

Clyne River Study

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Risk Assessment

- Risk – Could slip on mud/leaves and fall into the river.
Likelihood - 2
Severity - 1
Risk Rating – 2
To reduce risk – Wear suitable footwear and be extra careful if bad weather occurs.
- Risk – Unstable bank or loose ground near river could cause someone to fall in.
Likelihood – 2
Severity – 1
Risk Rating – 2
To reduce risk – Wear suitable footwear and stay away from the edge of the bank whenever possible
- Risk – Loose branches could fall from the trees and hurt someone.
Likelihood – 1
Severity – 2
Risk Rating – 2
To reduce risk – Observe the area of study before starting and be aware that not all risks are within human control.
- Risk – Fast current could cause imbalance in the water.
Likelihood – 3
Severity – 1
Risk Rating – 3
To reduce risk – Do not enter water that is above knee height, and be aware that a change in weather could increase the current speed and turbulence.
- Risk – Weil's disease (Leptospirosis)
Likelihood – 3
Severity – 3
Risk Rating – 9
To reduce risk – Wear waders/appropriate waterproofs and gloves whenever entering or coming into contact with the water.

Introduction

The River Clyne is located in Swansea, South Wales. Its catchment can be found in the west of the suburbs, before it drains through the industrial landscape of Dunvant in a steep-sided channel. It runs for 8km before depositing at Blackpill in Swansea Bay, otherwise known as the “black stream”. [(Mestre, 2009) in (Revitt and Ellis, 2016)]¹.

One of the aims of this study was to map a section of the river, and take a series of hydraulic measurements so that the discharge of water could be calculated. The second aim was to assess the bank stability. The final aim included identification of flora and macroinvertebrates. According to Mestre, the river receives contaminated water which contains heavy metal concentrations, mainly iron compounds (in Revitt and Ellis, 2016)¹. As a result, the ecological and chemical quality of the water is classed as being between “poor” and “moderate”. [King et al (2014) in (Revitt and Ellis, 2016)]¹.

The following hypotheses were set out before the investigation:

1. The bigger the channel depth, the smaller the bankfull depth.
2. The cross-sectional area of the river remains approximately the same across the whole of the 50m stretch.
3. The stream current speed remains the same over the 50m stretch.
4. The bigger the channel width, the more discharge there is in the river.
5. The bank is more stable towards the top.
6. There is more erosion on the area of bank nearer the river bed.
7. The river has a higher concentration of pollution upstream.
8. There is a more diverse selection of flora further away from the river.

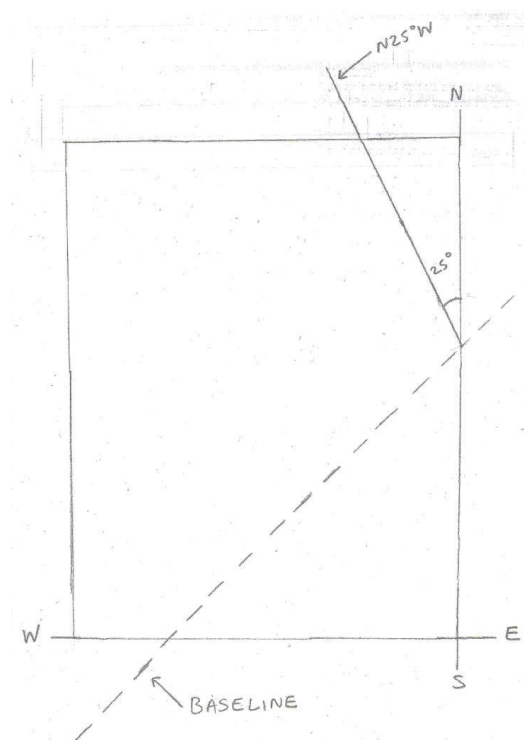
Three groups of scientists collected the relevant data on the 27th of October 2017. It was sunny but fairly cool throughout the day. (late morning to early afternoon). The lower temperature may have been due to the fact that the area studied was mainly sheltered by trees. The ground was damp and slightly muddy in places.

Methodology

To begin the study, a tape measure was used to establish a 50m baseline along the right hand side of the bank (facing upstream). One scientist then stood on the baseline and noted the compass bearing. It read N335°E, or 'North 335° to the East', if written fully. To make this easier to analyse, the following calculation was made:

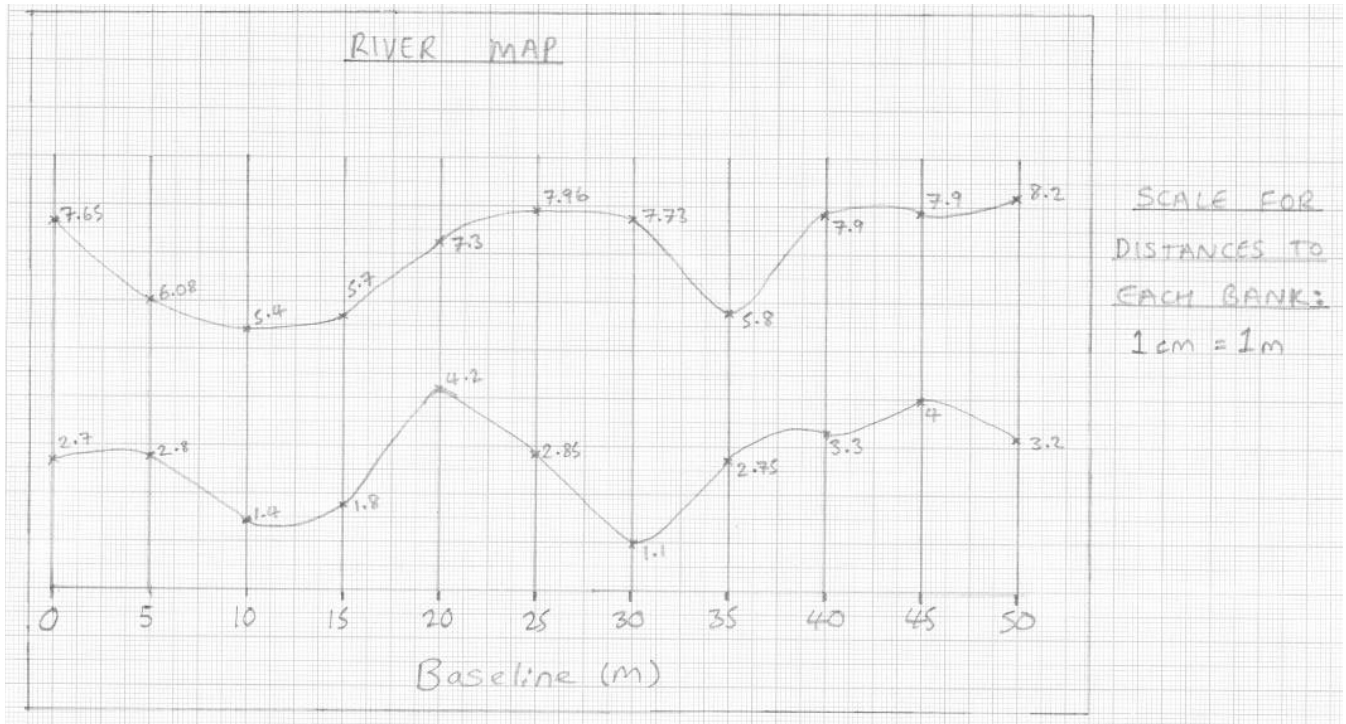
$$360^\circ - 335^\circ = 25^\circ$$

The recorded angle was subtracted from a full circle of 360° to give an alternative reading of N25°W. The map below attempts to illustrate this.



Map 1

Following this, the tape off-set method was used to collect measurements from a section of the river. The perpendiculars were created by using another tape measure and a quadrat to make 90 angles at the baseline. The tape measure was then pulled horizontally tightly, to the left hand side of the river bank to ensure that accurate and reliable results were obtained. This was done at eleven different points altogether. Two different distances were measured and recorded from the baseline to each side of the bank. This allowed the bankfull width to be calculated by subtracting the distance to the near bank from the distance to the far bank. This is shown on *Map 2*.



Map 2

The bankfull and river depth was then measured at 20cm/50cm intervals at a varying number of points across the river. This allowed an average value for river depth to be calculated for use in estimating the cross sectional area. The formula used for this is as follows:

$$\text{Cross-sectional area} = \text{channel width} \times \text{water depth}$$

To achieve accurate values for the current speed, a distance of 10m along the right hand river bank was measured and then marked at each end with surveying poles. A plastic bottle was dropped in the water alongside the pole that was nearest upstream, and a stopwatch was used to time how long it took to travel ten metres. This was repeated five times by two groups so that an average value could be reached.

Hence, the two groups arrived at average values for water discharge in the area they were studying. Shown below is the formula used:

$$\text{Discharge (Q)} = \text{Area (m}^2\text{)} \times \text{speed (m}^3\text{/s)}$$

Where area is the average cross-sectional area, and speed is the average speed.

One assessment of the bank profile was also made per group. The routine for this was to place a pole vertically in the water near the bank, and measure the horizontal distance between the pole and the bank at different heights. A metre rule was used to do this at 10cm intervals. It was completed by starting from the top of the bank until it was

impossible to take any more accurate readings due to the water obstructing the view of the numbers on the metre rule. The distance between the final height taken and the sea bed was also noted. See *Diagram 1* in Results and Analysis to see the data collected for one bank profile.

The bank stability was also assessed in a few different areas. This was done by using a metre rule to measure the height of the bank and the lean length. This allowed the bank angle to be calculated using basic trigonometry (SOH CAH TOA).

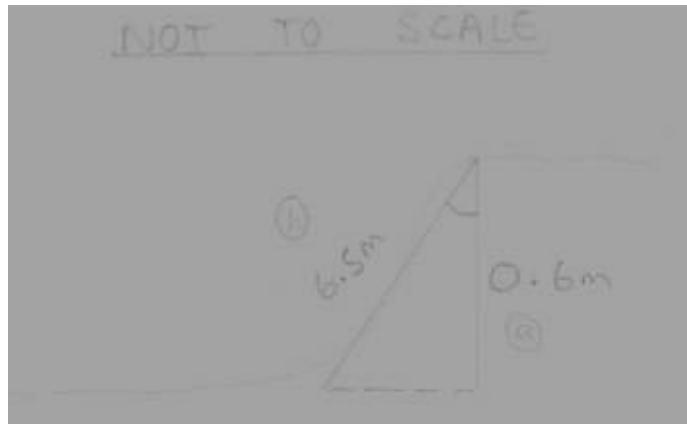


Diagram 2

Here are the calculations used for one of the bank angles:

$$\cos\theta = 0.6/6.5$$

$$\theta = \cos^{-1}(0.0923)$$

$$\theta = 84.7^\circ$$

Therefore this bank was very unstable.

Finally, an ecological assessment was conducted. A kick sample was done by each group in different areas of the stream for a period of one minute. The net was placed so that it was kicked into downstream. The sample was emptied into a tray of water so that the species present could be identified. Sediment and leaves were discarded, before one of each macro organism was removed from the original tray to a smaller one using pipettes, where they could be further analysed. Each macro organism was allocated a BMWP score. The lowest score of one, indicates a higher tolerance to pollution, whereas the highest score of ten, indicates a low tolerance to pollution. Therefore, the higher the score, the more promising the water quality. An ASPT score was also calculated for each sample.

Finally, a brief observation and identification of flora in the surrounding area was made.

Results and Analysis

Hypothesis 1 - The bigger the channel depth, the smaller the bankfull depth.

Below is a table showing the average channel and bankfull depths for each Point.

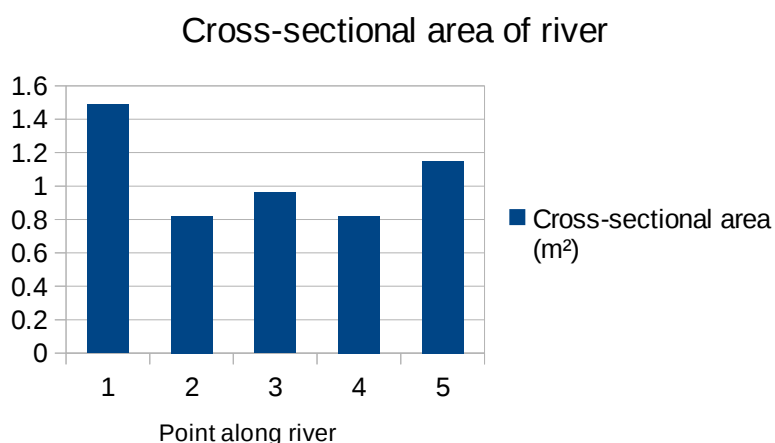
Point	Bankfull depth (m)	Channel depth (m)
1	1.31	0.30
2	1.52	0.25
3	1.59	0.24
4	1.45	0.21
5	1.63	0.37
6		0.37
7		0.11
8		0.24
9	1.75	0.49
10	1.22	0.13
11	1.34	0.15

Table 1

It is clear from *Table 1* that the hypothesis is wrong. In fact there is a consistent pattern that implies the bankfull depth is always larger than the channel depth by about the same amount.

Hypothesis 2 - The cross-sectional area of the river remains approximately the same across the whole 50m stretch.

The following bar chart shows the average cross-sectional area for the first 20m of river (heading upstream).



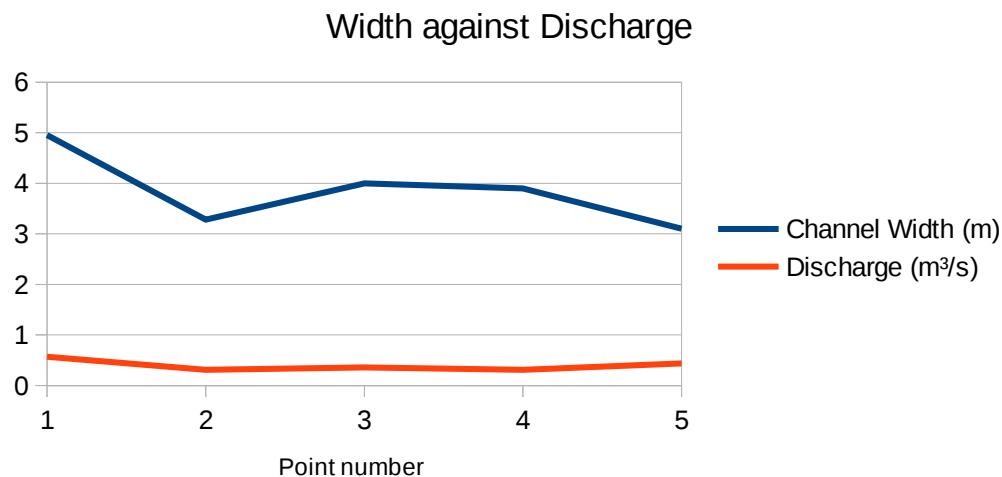
There are not enough results here to be able to make an accurate prediction, but it is still clear that there is not much of a variation in the cross-sectional area at each Point. The most significant difference is at Point 1. This is due to both the channel width and channel depth being larger than average. The bigger width is probably due to the banks being more silt dominated rather than clay, and the rocks in the bank being more permeable.

This would lead to more erosion. The bigger channel depth could be due to not much sediment being deposited on the river bed in that area.

Hypothesis 3 - The stream current speed remains the same over the 50m stretch

Two speeds of 0.38m/s and 0.55m/s were calculated from different areas along the river. Even though this experiment was only done in two areas (over a 10m stretch within 0-20m and 25-50m), the values are still very close and it can be concluded that the river velocity remains approximately the same over the 50m stretch.

Hypothesis 4 - The bigger the channel width, the more discharge there is in the river



The channel width and discharge do seem to increase/decrease with one another from Point 1 to Point 3, however this is not the case at Point 4 and 5. It is possible that Hypothesis 4 is correct, but there is nowhere near enough data to prove this. Also, the river velocity was calculated using a distance of 10m. As the width and discharge over 20m have been compared, this means that half of the results on the graph could be wrong.

Hypothesis 5 - The bank is more stable towards the top



Image 1 _ Bank stability, photograph taken by Sergio Garate

Through brief examination, this was found to be correct. On average, even though the vertical section of bank was mainly stable, it was mostly very stable at the top. *Image 1* proves this by showing how the bank is largely undercut due to erosion. This was the case along the whole left bank (facing upstream). This also answers Hypothesis 6, and proves it to be correct.

Diagram 1 shows the bank profile for one section of the bank. This particular area of bank had a big

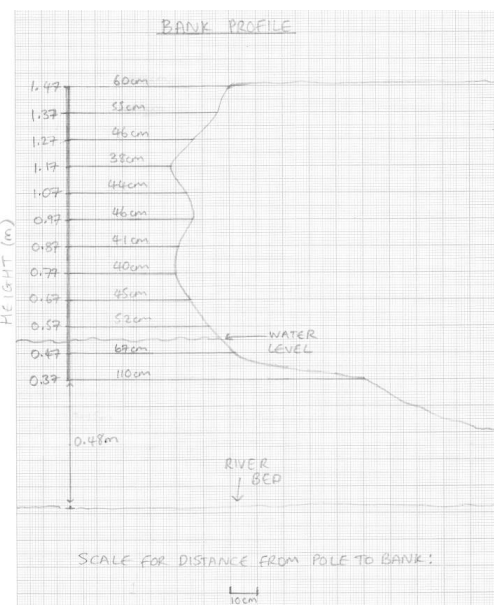


Diagram 1

tree on it, and therefore its roots were binding the earth. Also, its undercut was very clay dominated. This is why the bank had not eroded consistently.

Hypothesis 7 - The river has a higher concentration of pollution upstream.

On *Table 2*, 50m is the furthest point upstream.

Area along baseline	macroinvertebrates found	BMWP score	ASPT score
0-20m	Stoneflies, Mayflies, Shrimps, Beetles Flatworms and Crane fly/Blackfly	37	6.17
25-35m	Mayflies, Caddis flies, Leeches	23	7.67
40-50m	Stoneflies, Shrimps, Beetles, Leeches and Worms	26	5.2

Table 2

There was a larger variety of species downstream, and they all but one had BMWP scores ranging from 5-10. This indicates that the water in this area was of very good quality. Between 25 and 35 metres there were fewer types of species, but they were still mostly creatures that were very sensitive to pollution. Upstream, there seemed to be more macroinvertebrates that are tolerant to pollution, suggesting that Hypothesis 7 is correct. However there were still Stoneflies present, which have a BMWP score of ten. In conclusion, these results are probably a coincidence, as three kick samples were taken approximately twenty metres apart, so it is highly unlikely that there would have been a significant change in the concentration of pollution from one point to the next. A more accurate explanation of these results would be environmental differences in each area, such as shelter from the sun and nutrients in the earth.

Hypothesis 8 - There is a more diverse selection of flora further away from the river

The vegetation found was:

- Hazel
- Fern
- Ivy
- Moss
- Hornbeam
- Downy birch
- Elder
- Ash
- Himalayan Balsam
- Meadow Sweet

Flora such as trees were generally found nearer the river, whereas smaller and more delicate plants were found further away, e.g Himalayan Balsam. There was plenty of diversity in the flora found both next to the river and further away. The bigger and tougher plants were nearer the river as the living conditions were not as easy.

Conclusion

It was found that the bankfull depth was consistently larger than the channel depth, which was not expected. It was also concluded that Hypothesis 3 was correct, and that the river velocity remained approximately the same over the 50m stretch. The area of the bank that was most stable was the top. There was a variation of earth in the bank; most areas were clay dominated but silt was also found.

The water was of very good quality at every point studied, however the largest variety of species was found downstream. There was also a large variety of flora in the surrounding area, with the tougher plants such as trees being nearer the river, and the more delicate ones such as Himalayan Baslam being further away.

Recommendations

If this investigation was performed again, it would be beneficial to collect more data for e.g current speed, as an average value was only calculated over two ten metre stretches. It could also be suggested that taking data from different Sites would be helpful. This would allow the Hypotheses to have been answered more accurately. For example, Hypotheses 7 was not able to be answered properly as the kick samples taken were from areas very close to one another. Thus comparisons were very limited. Finally, more reliable values could have been noted for the bankfull width if engineering levels were used.

References

1. Revitt, M. and Ellis. B (2016). Urban surface water pollution problems arising from misconnections. *Science of the Total Environment*, 551-552, pp.163-174.

Appendix

The following tables show all the values obtained for the bankfull and channel depths, along with the averages highlighted in blue.

Point 1 (0m)			Point 2 (5m)			Point 3 (10m)			Point 4 (15m)		
Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)	Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)	Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)	Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)
3.60	1.36	0.26	2.80	1.70	0.49	1.40	1.52	0.12	1.80	1.38	0.02
3.80	1.44	0.36	3.00	1.70	0.50	1.60	1.80	0.40	2.00	1.38	0.04
4.00	1.50	0.47	3.20	1.72	0.50	1.80	1.82	0.46	2.20	1.34	0.02
4.20	1.60	0.47	3.40	1.73	0.41	2.00	1.72	0.39	2.40	1.34	0.02
4.40	1.48	0.40	3.60	1.71	0.38	2.20	1.70	0.36	2.60	1.36	0.06
4.60	1.46	0.38	3.80	1.61	0.29	2.40	1.66	0.32	2.80	1.37	0.07
4.80	1.44	0.38	4.00	1.60	0.24	2.60	1.64	0.30	3.00	1.38	0.10
5.00	1.39	0.35	4.20	1.64	0.25	2.80	1.60	0.29	3.20	1.38	0.12
5.20	1.36	0.34	4.40	1.66	0.24	3.00	1.59	0.28	3.40	1.40	0.16
5.40	1.32	0.32	4.60	1.53	0.20	3.20	1.59	0.28	3.60	1.44	0.20
5.60	1.29	0.29	4.80	1.53	0.16	3.40	1.59	0.27	3.80	1.46	0.22
5.80	1.24	0.26	5.00	1.30	0.10	3.60	1.58	0.26	4.00	1.46	0.26
6.00	1.16	0.21	5.20	1.28	0.07	3.80	1.55	0.24	4.20	1.50	0.28
6.20	1.18	0.24	5.40	1.26	0.06	4.00	1.49	0.18	4.40	1.49	0.31
6.40	1.14	0.19	5.60	1.20	0.02	4.20	1.49	0.16	4.60	1.51	0.30
6.60	1.10	0.18	5.80	1.20	0.01	4.40	1.48	0.15	4.80	1.55	0.38
6.80	1.09	0.19				4.60	1.49	0.14	5.00	1.58	0.46
7.00	1.18	0.18				4.80	1.50	0.10	5.20	1.64	0.49
7.20	1.08	0.18				5.00	1.56	0.10	5.40	1.64	0.50
						5.2	1.56	0.09			
						5.4	1.46	0.08			
	1.31	0.30		1.52	0.25		1.59	0.24		1.45	0.21

[illegible]

Point 9 (40m)			Point 10 (45m)			Point 11 (50m)		
Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)	Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)	Distance from baseline (m)	Bankfull depth (m)	Channel depth (m)
1.20	1.52	0.39	1.40	1.22	0.12	1.40	1.55	0.12
1.40	1.67	0.40	1.60	1.20	0.13	1.60	1.80	0.16
1.60	1.67	0.40	1.80	1.31	0.16	1.80	1.50	0.17
1.80	1.68	0.40	2.00	1.31	0.18	2.00	1.42	0.16
2.00	1.66	0.41	2.20	1.31	0.19	2.20	1.39	0.14
2.20	1.66	0.41	2.40	1.27	0.18	2.40	1.35	0.15
2.40	1.64	0.38	2.60	1.24	0.16	2.60	1.33	0.15
2.60	1.63	0.37	2.80	1.25	0.16	2.80	1.30	0.14
2.80	1.66	0.39	3.00	1.23	0.15	3.00	1.31	0.14
3.00	1.69	0.43	3.20	1.20	0.10	3.20	1.29	0.14
3.20	1.74	0.47	3.40	1.17	0.10	3.40	1.24	0.13
3.40	1.82	0.54	3.60	1.19	0.10	3.60	1.23	0.15
3.60	1.87	0.59	3.80	1.18	0.10	3.80	1.20	0.15
3.80	1.93	0.64	4.00	1.18	0.12	4.00	1.23	0.15
4.00	1.96	0.66	4.20	1.18	0.11	4.20	1.22	0.14
4.20	1.97	0.68	4.60	1.20	0.10	4.60	1.23	0.16
4.60	1.93	0.62	4.80	1.20	0.08	4.80	1.25	0.17
4.80	1.86	0.55	5.00	1.20	0.06	5.00	1.24	0.13
	1.75	0.49		1.22	0.13		1.34	0.15

Below are all the readings taken for the length of time it took the bottles to travel 10 metres at both points, with the averages highlighted in blue.

Try (Point 1)	Time (s)	Try (Point 2)	Time (s)
1	28	1	20
2	27	2	20.58
3	26	3	16.53
4	27	4	16.25
5	23	5	17.83
	26.2		18.238

The final table below shows the cross-sectional area and channel width for the first five points (0-20m), with the averages highlighted in blue.

Point	Cross-sectional area (m ²)	Channel Width (m)
1	1.49	4.95
2	0.82	3.28
3	0.96	4
4	0.82	3.9
5	1.15	3.1
	1.048	3.85