BEFORE INDEPENDANT HEARING COMMISSIONERS
APPOINTED BY THE CANTERBURY REGIONAL COUNCIL


IN THE MATTER OF: Proposed Plan Change 7 to the
Canterbury Land and Water Regional
Plan – Section 14: Orari-Temuka-Opihi-
Pareora

HEARING STATEMENT OF KEVIN O’KANE

Dated: 16 October 2020

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1. **Introduction**

1.1 My name is Kevin O’Kane

1.2 I am married to Karen and we have three boys.

1.3 We farm 192 ha effective 620 cow dairy farm in coastal Seadown. The farm is fully irrigated with shallow well water. We are a family run farm, employing a further 3 full time staff.

1.4 I am an active member of the “Seadown Water Users Enhancement Group”, previously termed the Seadown Irrigation Users Group. I have the authority to speak on behalf of our group.

1.5 The key outcome I am seeking from the Plan Change is the inclusion of the ability to augment the Seadown Drain so that the minimum flow is maintained and members of the Seadown Water Users Enhancement Group can continue to irrigate while the minimum flow in the Seadown Drain is maintained.

1.6 I did not have legal representation until very recently and so did not file any evidence as I am now aware, I should have. For this reason, my Hearing Statement covers a bit of ground.

1.7 I accept the current Minimum Flow of 150 l/s for the Seadown Drain. I appreciate that it is out of fashion to use water depth as a measure, although note that Greg Ryder recommended a minimum depth of 20 centimetres as being an alternative and perhaps better criteria for ensuring that the values of the Seadown Drain were maintained. The drain has very little fall and flow rates are often very low. The report prepared by Dr Greg Ryder I referred to in my original submission, is attached.
1.8 There are no practical alternative supplies of water in the area. I drilled for water down to 120 metres and found nothing. Neighbours have also explored this option, but there is insufficient water and the bores are unstable because of the sandy substructure and sea action.

2. **Brief History of Seadown Drain**

2.1 The Seadown Drain is a man-made drain that runs parallel to the coast from Beach Rd in Seadown to the Washdyke Lagoon. Please refer to **Annexure A**: Map of Seadown showing drain location, Levels Plain entry points, Seaforth Wetland and Washdyke Lagoon.

2.2 The drain was first built in the 1938 by the Ministry of Works to drain the waterlogged land along the Seadown coast that had developed after the opening of the Levels Irrigation Scheme in 1936. Lateral drains were introduced later to better drain the properties in Seadown.

2.3 The catalyst for developing the drain arose from the water seepage from the Levels Plain irrigation scheme causing saturating of paddocks in Seadown, below the newly constructed Levels Plain irrigation scheme. Crops could not be harvested and stock health was compromised. These concerns were alleviated once the drain was constructed.

2.4 The initial method of irrigation from the Levels Plain Irrigation Scheme was wild flood, then border dyke, followed by today’s more efficient spray irrigation (Pivots).

2.5 The Seadown Drain is maintained by ECAN and paid for by targeted drainage rates. There is a Drainage Board and I am currently a member.

2.6 The drain has had to be shifted from time to time due to erosion by the sea and it is estimated that part of it will need to be moved again within the next five years.

2.7 Water in the Seadown Drain comes primarily from the Levels Plains “wash water” which is released and used to push water across the Levels Plains. The wash water ends up in a large flooded area of several hectares to the north, where it enters the drain and flows down to the Washdyke Lagoon.
2.8 There is no accurate measure of the amount of this wash water but the estimate is that it is between 30 to 60 litres a second from October thru till May. When restrictions are placed on the Opuha Dam releases, the amount of wash water also reduces, affecting the minimum flow in the Seadown Drain.

*Seadown Drain (from Beach Road end)*
3. **Seadown Water Users Enhancement Group**

3.1 Seadown Water Users Enhancement Group consists of 17 landowners covering 1877 ha of land and whose irrigation consents currently are, or will be, connected to the minimum flow of the Seadown Drain under PC7 changes to stream depletion methodology (moving from 30 day pumping to 150 day pumping model). Submissions have also been made by other individual Group members.

3.2 The 17 members of the Seadown Water Users Enhancement Group are made up of 10 family farming enterprises. The land use split is 1040 ha Dairying (consisting of 6 family owned dairy farms and 837 ha cropping land (farmed by 3 long established Seadown families) All the farms are owned and operated by intergenerational farming families who have been and are currently major contributors to the Seadown community over many generations.

3.3 The group includes members of the Runanga o Arowhenua who farm in the area and we all genuinely share respect for the environment and the ecology that has
developed as a result of the building of the drain in 1938 which, in order to exist and survive, necessarily contains water from mixed sources, namely the Opuha Dam and Levels Plains.

3.4 The Seadown Drain provides for a significant population of eels (mahinga kai) and is part of the runanga mataitai reserve – refer Dr Greg Ryder’s Report.

Seadown Drain (Beach Road end)

4. CONSEQUENCES OF NOT BEING ABLE TO AUGMENT THE SEADOWN DRAIN

Financial – Contribution to Economic Wellbeing

4.1 I have spoken to all our group members and obtained the current value of their farms and an estimated value if they were unable to irrigate. In blunt terms, we believe that our asset base will devalue by 31% if we are not able to have a reliable water source for irrigation. The loss of overall capital value would be in the vicinity of $25 585 000.00, something our banks would not be happy with.
4.2 In terms of cashflow for our farming businesses, the current profit for the dairy farms in the group totals $4 088 300.00 before interest, tax and drawings and for cropping farms the total is $ 2 209 200.00. With restricted access to water it is estimated that these would fall to $2 491 380.00 and $946 800.00 respectively.

**Employment and Community**

4.3 The number of staff employed over the Seadown Water Enhancement Users Group is outlined in table below.

<table>
<thead>
<tr>
<th>Staff Category</th>
<th>Current Irrigation</th>
<th>Restricted Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>Casual</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>55</strong></td>
<td><strong>23</strong></td>
</tr>
</tbody>
</table>

4.4 These numbers include the family farm owners that work on their farms.

4.5 No casual staff would be employed under restricted irrigation because all of the casual staff are used for potato harvesting for 3-4 months in the autumn.

4.6 Of the 16 staff that would not be employed under restricted irrigation, over half of these staff are married couples with an average of 2 children in the district who attend local school and are involved in the community from sports clubs to churches.

**Family Impact**

4.7 As a family under the new irrigation levels of PC7 and without the ability to augment the Seadown drain our dairy farm business will not be able to survive. We converted our property in 2014 right at the time of the dairy payout collapse. Our bank has been supportive to us to date. Our business has low equity levels (30%) and any spare cashflow has been used to pay off debt. With unreliable irrigation, our on-farm expenses will increase by at least 27% ($950k up to $1.2m) which erodes directly off our bottom line and our ability to pay down debt. Our
bank would not be as accommodating under this situation, and we would be forced to sell.

4.8 As a family we have put a substantial amount of time into plantings and ongoing maintenance of native plants on our property and the department of Conservation reserve on our boundary, including planting, weeding and watering the native plants supplied by ECAN.

4.9 We obtained our dairy farm by working up through the sharemilking ladder, until we were able to sell our cows and purchase a farm. This has not been without its challenges both financially, physically, and mentally. We are committed to a sustainable farming and environmental future, but our future is dependent on the ability to have reliable irrigation. We are looking to achieve this through augmentation of the Seadown Drain.

Kevin O’Kane
16 October 2020
Seadown Drain
Minimum flow requirement assessment
Prepared for Irricon Resource Solutions Ltd
By Ryder Consulting Ltd

Seadown Drain

Minimum flow requirement assessment

prepared by

Ruth Goldsmith, PhD.
Greg Ryder, PhD.

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1. INTRODUCTION

1.1 Background

Seadown Drain is a man-made drain that runs parallel to the coast north of Timaru (Clarke 2015\(^1\)) (Figures 1 to 5). It drains farmland and flows south into Waitarakao/Washdyke Lagoon (Washdyke Creek is the other major tributary of Washdyke Lagoon). The drain was built to facilitate the removal of ponded water (as seen in many places along the coastline) to increase productive land acreage, and more recently to carry irrigation scheme by-wash from the Levels Plains Irrigation Scheme (Clarke 2015). The drain runs parallel to the Seaforth Coast wetland, which is a Canterbury Regional Wetland with an overall ecological significance ranking of 'high' (Parker 2011). The Washdyke Lagoon is also of 'high' significance (Grove 2009).

Existing consent requirements for water takes from Seadown Drain and adjacent bores require that takes cease "... whenever the flow in Seadown Main Drain at Aorangi Road, at or about map reference NZMS 260 J39:7182-4931, as estimated by the Canterbury Regional Council, falls below 150 litres per second." At the time that the existing minimum flow was set (circa 2004) there was only very limited information on drain flows and ecological values, and no understanding of the relationship between water takes and drain water levels, the magnitude of irrigation by-wash additions to the drain, and/or the relationship between water levels in the drain and Washdyke Lagoon. Consequently, the existing minimum flow was not based on maintaining certain hydrological relationships or ecological values. The purpose of the current report is therefore to revisit the minimum flow requirements for the drain, and recommend a minimum flow that is based on maintaining existing ecological values in the drain and Washdyke Lagoon.

Figure 1  Seadown Drain runs parallel to the coastline north of Timaru (map from ECan online GIS system). Canterbury Regional Wetlands in the vicinity of the Seadown Drain are the Seaforth Coast wetland (which runs parallel to Seadown Drain) and the Washdyke Lagoon (which Seadown Drain is a tributary of) are also shown with cross hatching.
Figure 2  Seadown Drain upstream of Aorangi Road, 17th December 2015.

Figure 3  Seadown Drain at water level recorder, downstream of Aorangi Road, 17th December 2015. Flow at Aorangi Road recorder 164 L/s (flow data provided by ECan).
Figure 4  Seadown Drain upstream of its outlet to Washdyke Lagoon, 17th December 2015.

Figure 5  Seadown Drain at its outlet to Washdyke Lagoon, 17th December 2015.
2. EXISTING ENVIRONMENT

2.1 Existing minimum flow

Measured (ECan gauged) flow data for Seadown Drain is available for the period September 1982 to August 1983, less regularly during the period 2006 to 2013, and on 11 occasions during 2015 to 2016 (Figure 6). Monitoring during 1982 to 1983 recorded flows ranging from 0.23 to 0.48 m\(^3\)/s (note that this data is less accurate (10 to 15 % accuracy) than recent measurements (3 to 4% accuracy)). During the 2006 to 2016 period flows were lower, ranging from 0.07 to 0.32 m\(^3\)/s (Figure 6). Average channel water velocities measured during these gaugings were low, ranging from 0.031 to 0.27 m/s. Instantaneous flow measurements (based on a measured flow and stage relationship) are also available for the period August to March 2016, showing flows ranging from 0.09 to 0.86 m\(^3\)/s (Figure 7).

There is no written documentation available describing the process of setting the existing minimum flow, however it is thought that 0.15 m\(^3\)/s was decided upon as it was well below the previously recorded minimum flow, based on the 1982-1983 data (Keri Johnson, Irricon, pers. comm.). It also was not known the contribution that by-wash from the Levels Plains Irrigation Scheme was making to the flow in Seadown Drain at that time. It is likely that the by-wash contribution to the drain has decreased over time, and will continue to do so, as irrigation systems become more water efficient. Low water levels in the Opuha Dam over the 2014/2015 season also lead to irrigation restrictions within the Levels Plains scheme that consequently reduced by-wash inputs to Seadown Drain. Measured flows in the drain in more recent years indicate that flows below 0.15 m\(^3\)/s do occur reasonably frequently, with 59% of measured flows (10 of 17 measurement occasions in November to April period) since 2010 below 0.15 m\(^3\)/s (minimum 0.07 m\(^3\)/s) (Figure 6).

Recent flow gaugings and stage measurements undertaken by Environment Canterbury (November 2015 to February 2016) indicate that a 100 L/s reduction in flow equates to a 9 cm decrease in water level in the drain (Figure 8). The reliability of flow rating curves for the drain, however, is likely limited to relatively short time periods due to a range of factors. These include the presence
at times of dense macrophyte beds (which can influence water depths and velocities), and drain maintenance works changing channel morphology.

Figure 6  Seadown Drain (at Aorangi Road) measured flow (m³/s) and water temperature (°C) on various dates, September 1982 to February 2016 (flow data provided by ECAn). The dashed black horizontal line shows the existing 150 m³/s minimum flow.

Figure 7  Seadown Drain (at Aorangi Road) instantaneous flow (m³/s) August 2015 to March 2016 (flow data provided by ECAn).
2.2 Existing water quality and aquatic ecology values

Seadown Drain receives inflow from a network of smaller drains that criss-cross coastal farmland to the north of Timaru (Figure 1). The drain is man-made and in keeping with its function it is very channelised and lacks any sinuosity (Clarke 2015). Environment Canterbury undertake regular works in the drain to maintain its drainage capacity, including both spraying with herbicide to reduce macrophyte (aquatic plant) growths and mechanical excavation of the channel to remove macrophytes and sediment. There is little habitat variation along the length of the drain, and this may limit the range of organisms able to exist here (Clarke 2015).

Seadown Drain and Washdyke Creek are the major tributaries of Washdyke Lagoon. Washdyke Creek has a catchment comprised of various land uses (Clarke 2015). The upper part of the catchment is used for grazing and lifestyle blocks, while closer to the lagoon much of the area is covered with industrial and manufacturing premises. As a result, the creek also receives a considerable amount of stormwater during heavy rainfall events. It is likely significant loads of sediment are transported into the lagoon during these short term high flow events. During the summer months water in the lower reaches of Washdyke Creek is frequently stagnant (Clarke 2015).
Although freshwater can dominate Washdyke Lagoon during high rainfall and flood events, under normal conditions the lagoon is brackish (Clarke 2015). It is likely that the average water residence time in the lagoon has been greatly reduced because of the reduction in water level, and frequent flushing by inflowing seawater as a result of the installation of the pipes through the beach crest. The installation of the Washdyke Creek bypass, which takes fresh water around the lagoon during low flows periods, is also likely to have further increased the salinity of the lagoon by reducing the dilution previously provided by this freshwater tributary (Clarke 2015). During high seas and storm events waves can overtop the low lying beach crest and flood the lagoon area with salt water. Although the lagoon is relatively shallow, the salinity difference between the fresh and marine water inputs is still sufficient to maintain a lens of freshwater on the top of the more saline water throughout almost the entire tidal cycle (Clarke 2015). Nutrient concentrations in the lagoon are highly variable, and reflect the different proportions of marine and fresh water found in the lagoon at different times (Clarke 2015).

Environment Canterbury undertook water quality monitoring in Seadown Drain\(^2\) (at Aorangi Road) monthly from July 2009 to June 2010, and less frequently in Washdyke Creek (downstream of the State Highway 1 bridge) over the same period. Water quality monitoring data is also available for a site at the south end of Washdyke Lagoon from June 2009 to June 2011. This monitoring generally coincided with low tide in an attempt to better characterise effects of land use on the lagoon (Clarke 2015). Flow data for Seadown Drain is only available on four dates during this period, none of which coincide exactly with water quality monitoring days, although dates are only two days apart in February 2010.

The available water quality monitoring data indicates that dissolved oxygen concentrations in the drain are highly variable (ranging from 61 to 177%, Figure 9), and this is thought to be due to the presence of large macrophyte beds at times\(^3\) (Clarke 2015). Submerged macrophyte cover of up to 90% has been observed in Seadown Drain and it is typically higher than that in Washdyke Creek

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\(^2\) Seadown Drain is not included within the proposed Canterbury Land and Water Regional Plan river management classification system (e.g., 'alpine upland', 'spring-fed plains'), Washdyke Creek is however classified as 'hill-fed lower' and Washdyke Lagoon as 'coastal lake'.

\(^3\) Resulting in large diurnal swings in photosynthetic activity.
and Washdyke Lagoon (Figure 10). High nutrient concentrations at times in the lagoon (dissolved reactive phosphorus - Figure 11, nitrate and nitrite nitrogen - Figure 12, ammonia nitrogen - Figure 13) are likely related to inputs from the drains. High levels of faecal contamination (E. coli, Figure 14) in the lagoon are also thought to be related to tributary inputs, and also the large numbers of wading birds present (Clark 2015).

Periphyton in the drain is typically dominated by long filamentous growths, although thick mats are also present at times. Periphyton cover is typically 30% or lower, although 50% cover was recorded in December 2009 (Figure 15). Suspended sediment levels are elevated in the drain at times, and on occasions water clarity has been sufficiently low to prevent periphyton and macrophyte surveys being completed (Figure 16).

Water temperatures in the drain, Washdyke Creek and the lagoon are similar and show an expected seasonal pattern (Figure 17). The maximum water temperature recorded in the drain was 22.6 °C, measured by Environment Canterbury in February 2010 during flow gauging at a flow of 0.07 m³/s (Figure 6). Based on the limited data available there was some evidence (R²=0.3) of a relationship between temperature and flow (Figure 18), over all though seasonal variation (i.e., warmer in summer, cooler in winter) was the dominant factor in determining water temperature (Figures 6 and 17).

**Figure 9** Dissolved oxygen saturation (%) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECan online GIS system). Flow (m³/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECan).
Figure 10  Submerged macrophyte cover (%) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system).

Figure 11  Dissolved reactive phosphorus concentration (mg/L) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system). Flow (m³/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAn).
Figure 12  Nitrate and nitrite nitrogen concentration (mg/L) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAN online GIS system). Flow (m$^3$/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAN).

Figure 13  Ammonia nitrogen concentration (mg/L) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAN online GIS system). Flow (m$^3$/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAN).
Figure 14  E. coli concentration (MPN/100 mL) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system). Flow (m³/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAn).

Figure 15  Total periphyton cover (%) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system).
Figure 16  Total suspended solids concentration (mg/L) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system). Flow (m$^3$/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAn).

Figure 17  Water temperature (°C) in Seadown Drain, Washdyke Creek and Washdyke Lagoon (data sourced from ECAn online GIS system). Flow (m$^3$/s) in Seadown Drain on four occasions in February to April 2010 is also shown (data supplied by ECAn).
Figure 18  Relationship between temperature (°C) and flow (m$^3$/s) in Seadown (data supplied by ECan).

There are no freshwater fish database (NZFFD) records for Seadown Drain, however records for Washdyke Creek, Washdyke Lagoon and associated drains include black flounder, common bully, common smelt, inanga, upland bully and shortfin eels. These species are also expected to be found in the drain. Inanga are likely to utilise the grassed banks of Washdyke Creek and drains surrounding the lagoon area for spawning (Clarke 2015, Figure 19). Seadown Drain also provides habitat for a significant population of eels and this area is part of the Arowhenua rūnanga mātaitai reserve (Clarke 2015).
Figure 19  Modelled potential inanga spawning areas in and around Washdyke Lagoon. Green - modelled potential spawning areas. Red dots – confirmed spawning sites. (Model based approach to predict inanga spawning sites in Canterbury DRAFT – Greer et al. 2015). From Clarke 2015.
3. MINIMUM FLOW ASSESSMENT

3.1 Significance of existing values

The process of assessing minimum flow requirements in Seadown Drain is complicated by its artificial nature, relatively stable flow, high macrophyte presence (at times) (Figure 20), and the lack of knowledge of the magnitude of irrigation by-wash inputs or relationship between water takes and drain water levels. As a result traditional minimum flow setting approaches (e.g., RHYHABSIM) are not appropriate for the drain. The approach taken here was instead to identify the existing values of the drain (and the downstream lagoon), how these could be affected by flow variation, and then recommending a minimum flow that will maintain these.

The existing aquatic ecology values of Seadown Drain are low due to its artificial nature and on-going disturbance. The drain has a relatively uniform channel with little habitat variation (Figure 21), and that which is present is disturbed by regular macrophyte (weed) removal activities, most recently in March 2016 upstream of Aorangi Road (Figures 22, 23 and 24).

While the drain is one of the major freshwater inputs to Washdyke Lagoon (Figure 25), the lagoon system is primarily brackish and dominated by its connection to the sea (which is maintained as a result of the installation of pipes through the beach crest). Water quality monitoring undertaken in the lagoon at low tide (i.e., when the inflow from the drain is expected to have its greatest influence) indicates that the drain inflows contribute to high nutrient and E. coli levels in the lagoon. Low flow inputs from the drain therefore do not appear to provide much value in maintaining water quality in the lagoon.

The primary ecological value of the drain therefore appears to be in providing habitat for migratory native fish, particularly eels and inanga, and trout. Several shoals of inanga were observed in the drain as far upstream as Settlement Road in April 2016 (Figure 26) and a medium sized trout was also seen downstream of the Aorangi Road recorder (the drain however does not provide suitable spawning habitat for trout). High levels of nitrate and ammonia can be toxic to fish and nutrient levels in the drain are at times high. Annual maximum and
median concentrations (year 2009-2010) were however well below the annual maximum ‘National Bottom Line’ values (1.30 and 2.20 mg/L, respectively) set in the National Policy Statement for Freshwater Management (MFoE 2014) and within the range for protection of 95% of species (starts impacting occasionally on the 5% of most sensitive species). Annual median nitrate concentrations (year 2009-2010) were also below ‘National Bottom Line’ concentrations for no acute effects (although growth effects on up to 20% of species [mainly sensitive species such as fish could occur]) (MFoE 2014).

The presence of dense macrophyte growths can result in large variations in dissolved oxygen levels that could negatively impact fish. However macrophyte presence in the drain is expected to be largely independent of the minimum flow, instead being related to seasonal patterns and the stable flow regime that the drain habitat provides (i.e., similar to that in spring-fed streams). Although low at times, the minimum dissolved oxygen level recorded in the drain (5.8 mg/L) meets the instantaneous minimum imperative and guideline values recommended for the protection of early life stages and adult freshwater fish (Franklin 2013*). This conclusion is based on very limited data and longer term monitoring would be required to evaluate against the 7-day guideline values. In any case the native fish species expected to be present in the drain are not especially sensitive to low dissolved oxygen levels, in comparison to salmonid species.

The primary consideration for minimum flow requirements in the Seadown Drain is therefore ensuring that sufficient water depth is maintained in the drain (and in existing culverts within the drain) to ensure a connection for fish between the drain and lagoon. There are two major culverts located within the main drain, at Sheffield Street and Aorangi Road. There are several smaller drains that enter the main drain at points, some of which also have culvert pipes (Figure 27). Most of these smaller drains enter in the reach downstream of Aorangi Road, with the exception of the drain that contributes the Opuha bywash, which is located approximately 700 m upstream of Aorangi Road, although this drain does not have a culvert (Figure 28). The larger side tributaries of the main drain are

likely to provide additional habitat for inanga, including spawning habitat in those tributaries that are within the tidally influenced section of the drain.

Figure 20  Macrophyte growth in Seadown Drain at the Sheffield Street culvert, 6th April 2016.

Figure 21  Seadown Drain reach between Aorangi Road and Beach Road, 6th April 2016.
Figure 22  Excavator working in Seadown Drain near Kereta Road, 8th March 2016.
Figure 23  Seadown Drain immediately upstream of Aorangi Road, before (top) and after (bottom), macrophyte (weed) removal, 17th December 2015 and 8th of March 2016. Flows 164 L/s and 178 L/s, respectively (flow data provided by ECan).

Figure 24  Seadown Drain at water level recorder, downstream of Aorangi Road, 8th of March 2016. Flow 178 L/s (flow data provided by ECan). Note the large pile of removed macrophytes on the true left bank.
**Figure 25** Washdyke Lagoon (top), and Seadown Drain entering Washdyke Lagoon (bottom), 6th April 2016.
Figure 26  Inanga in Seadown Drain, 6th April 2016.

Figure 27  Side drains with culverts entering the Seadown Drain, downstream of Aorangi Road, 6th April 2016.

Figure 28  Opuna bywash drain entering true right of Seadown Drain, approximately 700 m upstream of Aorangi Road, 6th April 2016.
3.2 Field assessment

A survey of the drain was undertaken on the 6th of April 2016. This was a follow-up to the previous site visits that had been undertaken on the 17th of December 2015 and the 8th of March 2016. The drain was surveyed from downstream to upstream, beginning at the Washdyke Lagoon confluence. It was low tide when this lower section of the drain was surveyed and therefore the direction of flow was from the drain into the lagoon. Water depths at the two main drain culverts were measured, and water depths and channel widths were measured at five transects across the drain. These transects were chosen to be representative of the typical channel shape in that reach. At three of these transects (3, 4, and 5) water velocities were also measured to enable flow to be calculated (Table 1). At the two lower transects (1 and 2) it was not possible to measure water velocity due to the large amount of macrophyte growth. It was initially intended that the ECan water level recorder at Aorangi Road would be used to estimate flow in this section, however the macrophyte growth meant that the weir at the recorder was overtopped and as a result there was no flow data available from the recorder after the 20th of March (Monica Wilson, ECan, pers. comm.). The measured flow at transect 3 likely provides a good approximation of the flow at the Aorangi Road recorder, as there were only minimal inputs to the drain between these two locations, however as noted by ECan macrophyte growth downstream of Aorangi Road would have effected water levels.

The measured flow at transect 3 on the 6th of April was 200 L/s and the flow at transect 4 was 180 L/s (Table 1). The Opuha bywash drain enters the Seadown Drain between these two locations, therefore indicating that this drain was contributing a flow 20 L/s at this time. Further upstream in Seadown Drain at transect 5 the measured flow was 100 L/s (Table 1). Photos of each transect and their water depth cross-sections are shown in Figure 29. Although the width of the channel varies, all five cross-sections show a typical U-shape as was expected for a drain, with water depth increasing sharply on the channel edges then staying relatively consistent across the centre. Maximum water depths ranged from approximately 60 cm to 1 m, with median depths of 46 to 80 cm (Table 1).
Table 1  Location of Seadown Drain transects, 6th April 2016.

<table>
<thead>
<tr>
<th>Transect</th>
<th>Location</th>
<th>Channel width (m)</th>
<th>Median depth (m)</th>
<th>Maximum depth (m)</th>
<th>Flow (m³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Approx. 150 m upstream of Washdyke Lagoon, 50 m downstream of Sheffield Street culvert</td>
<td>5.2</td>
<td>0.46</td>
<td>0.68</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>At ECan Aorangi Road water level recorder weir, approx. 200 m downstream of Aorangi Road</td>
<td>7.4</td>
<td>0.54</td>
<td>0.58</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Immediately downstream of Opuha bywash drain entrance, approx. 700 m upstream of Aorangi Road</td>
<td>7.7</td>
<td>0.78</td>
<td>1.00</td>
<td>0.20</td>
</tr>
<tr>
<td>4</td>
<td>Approx. 1.5 km upstream of Aorangi Road</td>
<td>7.6</td>
<td>0.80</td>
<td>0.98</td>
<td>0.18</td>
</tr>
<tr>
<td>5</td>
<td>Approx. 5.5 km upstream of Aorangi Road</td>
<td>4.1</td>
<td>0.62</td>
<td>0.71</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Figure 29  Seadown Drain water depth cross-sections at transects 1 and 2 (top to bottom), 6th April 2016.
Figure 29 (con.) Seadown Drain water depth cross-sections at transects 3, 4 and 5 (top to bottom), 6th April 2016.

There are two piped culverts within the Seadown Drain, located at Sheffield Street and Aorangi Road (Figures 30 and 31). Each culvert consists of two side-by-side pipes of diameter approximately 1.1 m, located at the same height (i.e. not offset). Due to its location close to the Washdyke Lagoon it is likely that the water level in the Sheffield Street culvert is influenced by tidal variation. On the 6th of April, at low tide, the water depth at the downstream end of the Sheffield Street culvert was 53 cm (Figure 30). Water depth in the drain itself immediately
downstream of the culvert was approximately 80 cm. Water depth in the Aorangi Road culvert pipes was 92 cm on the 6th of April, with the water depth in the drain downstream approximately 1 m (Figure 31). It is likely however that macrophyte growth downstream of Aorangi Road was influencing water levels in the culvert at this time.

Figure 30  Seadown Drain Sheffield Street culvert, 17th December 2015 (top) and 6th April 2016 (bottom).
Figure 31  Seadown Drain Aorangi Road culvert, 17th December 2015 (top), 8th March 2016 (middle) and 6th April 2016 (bottom).
3.3 Minimum flow requirement

Guidelines for fish friendly culvert designs (Auckland Regional Council 2000) recommend that for short culverts with the same slope as the stream (normally flat), as in Seadown Drain, mean water velocities through the culvert should be less than or equal to 0.3 m/s, with the water depth specific to the largest fish needing passage, in this case large trout. The minimum recommended water depth for upstream passage of large trout is 20 cm (Hudson and Harkness 2010). Additionally, where the flow regime of the stream permits, to ensure the maintenance of a wetted margin within the culvert (to assist upstream passage of native fish), water depth should be no greater than 45% of the culvert height for the majority of the September to February upstream migration period (Auckland Regional Council 2000). For the Seadown Down main culverts, which have a diameter of 1.1 m, this depth required is therefore no greater than approximately 50 cm. The minimum depth required through the culverts is therefore 20 cm (i.e., the minimum depth for large trout passage).

The flow required to maintain a water depth of 20 cm through the Aorangi Road culvert can be predicted based on estimates of water depth in the culvert at different flows. To ensure that water depths in the culvert were not being overly influenced by the presence of dense macrophyte growth downstream only estimates made prior to the 20th of March were used in this prediction (i.e., following the ECAN approach, see Section 3.3). Water depth in the Aorangi Road culvert was approximately 55 cm at a flow of 178 L/s and 50 cm at a flow of 167 L/s. Based on this a minimum 20 cm depth through this culvert would be achieved at flows of approximately 100 L/s at Aorangi Road. At this flow, water velocity through each culvert pipe would also below the recommended 0.3 m/s.

Measured flows in the drain in recent years indicate that flows of 100 L/s are not uncommon, with 41% of measured flows (seven of 17 measurement occasions in November to April period) since 2010 below 100 L/s (minimum 70 L/s) (Figure 6).

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4. CONCLUSION AND RECOMMENDATION

The existing ecological values of Seadown Drain were assessed in order to assist with the recommendation of minimum flow requirements for the drain. The key ecological value of the drain is the provision of habitat for migratory native fish, particularly eels and inanga, and trout. The primary consideration for minimum flow requirements in the drain is that sufficient water depth is available in existing culverts within the drain to ensure a connection for fish between the drain and lagoon.

It is recommended that a water depth of at least 20 cm be maintained through the Aorangi Road culvert to allow fish passage. It has been calculated that this equates to a flow of 100 L/s. However, given that it has proven difficult to establish a long-term relationship between water level and flow in the drain, it is recommended that rather than a minimum flow requirement being set for the drain, as is the current situation, a minimum water level is adopted instead. This could relate either to maintaining a 20 cm water depth though the Aorangi Road culvert, or the equivalent water level at the Aorangi Road recorder to maintain the culvert water depth upstream.