                    | 0.00                      | 3.13                            |
| Percent other meso habitat (%)         | 0.00                | 0.00                       | 0.00                    | 0.00                      | 0.00                            |
| Meso habitat richness                  | 4                   | 3                          | 2                       | 3                         | 5                               |
| Start of reach easting                 | 2179774.479         | 2215852.127                | 2220204.461             | 2254225.96                | 2244309.866                     |
| Start of reach northing                | 5573860.145         | 5475051.887                | 5449039.731             | 5459531.018               | 5443959.047                     |
| End of reach easting                   | 2179811.927         | 2215889.133                | 2220141.839             | 2254164.501               | 2244334.981                     |
| End of reach northing                  | 5573891.489         | 5475121.284                | 5448866.084             | 5459630.668               | 5443813.184                     |
| Average pool maximum depth (m)         | 0.30                | 1.40                       | 1.50                    | 2.00                      | 1.20                            |
| Average pool sediment depth (m)        | 0.02                | 0.00                       | <sup>d</sup>            | 0.10                      | 0.00                            |
| Average pool crest depth (m)           | 0.10                | 0.15                       | 0.50                    | 0.20                      | 0.25                            |
| Residual pool depth (m)                | 0.20                | 1.25                       | 1.00                    | 1.80                      | 0.95                            |
| Floodplain shape                       | Wide                | Wide                       | Wide                    | Multi-stage               | Multi-stage                     |
| Run bankfull shape                     | Wide                | U shape                    | U shape                 | U shape                   | U shape                         |
| Riffle bankfull shape                  | Wide                | U shape                    | 0                       | U shape                   | U shape                         |
| Pool bankfull shape                    | U shape             | U shape                    | U shape                 | U shape                   | U shape                         |
| Run channel shape                      | Wide                | Wide                       | Wide                    | Wide                      | Wide                            |
| Riffle channel shape                   | Wide                | Wide                       | 0                       | Wide                      | Wide                            |
| Pool channel shape                     | U shape             | U shape                    | Wide                    | U shape                   | U shape                         |
| Average bank undercut (m)              | 0.07                | 0.00                       | 0.15                    | 0.30                      | 0.03                            |
| Bank height (m)                        | 0.53                | 1.30                       | 1.50                    | 1.84                      | 1.28                            |
| Average bank slope (m/m)               | 0.69                | 0.57                       | 0.77                    | 0.77                      | 0.14                            |
| Bankfull width (m)                     | 5.50                | 9.50                       | 15.00                   | 12.40                     | 18.20                           |
| Thalweg depth (m)                      | 0.23                | 0.15                       | 0.75                    | 0.92                      | 0.58                            |
| Mean water depth (m)                   | 0.15                | 0.10                       | 0.47                    | 0.47                      | 0.34                            |
| Cross-sectional area (m <sup>2</sup> ) | 0.58                | 0.88                       | 7.42                    | 3.84                      | 3.21                            |
| Mean water velocity (m/s)              | 0.33                | 0.29                       | 0.18                    | 0.10                      | 0.16                            |
| Discharge (m <sup>3</sup> /s)          | 0.22                | 0.27                       | 1.51                    | 0.43                      | 0.62                            |
| Channel shape: Width/depth ratio       | 10.38               | 7.31                       | 10.00                   | 6.74                      | 14.22                           |
| Channel shape: Gini coefficient        | 0.46                | 0.61                       | 0.42                    | 0.39                      | 0.40                            |
| Channel slope (° or m/m)               |                     |                            |                         |                           |                                 |
| Sinuosity                              |                     |                            |                         |                           |                                 |

<sup>d</sup> Pool too deep to measure sediment depth



| Site code                              | 26                                | 27                           | 28                     | 29                               | 30                       |
|--|-----------------------------------|------------------------------|------------------------|----------------------------------|--------------------------|
| Site name                              | Crookston Burn @ Kelso-Tapanui Rd | Waikoikoi Ck @ Bailey Bridge | Waipahi River @ Cairns | Tokomairiro @ West Branch Bridge | Catlins River @ Houipapa |
| Assessor                               | AS & VB                           | AS & VB                      | AS & VB                | AS & VB                          | AS & VB                  |
| Date                                   | 8/02/10                           | 8/02/10                      | 7/02/10                | 6/02/10                          | 7/02/10                  |
| Wetted width (m)                       | 4.00                              | 7.00                         | 2.00                   | 5.05                             | 20.00                    |
| Site length (m)                        | 80                                | 140                          | 50                     | 120                              | 200                      |
| Percent rapid (%)                      | 0.00                              | 0.00                         | 0.00                   | 0.00                             | 0.00                     |
| Percent run (%)                        | 55.00                             | 41.43                        | 78.00                  | 30.83                            | 29.00                    |
| Percent riffle (%)                     | 0.00                              | 24.29                        | 22.00                  | 30.83                            | 35.00                    |
| Percent pool (%)                       | 45.00                             | 34.29                        | 0.00                   | 33.33                            | 36.00                    |
| Percent backwater (%)                  | 0.00                              | 0.00                         | 0.00                   | 4.17                             | 0.00                     |
| Percent other meso habitat (%)         | 0.00                              | 0.00                         | 0.00                   | 0.00                             | 0.00                     |
| Meso habitat richness                  | 2                                 | 3                            | 2                      | 4                                | 3                        |
| Start of reach easting                 | 2217843.324                       | 2217089.938                  | 2219430.19             | 2266539.506                      | 2244834.083              |
| Start of reach northing                | 5472114.263                       | 5458566.436                  | 5428733.62             | 5453806.249                      | 5410752.87               |
| End of reach easting                   | 2217775.203                       | 2217015.803                  | 2219443.285            | 2266415.036                      | 2244719.893              |
| End of reach northing                  | 5472128.86                        | 5458679.288                  | 5428691.867            | 5453777.815                      | 5410900.889              |
| Average pool maximum depth (m)         | 0.80                              | 0.93                         | 0.35                   | 0.40                             | 1.75                     |
| Average pool sediment depth (m)        | 0.05                              | 0.02                         | 0.05                   | 0.00                             | 0.00                     |
| Average pool crest depth (m)           | 0.20                              | 0.30                         | 0.15                   | 0.05                             | 0.50                     |
| Residual pool depth (m)                | 0.60                              | 0.63                         | 0.20                   | 0.35                             | 1.25                     |
| Floodplain shape                       | Wide                              | Wide                         | Wide                   | Multi-stage                      | Multi-stage              |
| Run bankfull shape                     | U shape                           | U shape                      | U shape                | Multi-stage                      | Wide                     |
| Riffle bankfull shape                  | 0                                 | U shape                      | U shape                | Multi-stage                      | Wide                     |
| Pool bankfull shape                    | U shape                           | U shape                      | 0                      | Multi-stage                      | U shape                  |
| Run channel shape                      | Wide                              | Wide                         | Wide                   | Wide                             | Wide                     |
| Riffle channel shape                   | 0                                 | Wide                         | Wide                   | Wide                             | Wide                     |
| Pool channel shape                     | U shape                           | U shape                      | 0                      | Wide                             | U shape                  |
| Average bank undercut (m)              | 0.00                              | 0.27                         | 0.20                   | 0.10                             | 0.10                     |
| Bank height (m)                        | 1.05                              | 1.57                         | 1.46                   | 0.81                             | 2.38                     |
| Average bank slope (m/m)               | 0.52                              | 1.24                         | 0.75                   | 3.36                             | 0.67                     |
| Bankfull width (m)                     | 7.30                              | 8.10                         | 5.00                   | 3.00                             | 19.00                    |
| Thalweg depth (m)                      | 0.35                              | 0.72                         | 0.31                   | 0.16                             | 0.78                     |
| Mean water depth (m)                   | 0.23                              | 0.44                         | 0.21                   | 0.08                             | 0.34                     |
| Cross-sectional area (m <sup>2</sup> ) | 0.96                              | 3.43                         | 0.81                   | 0.41                             | 5.45                     |
| Mean water velocity (m/s)              | 0.15                              | 0.05                         | 0.04                   | 0.30                             | 0.19                     |
| Discharge (m <sup>3</sup> /s)          | 0.16                              | 0.19                         | 0.04                   | 0.18                             | 1.32                     |
| Channel shape: Width/depth ratio       | 6.95                              | 5.16                         | 3.42                   | 3.70                             | 7.98                     |
| Channel shape: Gini coefficient        | 0.48                              | 0.41                         | 0.55                   | 0.50                             | 0.38                     |
| Channel slope (° or m/m)               |                                   |                              |                        |                                  |                          |
| Sinuosity                              |                                   |                              |                        |                                  |                          |

## 5.2 Summary of instream habitat data

TABLE 5.2 Summary of P2c instream habitat information (as per Harding *et al.* 2009) collected from 30 sites in the Otago region as part of Otago Regional Council's 2010 State of the Environment monitoring. Information was collected between February 3rd and 10th, 2010. Substrate compactness: 1 = loose, easily moved; 2 = mostly loose, little compaction; 3 = moderately packed; 4 = tightly packed.

| Site code                   | 1                             |     |      | 2                       |     |      | 3              |     |      | 4                     |     |      |
|-----------------------------|-------------------------------|-----|------|-------------------------|-----|------|----------------|-----|------|-----------------------|-----|------|
|                             | Kakanui River @ Clifton Falls |     |      | Kakanui River @ McCones |     |      | Kauru @ Ewings |     |      | Shag River @ Craig Rd |     |      |
| Site name                   | Riffle                        | Run | Pool | Riffle                  | Run | Pool | Riffle         | Run | Pool | Riffle                | Run | Pool |
| Meso habitat type           |                               |     |      |                         |     |      |                |     |      |                       |     |      |
| % Concrete/artificial       | 0                             | 0   | 0    | 0                       | 0   | 0    | 0              | 0   | 0    | 0                     | 0   | 0    |
| % Bedrock (>4000 mm)        | 60                            | 30  | 20   | 0                       | 0   | 0    | 60             | 30  | 0    | 0                     | 15  | 0    |
| % Boulder (256-4000 mm)     | 10                            | 30  | 40   | 0                       | 0   | 0    | 20             | 50  | 30   | 2                     | 5   | 5    |
| % Cobble (64-255 mm)        | 20                            | 30  | 30   | 49                      | 20  | 50   | 20             | 10  | 55   | 68                    | 25  | 65   |
| % Gravel (2-63 mm)          | 10                            | 10  | 10   | 50                      | 75  | 35   | 0              | 10  | 10   | 40                    | 45  | 15   |
| % Sand, silt, mud (<2mm)    | 0                             | 0   | 0    | 0                       | 5   | 15   | 0              | 0   | 5    | 0                     | 10  | 15   |
| % Embeddedness              | 10                            | 10  | 10   | 5                       | 10  | 20   | 0              | 0   | 10   | 5                     | 30  | 40   |
| Substrate compactness (1-4) | 1                             | 1   | 1    | 1                       | 2   | 1    | 1              | 1   | 1    | 2                     | 2   | 3    |
| % Deposition & scouring     | 0                             | 0   | 5    | 0                       | 0   | 5    | 0              | 0   | 5    | 0                     | 5   | 5    |
| % Macrophytes               | 0                             | 0   | 0    | 0                       | 5   | 25   | 0              | 0   | 0    | 0                     | 0   | 0    |
| % Moss                      | 5                             | 0   | 0    | 0                       | 0   | 0    | 20             | 0   | 0    | 0                     | 0   | 0    |
| % Algae                     | 80                            | 90  | 95   | 95                      | 30  | 75   | 0              | 20  | 80   | 95                    | 95  | 99   |
| % Woody debris & leaf packs | 0                             | 5   | 5    | 5                       | 5   | 0    | 0              | 0   | 5    | 0                     | 0   | 1    |
| % Obstructions to flow      | 0                             | 0   | 0    | 0                       | 50  | 0    | 0              | 0   | 0    | 0                     | 0   | 0    |
| % Bank cover                | 0                             | 0   | 5    | 0                       | 0   | 0    | 0              | 0   | 5    | 0                     | 0   | 0    |
| Fish habitat                |                               |     |      |                         |     |      |                |     |      |                       |     |      |

| Site code                   | 5                          |     |      | 6                       |     |      | 7                       |     |      | 8                      |     |      |
|-----------------------------|----------------------------|-----|------|-------------------------|-----|------|-------------------------|-----|------|------------------------|-----|------|
| Site name                   | Shag River @ Goodwood Pump |     |      | Trotters Ck @ Mathesons |     |      | Waiakarua @ Browns Pump |     |      | Waiareka Ck @ Taipo Rd |     |      |
| Meso habitat type           | Riffle                     | Run | Pool | Riffle                  | Run | Pool | Riffle                  | Run | Pool | Riffle                 | Run | Pool |
| % Concrete/artificial       | 0                          | 0   | 0    | 0                       | 0   | 5    | 0                       | 0   | 0    | 0                      | 0   | 0    |
| % Bedrock (> 4000 mm)       | 0                          | 0   | 0    | 0                       | 80  | 60   | 0                       | 0   | 20   | 0                      | 0   | 0    |
| % Boulder (256-4000 mm)     | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 0   | 0    |
| % Cobble (64-255 mm)        | 30                         | 30  | 10   | 20                      | 0   | 0    | 80                      | 80  | 70   | 0                      | 0   | 0    |
| % Gravel (2-63 mm)          | 70                         | 60  | 50   | 70                      | 0   | 5    | 19                      | 20  | 10   | 0                      | 60  | 0    |
| % Sand, silt, mud (< 2mm)   | 0                          | 10  | 40   | 10                      | 20  | 30   | 0                       | 0   | 0    | 0                      | 40  | 100  |
| % Embeddedness              | 10                         | 30  | 70   | 40                      | 0   | 50   | 5                       | 5   | 15   | 0                      | 50  | 100  |
| Substrate compactness (1-4) | 2                          | 1   | 2    | 2                       | 0   | 1    | 1                       | 1   | 1    | 0                      | 2   | 1    |
| % Deposition & scouring     | 0                          | 0   | 30   | 10                      | 20  | 30   | 0                       | 0   | 0    | 0                      | 0   | 100  |
| % Macrophytes               | 1                          | 3   | 5    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 20  | 90   |
| % Moss                      | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 0   | 0    |
| % Algae                     | 80                         | 80  | 90   | 80                      | 100 | 100  | 80                      | 80  | 90   | 0                      | 60  | 0    |
| % Woody debris & leaf packs | 0                          | 0   | 5    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 10  | 10   |
| % Obstructions to flow      | 0                          | 0   | 2    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 5   | 0    |
| % Bank cover                | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                       | 0   | 0    | 0                      | 0   | 5    |

| Site code                   | 9                                     |     |      | 10                         |     |      | 11                        |     |      | 12                             |     |      |
|-----------------------------|---------------------------------------|-----|------|----------------------------|-----|------|---------------------------|-----|------|--------------------------------|-----|------|
|                             | Waikouraiti River @ Orbell's Crossing |     |      | Kaikorai Stm @ Brighton Rd |     |      | Lindsay Ck @ North Bar Rd |     |      | Water of Leith @ Dundas Street |     |      |
| Site name                   | Riffle                                | Run | Pool | Riffle                     | Run | Pool | Riffle                    | Run | Pool | Riffle                         | Run | Pool |
| Meso habitat type           |                                       |     |      |                            |     |      |                           |     |      |                                |     |      |
| % Concrete/artificial       | 0                                     | 0   | 1    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                              | 0   | 0    |
| % Bedrock (>4000 mm)        | 0                                     | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                              | 0   | 0    |
| % Boulder (256-4000 mm)     | 0                                     | 0   | 0    | 1                          | 1   | 0    | 5                         | 5   | 0    | 20                             | 20  | 20   |
| % Cobble (64-255 mm)        | 0                                     | 0   | 4    | 79                         | 79  | 5    | 80                        | 75  | 60   | 80                             | 80  | 70   |
| % Gravel (2-63 mm)          | 0                                     | 30  | 20   | 20                         | 20  | 25   | 15                        | 15  | 20   | 0                              | 0   | 10   |
| % Sand, silt, mud (< 2mm)   | 0                                     | 70  | 75   | 0                          | 0   | 70   | 0                         | 5   | 20   | 0                              | 0   | 0    |
| % Embeddedness              | 0                                     | 40  | 60   | 20                         | 20  | 80   | 30                        | 20  | 40   | 5                              | 5   | 30   |
| Substrate compactness (1-4) | 0                                     | 1   | 1    | 2                          | 2   | 1    | 3                         | 3   | 3    | 3                              | 3   | 3    |
| % Deposition & scouring     | 0                                     | 5   | 60   | 0                          | 0   | 20   | 0                         | 0   | 20   | 0                              | 5   | 10   |
| % Macrophytes               | 0                                     | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                              | 0   | 0    |
| % Moss                      | 0                                     | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                              | 0   | 0    |
| % Algae                     | 0                                     | 85  | 85   | 95                         | 95  | 90   | 100                       | 100 | 100  | 95                             | 95  | 95   |
| % Woody debris & leaf packs | 0                                     | 5   | 5    | 1                          | 1   | 5    | 0                         | 0   | 0    | 5                              | 5   | 5    |
| % Obstructions to flow      | 0                                     | 15  | 5    | 1                          | 0   | 0    | 0                         | 0   | 0    | 2                              | 0   | 2    |
| % Bank cover                | 0                                     | 0   | 0    | 0                          | 0   | 5    | 0                         | 0   | 0    | 0                              | 0   | 0    |
| Fish habitat                |                                       |     |      |                            |     |      |                           |     |      |                                |     |      |

| Site code                   | 13                        |     |      | 14                            |     |      | 15                      |     |      | 16              |     |      |
|-----------------------------|---------------------------|-----|------|-------------------------------|-----|------|-------------------------|-----|------|-----------------|-----|------|
|                             | Silver Stm @ Riccarton Rd |     |      | Waipori River @ Falls Reserve |     |      | Dunstan Ck @ Beattie Rd |     |      | Ida Burn @ SH85 |     |      |
| Site name                   | Riffle                    | Run | Pool | Riffle/Rapid                  | Run | Pool | Riffle                  | Run | Pool | Riffle          | Run | Pool |
| Meso habitat type           |                           |     |      |                               |     |      |                         |     |      |                 |     |      |
| % Concrete/artificial       | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 0   | 0    | 0               | 0   | 0    |
| % Bedrock (> 4000 mm)       | 0                         | 0   | 0    | 0                             | 0   | 0    | 5                       | 15  | 50   | 0               | 0   | 0    |
| % Boulder (256-4000 mm)     | 0                         | 0   | 0    | 10                            | 10  | 0    | 5                       | 5   | 0    | 1               | 1   | 0    |
| % Cobble (64-255 mm)        | 40                        | 40  | 0    | 90                            | 80  | 0    | 60                      | 45  | 10   | 29              | 29  | 0    |
| % Gravel (2-63 mm)          | 60                        | 50  | 0    | 0                             | 10  | 0    | 30                      | 30  | 10   | 70              | 70  | 0    |
| % Sand, silt, mud (<2mm)    | 0                         | 10  | 0    | 0                             | 0   | 0    | 0                       | 5   | 30   | 0               | 0   | 0    |
| % Embeddedness              | 10                        | 50  | 0    | 10                            | 10  | 0    | 5                       | 5   | 20   | 5               | 5   | 0    |
| Substrate compactness (1-4) | 2                         | 3   | 0    | 3                             | 3   | 0    | 2                       | 2   | 2    | 2               | 2   | 0    |
| % Deposition & scouring     | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 5   | 20   | 0               | 0   | 0    |
| % Macrophytes               | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 0   | 0    | 0               | 0   | 0    |
| % Moss                      | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 0   | 0    | 0               | 0   | 0    |
| % Algae                     | 90                        | 90  | 0    | 50                            | 50  | 0    | 60                      | 60  | 20   | 50              | 50  | 0    |
| % Woody debris & leaf packs | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 0   | 5    | 0               | 0   | 0    |
| % Obstructions to flow      | 0                         | 0   | 0    | 0                             | 0   | 0    | 0                       | 0   | 1    | 0               | 0   | 0    |
| % Bank cover                | 5                         | 5   | 0    | 0                             | 0   | 0    | 0                       | 0   | 5    | 0               | 0   | 0    |
| Fish habitat                |                           |     |      |                               |     |      |                         |     |      |                 |     |      |

| Site code                   | 17                         |     |      | 18                         |     |      | 19                        |     |      | 20                      |     |      |
|-----------------------------|----------------------------|-----|------|----------------------------|-----|------|---------------------------|-----|------|-------------------------|-----|------|
|                             | Fraser River @ Marshall Rd |     |      | Cartrona River @ Mt Barker |     |      | Lindis River @ Ardgour Rd |     |      | Luggate Ck @ SH6 bridge |     |      |
| Site name                   | Riffle                     | Run | Pool | Riffle                     | Run | Pool | Riffle                    | Run | Pool | Riffle                  | Run | Pool |
| Meso habitat type           |                            |     |      |                            |     |      |                           |     |      |                         |     |      |
| % Concrete/artificial       | 0                          | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                       | 0   | 0    |
| % Bedrock (> 4000 mm)       | 0                          | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                       | 0   | 0    |
| % Boulder (256-4000 mm)     | 5                          | 5   | 0    | 5                          | 5   | 0    | 5                         | 5   | 5    | 0                       | 1   | 0    |
| % Cobble (64-255 mm)        | 85                         | 85  | 40   | 55                         | 10  | 10   | 75                        | 75  | 65   | 5                       | 14  | 5    |
| % Gravel (2-63 mm)          | 10                         | 10  | 40   | 30                         | 55  | 10   | 20                        | 10  | 20   | 80                      | 45  | 30   |
| % Sand, silt, mud (< 2mm)   | 0                          | 0   | 20   | 10                         | 30  | 80   | 0                         | 10  | 10   | 15                      | 40  | 65   |
| % Embeddedness              | 0                          | 0   | 10   | 20                         | 40  | 60   | 0                         | 5   | 20   | 5                       | 30  | 50   |
| Substrate compactness (1-4) | 2                          | 2   | 2    | 2                          | 2   | 1    | 1                         | 1   | 2    | 2                       | 4   | 2    |
| % Deposition & scouring     | 0                          | 0   | 10   | 0                          | 0   | 80   | 0                         | 0   | 10   | 0                       | 10  | 40   |
| % Macrophytes               | 0                          | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                       | 0   | 0    |
| % Moss                      | 0                          | 0   | 0    | 0                          | 0   | 0    | 0                         | 0   | 0    | 0                       | 1   | 0    |
| % Algae                     | 80                         | 80  | 80   | 70                         | 60  | 20   | 100                       | 100 | 100  | 50                      | 80  | 40   |
| % Woody debris & leaf packs | 0                          | 0   | 0    | 0                          | 0   | 5    | 0                         | 0   | 0    | 1                       | 0   | 0    |
| % Obstructions to flow      | 0                          | 0   | 0    | 0                          | 0   | 5    | 0                         | 0   | 10   | 1                       | 0   | 0    |
| % Bank cover                | 0                          | 0   | 0    | 0                          | 0   | 5    | 0                         | 0   | 5    | 0                       | 0   | 5    |
| Fish habitat                |                            |     |      |                            |     |      |                           |     |      |                         |     |      |



| Site code                   | 21                  |     |      | 22                         |     |      | 23                      |     |      | 24                       |     |      |
|-----------------------------|---------------------|-----|------|----------------------------|-----|------|-------------------------|-----|------|--------------------------|-----|------|
| Site name                   | Mill Ck @ Fish Trap |     |      | Heriot Burn @ Park Hill Rd |     |      | Waipahi River @ Waipahi |     |      | Waiahuna @ Tweeds Bridge |     |      |
| Meso habitat type           | Riffle              | Run | Pool | Riffle                     | Run | Pool | Riffle                  | Run | Pool | Riffle                   | Run | Pool |
| % Concrete/artificial       | 0                   | 0   | 0    | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                        | 0   | 0    |
| % Bedrock (> 4000 mm)       | 0                   | 0   | 0    | 0                          | 0   | 0    | 0                       | 50  | 40   | 0                        | 0   | 0    |
| % Boulder (256-4000 mm)     | 5                   | 0   | 10   | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                        | 0   | 0    |
| % Cobble (64-255 mm)        | 0                   | 0   | 0    | 0                          | 0   | 0    | 0                       | 10  | 10   | 10                       | 10  | 10   |
| % Gravel (2-63 mm)          | 40                  | 20  | 20   | 80                         | 50  | 20   | 0                       | 20  | 10   | 90                       | 70  | 60   |
| % Sand, silt, mud (< 2mm)   | 55                  | 80  | 70   | 20                         | 50  | 80   | 0                       | 20  | 40   | 0                        | 20  | 30   |
| % Embeddedness              | 30                  | 40  | 50   | 10                         | 40  | 30   | 0                       | 10  | 40   | 20                       | 10  | 30   |
| Substrate compactness (1-4) | 2                   | 2   | 2    | 2                          | 2   | 1    | 0                       | 2   | 2    | 1                        | 1   | 1    |
| % Deposition & scouring     | 0                   | 15  | 20   | 0                          | 10  | 60   | 0                       | 5   | 40   | 0                        | 10  | 30   |
| % Macrophytes               | 0                   | 0   | 0    | 0                          | 0   | 0    | 0                       | 20  | 60   | 0                        | 0   | 0    |
| % Moss                      | 0                   | 0   | 0    | 0                          | 0   | 0    | 0                       | 0   | 0    | 0                        | 0   | 0    |
| % Algae                     | 40                  | 40  | 40   | 60                         | 50  | 20   | 0                       | 60  | 30   | 90                       | 90  | 90   |
| % Woody debris & leaf packs | 5                   | 0   | 5    | 0                          | 0   | 0    | 0                       | 1   | 5    | 0                        | 5   | 5    |
| % Obstructions to flow      | 0                   | 5   | 5    | 5                          | 0   | 1    | 0                       | 0   | 2    | 0                        | 1   | 1    |
| % Bank cover                | 0                   | 5   | 5    | 0                          | 0   | 0    | 0                       | 1   | 1    | 10                       | 15  | 20   |

| Site code                   | 25                              |     |      | 26                                |     |      | 27                           |     |      | 28                     |     |      |
|-----------------------------|---------------------------------|-----|------|-----------------------------------|-----|------|------------------------------|-----|------|------------------------|-----|------|
| Site name                   | Waiverua River 1km US of Clutha |     |      | Crookston Burn @ Kelso-Tapanui Rd |     |      | Waikotkoi Ck @ Bailey Bridge |     |      | Waipahi River @ Cairns |     |      |
| Meso habitat type           | Riffle                          | Run | Pool | Riffle                            | Run | Pool | Riffle                       | Run | Pool | Riffle                 | Run | Pool |
| % Concrete/artificial       | 0                               | 0   | 0    | 0                                 | 0   | 0    | 0                            | 0   | 0    | 0                      | 0   | 0    |
| % Bedrock (> 4000 mm)       | 70                              | 40  | 40   | 0                                 | 0   | 0    | 0                            | 0   | 0    | 0                      | 0   | 0    |
| % Boulder (256-4000 mm)     | 30                              | 40  | 30   | 0                                 | 0   | 0    | 2                            | 1   | 0    | 0                      | 0   | 0    |
| % Cobble (64-255 mm)        | 10                              | 10  | 20   | 0                                 | 1   | 1    | 38                           | 19  | 10   | 10                     | 10  | 0    |
| % Gravel (2-63 mm)          | 0                               | 0   | 0    | 0                                 | 59  | 59   | 60                           | 70  | 50   | 50                     | 70  | 0    |
| % Sand, silt, mud (<2mm)    | 0                               | 0   | 0    | 0                                 | 40  | 40   | 0                            | 10  | 40   | 40                     | 70  | 0    |
| % Embeddedness              | 0                               | 0   | 10   | 0                                 | 30  | 40   | 0                            | 5   | 20   | 50                     | 70  | 0    |
| Substrate compactness (1-4) | 4                               | 4   | 3    | 0                                 | 2   | 2    | 2                            | 2   | 3    | 2                      | 2   | 0    |
| % Deposition & scouring     | 0                               | 0   | 0    | 0                                 | 20  | 30   | 0                            | 0   | 40   | 20                     | 50  | 0    |
| % Macrophytes               | 0                               | 0   | 0    | 0                                 | 20  | 15   | 5                            | 10  | 15   | 5                      | 15  | 0    |
| % Moss                      | 0                               | 0   | 0    | 0                                 | 0   | 0    | 0                            | 0   | 0    | 10                     | 5   | 0    |
| % Algae                     | 75                              | 80  | 95   | 0                                 | 60  | 60   | 90                           | 80  | 70   | 40                     | 40  | 0    |
| % Woody debris & leaf packs | 0                               | 0   | 0    | 0                                 | 0   | 0    | 0                            | 0   | 0    | 5                      | 5   | 0    |
| % Obstructions to flow      | 0                               | 0   | 5    | 0                                 | 1   | 1    | 0                            | 0   | 20   | 5                      | 5   | 0    |
| % Bank cover                | 0                               | 5   | 0    | 0                                 | 0   | 0    | 1                            | 1   | 5    | 10                     | 15  | 0    |

| Site code                   | 29                               | 30                       |
|-----------------------------|----------------------------------|--------------------------|
| Site name                   | Tokomairiro @ West Branch Bridge | Catfins River @ Houipapa |
| Meso habitat type           | Riffle                           | Run                      |
| % Concrete/artificial       | 0                                | 0                        |
| % Bedrock (> 4000 mm)       | 0                                | 0                        |
| % Boulder (256-4000 mm)     | 0                                | 0                        |
| % Cobble (64-255 mm)        | 60                               | 65                       |
| % Gravel (2-63 mm)          | 30                               | 20                       |
| % Sand, silt, mud (< 2mm)   | 10                               | 10                       |
| % Embeddedness              | 20                               | 30                       |
| Substrate compactness (1-4) | 2                                | 2                        |
| % Deposition & scouring     | 0                                | 0                        |
| % Macrophytes               | 0                                | 0                        |
| % Moss                      | 0                                | 0                        |
| % Algae                     | 75                               | 90                       |
| % Woody debris & leaf packs | 5                                | 5                        |
| % Obstructions to flow      | 0                                | 0                        |
| % Bank cover                | 5                                | 1                        |

### 5.3 Summary of riparian data

TABLE 5.3 Summary of P2d riparian information (as per Harding *et al.* 2009) collected from 30 sites in the Otago region as part of Otago Regional Council's 2010 State of the Environment monitoring. Information was collected between February 3rd and 10th, 2010.

| Site code  | 1                             |            | 2                       |            | 3              |            | 4                     |            | 5                          |            |
|--|-------------------------------|------------|-------------------------|------------|----------------|------------|-----------------------|------------|----------------------------|------------|
|  | True-left                     | True-right | True-left               | True-right | True-left      | True-right | True-left             | True-right | True-left                  | True-right |
| Site name  | Kakanui River @ Clifton Falls |            | Kakanui River @ McCones |            | Kauru @ Ewings |            | Shag River @ Craig Rd |            | Shag River @ Goodwood Pump |            |
| Side of bank   | True-left                     | True-right | True-left               | True-right | True-left      | True-right | True-left             | True-right | True-left                  | True-right |
| Shading of water   | 1                             | 1          | 2                       | 1          | 1              | 2          | 2                     | 1          | 1                          | 1          |
| Buffer width   | 4                             | 3          | 2                       | 2          | 5              | 3          | 3                     | 2          | 2                          | 2          |
| Buffer intactness  | 5                             | 5          | 5                       | 5          | 5              | 4          | 5                     | 4          | 4                          | 4          |
| Vegetation composition of buffer                                 | 2                             | 2          | 2                       | 2          | 3              | 2          | 3                     | 2          | 2                          | 2          |
| Vegetation composition of adjacent land to 30 m from stream bank | 2                             | 1/3        | 2                       | 2          | 3              | 1          | 3                     | 2          | 2                          | 1          |
| Bank stability   | 5                             | 5          | 3                       | 4          | 5              | 3          | 4                     | 3          | 3                          | 3          |
| Livestock access   | 4                             | 4          | 3                       | 3          | 5              | 2          | 5                     | 5          | 4                          | 4          |
| Riparian soil denitrification potential                          | 1                             | 1          | 1                       | 1          | 1              | 1          | 1                     | 1          | 1                          | 1          |
| Land slope 0-30 m from stream bank                               | 4                             | 1          | 3                       | 5          | 4              | 2          | 2                     | 4          | 3                          | 4          |
| Groundcover of buffer  | 5                             | 5          | 3                       | 3          | 5              | 3          | 5                     | 4          | 4                          | 4          |
| Groundcover of adjacent land to 30 m from streambank             | 4                             | 4          | 3                       | 3          | 5              | 3          | 5                     | 3          | 3                          | 2          |
| Soil drainage  | 4                             | 2          | 3                       | 3          | 3              | 2          | 3                     | 4          | 4                          | 4          |
| Rills/channels   | 5                             | 5          | 5                       | 5          | 5              | 5          | 5                     | 5          | 5                          | 5          |

| Site code  | 6                       |            | 7                       |            | 8                      |            | 9                                   |            | 10                         |            |
|--|-------------------------|------------|-------------------------|------------|------------------------|------------|-------------------------------------|------------|----------------------------|------------|
| Site name  | Trotters Ck @ Mathesons |            | Waiakarua @ Browns Pump |            | Waiaieka Ck @ Taipo Rd |            | Waikouaiti River @ Orbells Crossing |            | Kaikorai Stm @ Brighton Rd |            |
| Side of bank   | True-left               | True-right | True-left               | True-right | True-left              | True-right | True-left                           | True-right | True-left                  | True-right |
| Shading of water   | 1                       | 1          | 2                       | 1          | 1                      | 4          | 1                                   | 2          | 3                          | 3          |
| Buffer width   | 1                       | 1          | 4                       | 4          | 3                      | 3          | 2                                   | 3          | 2                          | 2          |
| Buffer intactness  | 2                       | 2          | 4                       | 4          | 4                      | 4          | 4                                   | 4          | 4                          | 5          |
| Vegetation composition of buffer                                 | 1                       | 1          | 3                       | 2          | 2                      | 2          | 2                                   | 3          | 2                          | 2          |
| Vegetation composition of adjacent land to 30 m from stream bank | 2                       | 2          | 2                       | 2          | 2                      | 2          | 2                                   | 3          | 1                          | 1          |
| Bank stability   | 1                       | 1          | 3                       | 4          | 3                      | 2          | 4                                   | 3          | 3                          | 2          |
| Livestock access   | 2                       | 2          | 5                       | 5          | 3                      | 5          | 1                                   | 5          | 5                          | 5          |
| Riparian soil denitrification potential                          | 1                       | 1          | 1                       | 1          | 3                      | 3          | 1                                   | 1          | 1                          | 1          |
| Land slope 0-30 m from stream bank                               | 2                       | 4          | 1/4                     | 3          | 4                      | 3          | 2                                   | 1          | 4                          | 2          |
| Groundcover of buffer  | 1                       | 3          | 5                       | 5          | 4                      | 3          | 5                                   | 5          | 3                          | 5          |
| Groundcover of adjacent land to 30 m from streambank             | 1                       | 3          | 5                       | 5          | 5                      | 5          | 4                                   | 5          | 1                          | 1          |
| Soil drainage  | 4                       | 4          | 4                       | 4          | 3                      | 3          | 4                                   | 4          | 3                          | 3          |
| Rills/channels   | 1                       | 2          | 5                       | 5          | 5                      | 5          | 5                                   | 5          | 5                          | 5          |

| Site code  | 11                        |            | 12                             |            | 13                        |            | 14                            |            | 15                      |            |
|--|---------------------------|------------|--------------------------------|------------|---------------------------|------------|-------------------------------|------------|-------------------------|------------|
|  | Lindsay Ck @ North Bar Rd |            | Water of Leith @ Dundas Street |            | Silver Stm @ Riccarton Rd |            | Waipori River @ Falls Reserve |            | Dunstan Ck @ Beattie Rd |            |
| Site name  | True-left                 | True-right | True-left                      | True-right | True-left                 | True-right | True-left                     | True-right | True-left               | True-right |
| Side of bank   |                           |            |                                |            |                           |            |                               |            |                         |            |
| Shading of water   | 2                         | 2          | 2                              | 2          | 1                         | 1          | 2                             | 1          | 1                       | 1          |
| Buffer width   | 2                         | 2          | 2                              | 2          | 3                         | 3          | 3                             | 5          | 3                       | 3          |
| Buffer intactness  | 5                         | 4          | 5                              | 5          | 5                         | 5          | 4                             | 5          | 3                       | 3          |
| Vegetation composition of buffer                                 | 2                         | 2          | 1                              | 3          | 2                         | 2          | 2                             | 5          | 3                       | 2          |
| Vegetation composition of adjacent land to 30 m from stream bank | 2                         | 3          | 1                              | 1          | 2                         | 2          | 3                             | 5          | 3                       | 1          |
| Bank stability   | 4                         | 4          | 4                              | 4          | 4                         | 4          | 4                             | 4          | 2                       | 2          |
| Livestock access   | 5                         | 5          | 5                              | 5          | 2                         | 2          | 5                             | 5          | 5                       | 3          |
| Riparian soil denitrification potential                          | 2                         | 2          | 1                              | 1          | 1                         | 1          | 3                             | 3          | 2                       | 2          |
| Land slope 0-30 m from stream bank                               | 3                         | 1          | 2                              | 2          | 3                         | 3          | 5                             | 2          | 3                       | 3          |
| Groundcover of buffer  | 5                         | 4          | 2                              | 5          | 5                         | 5          | 4                             | 3          | 2                       | 2          |
| Groundcover of adjacent land to 30 m from streambank             | 1                         | 3          | 2                              | 2          | 4                         | 4          | 4                             | 3          | 3                       | 3          |
| Soil drainage  | 3                         | 3          | 3                              | 3          | 4                         | 4          | 3                             | 3          | 4                       | 4          |
| Rills/channels   | 5                         | 5          | 5                              | 5          | 5                         | 5          | 5                             | 5          | 5                       | 5          |



| Site code  | 16              |            | 17                         |            | 18                         |            | 19                        |            | 20                      |            |
|--|-----------------|------------|----------------------------|------------|----------------------------|------------|---------------------------|------------|-------------------------|------------|
|  | Ida Burr @ SH85 |            | Fraser River @ Marshall Rd |            | Cardrona River @ Mt Barker |            | Lindis River @ Ardgour Rd |            | Luggate Ck @ SH6 bridge |            |
| Site name  | True-left       | True-right | True-left                  | True-right | True-left                  | True-right | True-left                 | True-right | True-left               | True-right |
| Side of bank   |                 |            |                            |            |                            |            |                           |            |                         |            |
| Shading of water   | 1               | 1          | 3                          | 3          | 2                          | 2          | 1                         | 1          | 1                       | 1          |
| Buffer width   | 2               | 3          | 3                          | 2          | 3                          | 2          | 2                         | 2          | 2                       | 2          |
| Buffer intactness  | 3               | 4          | 4                          | 4          | 5                          | 4          | 4                         | 4          | 4                       | 4          |
| Vegetation composition of buffer                                 | 1               | 2          | 2                          | 2          | 2                          | 1          | 1                         | 2          | 2                       | 2          |
| Vegetation composition of adjacent land to 30 m from stream bank | 1               | 2          | 2                          | 1          | 3                          | 1          | 1                         | 1          | 1                       | 1          |
| Bank stability   | 3               | 3          | 3                          | 3          | 3                          | 3          | 2                         | 2          | 3                       | 4          |
| Livestock access   | 2               | 5          | 5                          | 5          | 5                          | 1          | 2                         | 4          | 5                       | 5          |
| Riparian soil denitrification potential                          | 1               | 1          | 1                          | 1          | 2                          | 2          | 1                         | 1          | 1                       | 1          |
| Land slope 0-30 m from stream bank                               | 1               | 3          | 5                          | 5          | 4                          | 4          | 2                         | 2          | 3                       | 3          |
| Groundcover of buffer  | 2               | 4          | 4                          | 4          | 2                          | 4          | 1                         | 4          | 3                       | 3          |
| Groundcover of adjacent land to 30 m from streambank             | 1               | 5          | 4                          | 3          | 2                          | 5          | 1                         | 2          | 2                       | 1          |
| Soil drainage  | 4               | 4          | 3                          | 3          | 4                          | 4          | 4                         | 4          | 3                       | 3          |
| Rills/channels   | 5               | 5          | 5                          | 5          | 5                          | 5          | 5                         | 5          | 5                       | 5          |

| Site code  | 21                  |            | 22                         |            | 23                      |            | 24                        |            | 25                             |            |
|--|---------------------|------------|----------------------------|------------|-------------------------|------------|---------------------------|------------|--------------------------------|------------|
|  | True-left           | True-right | True-left                  | True-right | True-left               | True-right | True-left                 | True-right | True-left                      | True-right |
| Site name  | Mill Ck @ Fish Trap |            | Heriot Burn @ Park Hill Rd |            | Waipahi River @ Waipahi |            | Waitanuna @ Tweeds Bridge |            | Waivera River 1km US of Clutha |            |
| Side of bank   | True-left           | True-right | True-left                  | True-right | True-left               | True-right | True-left                 | True-right | True-left                      | True-right |
| Shading of water   | 2                   | 2          | 4                          | 4          | 1                       | 1          | 1                         | 1          | 1                              | 1          |
| Buffer width   | 2                   | 5          | 2                          | 2          | 1                       | 1          | 1                         | 1          | 5                              | 4          |
| Buffer intactness  | 4                   | 5          | 5                          | 5          | 5                       | 5          | 4                         | 4          | 5                              | 5          |
| Vegetation composition of buffer                                 | 1                   | 2          | 2                          | 2          | 1                       | 1          | 1                         | 1          | 2                              | 2          |
| Vegetation composition of adjacent land to 30 m from stream bank | 1                   | 3          | 1                          | 1          | 1                       | 1          | 1                         | 1          | 2                              | 2          |
| Bank stability   | 2                   | 3          | 3                          | 3          | 3                       | 3          | 2                         | 2          | 4                              | 4          |
| Livestock access   | 5                   | 5          | 5                          | 5          | 1                       | 1          | 1                         | 1          | 5                              | 4          |
| Riparian soil denitrification potential                          | 3                   | 3          | 2                          | 2          | 1                       | 1          | 1                         | 1          | 3                              | 3          |
| Land slope 0-30 m from stream bank                               | 5                   | 5          | 2                          | 3          | 4                       | 4          | 2                         | 3          | 3                              | 4          |
| Groundcover of buffer  | 2                   | 4          | 5                          | 4          | 2                       | 2          | 2                         | 2          | 5                              | 5          |
| Groundcover of adjacent land to 30 m from streambank             | 2                   | 5          | 2                          | 2          | 2                       | 2          | 2                         | 2          | 5                              | 5          |
| Soil drainage  | 4                   | 4          | 3                          | 3          | 3                       | 3          | 2                         | 2          | 4                              | 4          |
| Rills/channels   | 5                   | 5          | 5                          | 5          | 5                       | 5          | 3                         | 3          | 5                              | 5          |

| Site code  | 26                                |            | 27                           |            | 28                     |            | 29                               |            | 30                        |            |
|--|-----------------------------------|------------|------------------------------|------------|------------------------|------------|----------------------------------|------------|---------------------------|------------|
| Site name  | Crookston Burn @ Kelso-Tapanui Rd |            | Waikoikoi Ck @ Bailey Bridge |            | Waipahi River @ Cairns |            | Tokomairiro @ West Branch Bridge |            | Cattlins River @ Houipapa |            |
| Side of bank   | True-left                         | True-right | True-left                    | True-right | True-left              | True-right | True-left                        | True-right | True-left                 | True-right |
| Shading of water   | 1                                 | 1          | 3                            | 2          | 2                      | 3          | 4                                | 4          | 1                         | 2          |
| Buffer width   | 1                                 | 2          | 2                            | 2          | 1                      | 2          | 5                                | 1          | 1                         | 3          |
| Buffer intactness  | 2                                 | 4          | 5                            | 5          | 4                      | 5          | 5                                | 5          | 5                         | 5          |
| Vegetation composition of buffer                                 | 1                                 | 1          | 2                            | 2          | 1                      | 2          | 4                                | 2          | 1                         | 4          |
| Vegetation composition of adjacent land to 30 m from stream bank | 1                                 | 1          | 1                            | 1          | 1                      | 1          | 4                                | 1          | 1                         | 1          |
| Bank stability   | 1                                 | 3          | 3                            | 3          | 2                      | 3          | 4                                | 4          | 4                         | 5          |
| Livestock access   | 1                                 | 3          | 5                            | 5          | 1                      | 3          | 5                                | 5          | 2                         | 5          |
| Riparian soil denitrification potential                          | 1                                 | 1          | 2                            | 2          | 1                      | 2          | 3                                | 3          | 1                         | 2          |
| Land slope 0-30 m from stream bank                               | 4                                 | 4          | 3                            | 4          | 3                      | 2          | 2                                | 5          | 3                         | 2          |
| Groundcover of buffer  | 2                                 | 4          | 4                            | 5          | 2                      | 5          | 4                                | 4          | 2                         | 4          |
| Groundcover of adjacent land to 30 m from streambank             | 2                                 | 3          | 2                            | 2          | 2                      | 3          | 4                                | 2          | 2                         | 1          |
| Soil drainage  | 2                                 | 2          | 4                            | 4          | 4                      | 4          | 4                                | 4          | 3                         | 3          |
| Rills/channels   | 5                                 | 5          | 5                            | 5          | 4                      | 5          | 5                                | 5          | 5                         | 5          |



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