Teviot Valley Water Quality Monitoring Programme Review

July 2024

Introduction

The Teviot Water Care Group (TWCG) has been undertaking quarterly monitoring since November 2020. Upstream and downstream samples are taken from six catchments, from throughout the Teviot area. Funding was sought through the Access to Experts to review the monitoring programme being undertaken and to make suggestions as to what the results are showing. The sampling sites along with their associated catchments are mapped in Figure 1.

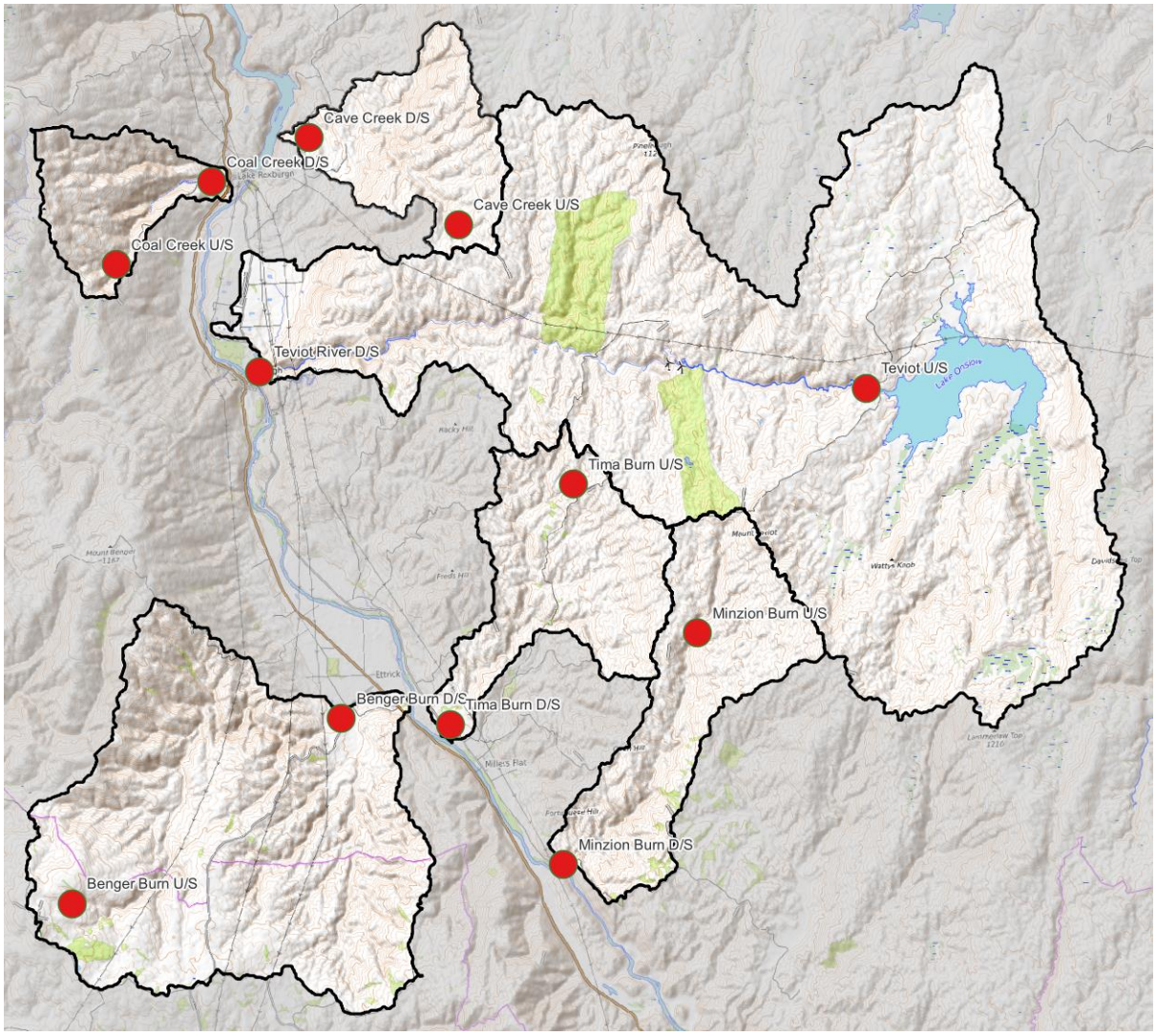

Figure 1. An outline of the sampling sites that have been monitored by the Teviot Water Care Group, along with their associated catchments.

Monitoring programme

Two primary observations were made regarding the monitoring programme, the timing of sample collection, and the purpose of the monitoring programme and whether there was a desire to compare to national standards.

Timing of sampling

It was noted that half of the samples were taken when the area's representative flow site at Benger Burn at Booths was above its median flow levels. On one sampling round, in March 2023, many of the sampling sites, particularly at the downstream sites, recorded significantly elevated *E.coli* levels. Upon investigation this sampling round was taken after heavy rain (22.5mm) following a long dry period. During events such as these it is expected that contaminants will move, and levels will become elevated.

The area is large, and it's likely that for some catchments the streams would be running at normal flow rates, however, without these flow rates being measured, when assessing the water quality results, we must defer to the representative flow site. Collecting samples during periods of higher flow can add valuable information to an established monitoring programme, however, when trying to ascertain baseline levels, it is not recommended. This comment is made to steer the group towards the more fundamental question, what is the intended purpose of the monitoring programme? If it is to establish baseline levels, it is recommended that sampling be taken during periods of settled weather, and when representative sites are at or below median flow.

An alternative could be to try and ascertain localised flow readings using for example a bucket test where appropriate, and care should be taken to capture site conditions, and any unusual observations. Rainfall in the immediate vicinity for the past 24 hours and 7 days should also be kept, to allow a fuller appreciation of what is happening in the area.

Recommendation
To collect samples to establish baseline conditions, it is recommended that sampling be taken when there has been consistent settled weather conditions and representative sampling sites are at or below median flow.

Purpose of the monitoring programme

While analysing the results, the purpose of the monitoring programme was considered. How are the results being used? Are they understood, and to what extent? One area where this question was highlighted was in the testing analysis. In this report, we have endeavoured to compare TWCG's results to the National Policy Statement for Freshwater Management (NPS-FM) attribute bands, however, there are problems comparing the analysis as different methods are being used for some tests. This was highlighted with all sites recording elevated phosphorus levels. A master's student undertook further investigations into these levels trying to ascertain the cause of the elevated phosphorus, he likewise found levels difficult to replicate – again this is likely due to the different methodology being performed.

This observation was further highlighted for the Benger Burn, where ORC monthly samples were compared with the TWCG's testing. Results are presented in Table 1, showing that for phosphorus the TWCG's analysis gives results in the D band, whereas the ORC's testing gives results in the C band. While it is difficult to make this comparison, due to differing timing and samples being collected from different locations, the trends suggest quite different results, and highlight the difficulties in comparing TWCG's samples to National guidelines. This pattern can also be observed for the nitrate results, where similar comments can be made.

Table 1. Benger Burn water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). ORC @ Booths column shows median levels of tests between 2017-2024, while ORC Same Months presents the ORC's sampling results for the same months as TWCG's sampling

Site	Benger Burn U/S	Benger Burn D/S	ORC @ Booths	ORC Same Months
Dissolved Reactive Phosphorus	0.052	0.037	0.0102	0.0111
Ammonia Toxicity	<0.03	<0.03	0.006	0.006
Nitrate Toxicity	1.15	0.59	0.135	0.19
Suspended fine sediment	7.84	2.59	1.56	1.56
E. coli Bacteria	100	400	249	345

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

The testing the TWCG is undertaking is a user friendly and great way to compare sites within a stream, with perhaps upstream and downstream sites, and with results being reviewed to help guide management decisions. However, it is difficult to compare these results with National bands due to the different methods being used.

Recommendation
Review the purpose of the monitoring programme – if it is intended to compare to national levels, then it is recommended that testing be carried out using an accredited laboratory. However, the current methods would be suitable to compare levels within a stream, to highlight problem areas for instance.

Results

The results of the monitoring is presented in Table 2, where the results captured by the Teviot Water Care Group are presented and compared with the NPS-FM. It should be noted that these bands assigned are indicative only, as the methodology differs from that in the NPS-FM. A summary and discussion of the results for each catchment is presented below.

All results have been collected by local farmers and have been analysed by Eco-Dynamic Systems Ltd and are tested in accordance with their methods.

Table 2. Summary of the Teviot Water Care Group's sampling programme from Nov 2020 – March 2023. Comparing median results from the Group's testing with NPS-FM 2020 attribute bands. (A = best, D = national bottom line)

Site	Dissolved Reactive Phosphorus	Ammonia Toxicity	Nitrate toxicity	Suspended fine sediment	*E. coli*
Cave Creek U/S	D	A	A	A	A
Cave Creek D/S	D	A	A	B	B
Teviot River U/S	D	A	A	C	A
Teviot River D/S	D	A	A	B	A
Tima Burn U/S	D	A	A	B	B
Tima Burn D/S	D	A	A	D	C
Minzion Burn U/S	D	A	A	D	C
Minzion Burn D/S	D	A	A	B	C
Coal Creek U/S	D	A	A	A	A
Coal Creek D/S	D	A	A	A	A
Benger Burn U/S	D	A	B	D	A
Benger Burn D/S	D	A	A	B	C

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Cave Creek was based on 9 samples. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

Further investigation

Table 3 summarises the areas highlighted in the report requiring further investigation. The Teviot Water Care Group may choose to follow some of these suggestions to get the most out of their results collected so far.

Table 3. Observations from the monitoring results, with suggested next steps for further discussion or investigation

Catchment	Test of concern	Potential investigation or next steps
Cave Creek	Elevated sediment	Talk to local landowners to assess where elevated sediment levels might come from
Teviot River	Elevated sediment	Talk to local landowners to assess where elevated sediment levels might come from
Tima Burn	Elevated sediment, bacteria and phosphorus	Investigate the causes of elevated levels through further testing Talk to local landowners and discuss results with them and come up with a plan going forward
Minzion Burn	Elevated bacteria	Further testing
	Elevated sediment and phosphorus at the Upstream site	Investigate land use in the upstream area, to assess the likely cause of elevated levels
Coal Creek	High phosphorus – likely associated with analytical testing method	Test Coal Creek phosphorus with an accredited lab to assess true levels
Benger Burn	Elevated bacteria downstream	Investigate the probable reason for elevated bacteria levels at the downstream site
	Elevated nitrate at the upstream site	Investigate the likely source of nitrate at the upstream site

Conclusion

Any monitoring programme is only effective if the results are being used and are fit for purpose. There are a number of areas requiring further investigation, a number of discrepancies, and opportunities to fine tune the TWCG water monitoring programme, which will benefit landowners and the overall catchment health. This report highlights some of these features and raises several questions worth considering. The report also suggests mitigation options, which will likely be quite successful at minimizing contaminant loss from land to water throughout the Teviot area.

Cave Creek

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 2.

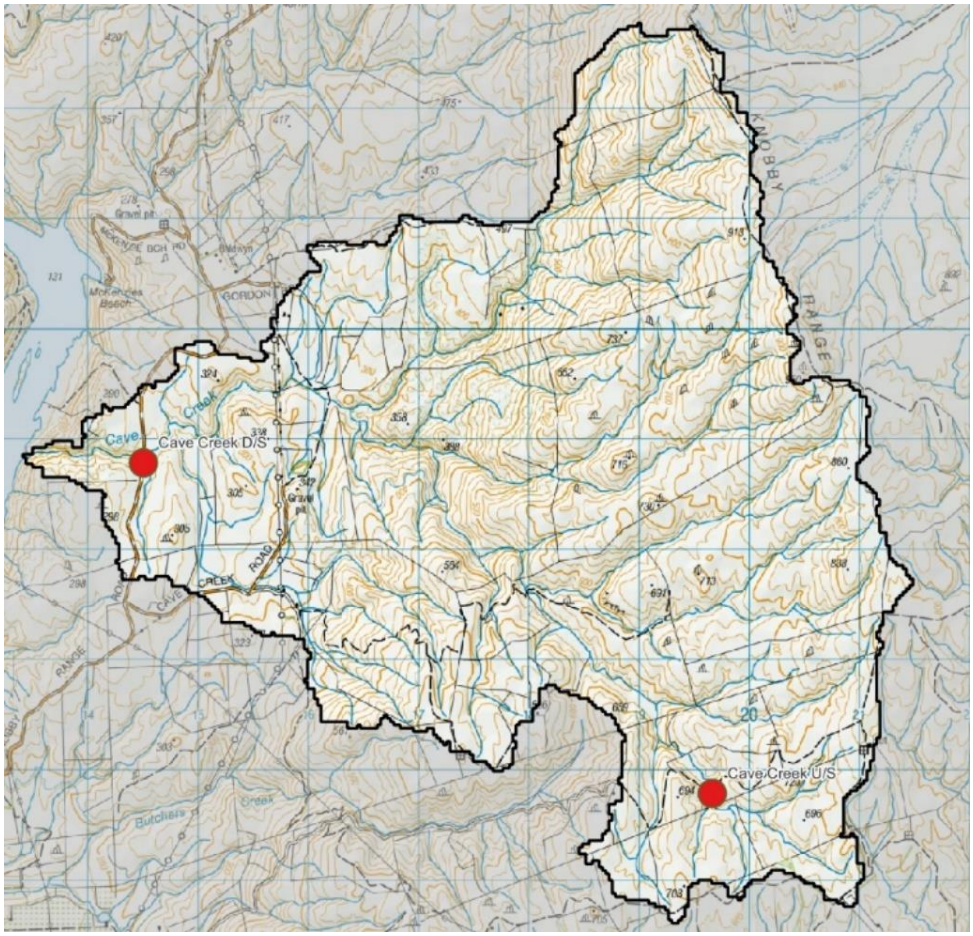

Figure 2. Sampling sites of Cave Creek

As can be seen from Table 4. Ammonia and Nitrate toxicity, are both in the A band for both sites, highlighting the lack of nitrate loss from the Cave Creek catchment. Both the upstream and downstream sites are situated in the B band for suspended fine sediment, which indicates that at times there is some sediment movement. The sediment levels were more variable at the upstream site, with much higher levels at times (e.g. 7.98 March 2021). In both years, the results in November and March were in the D band for the upstream site (5.48, 7.98, 5.45, 6.26) indicating that sediment can be a risk during these times – perhaps as things dry out in the area. During other sampling rounds the sediment levels at this site were relatively low, see Figure 3. Conversely, these levels were not noted for the downstream site.

Table 4. Cave Creek water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change

Site	Cave Creek U/S	Cave Creek D/S	Variance
Dissolved Reactive Phosphorus	0.046	0.046	—
Ammonia Toxicity	<0.03	<0.03	—
Nitrate toxicity	0.600	0.520	—
Suspended fine sediment	2.94	2.27	▲
E. coli	100	200	▼

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 9 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

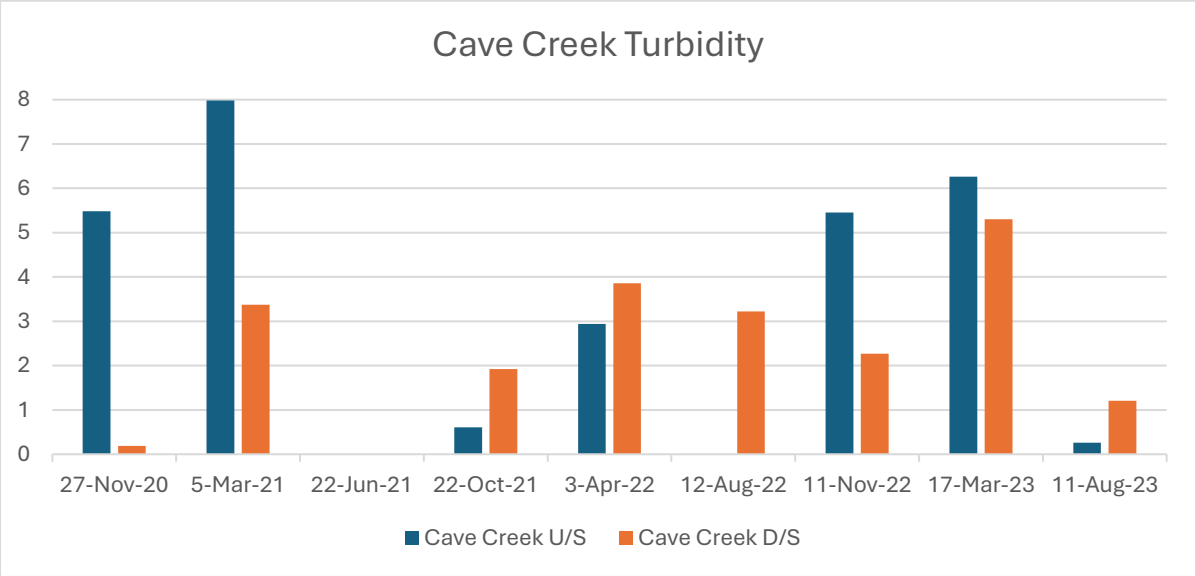

Figure 3. Turbidity results for Cave Creek

Bacteria levels were higher for the lower part of the catchment, potentially due to an accumulation of factors at the downstream site. No other results seemed to increase at this site.

Phosphorus results were the same at both sites, with both in the D Band, this is likely due to the different analysis being undertaken, and the fact we are comparing with the NPS-FM levels. Phosphorus generally binds and moves with sediment; however, this particular test analyses the dissolved form which has separated from the associated sediment.

Discussion

The results highlight one main area of concern the elevated levels of sediment at the upper catchment site. These results raise a number of questions catchment landowners may like to consider. Is this associated with higher stocking rates, coupled with lower stream flows at this time of year? Are the results associated with sediment loss as the north faces dry out during spring and summer? Could these elevated sediment levels be contributing to the higher phosphorus levels in the stream?

In areas of strong bedrock such as this, the main contaminant risks are likely those that move in overland flow, such as microbes, sediment, and sediment bound nutrients (phosphorus), therefore in these environments extra care needs to be taken to minimise direct inputs from land to water. The following mitigations can be used to effectively minimise impacts from land to water in these environments:

- Where possible maintain vegetation cover especially on sloping land
- Use low solubility phosphate fertilisers
- Trap sediment in sediment traps
- Think about impeding direct flow from land to water e.g. where practical direct water from farm and stock tracks to filter in vegetation rather than directly to a waterway

Teviot River

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 4.

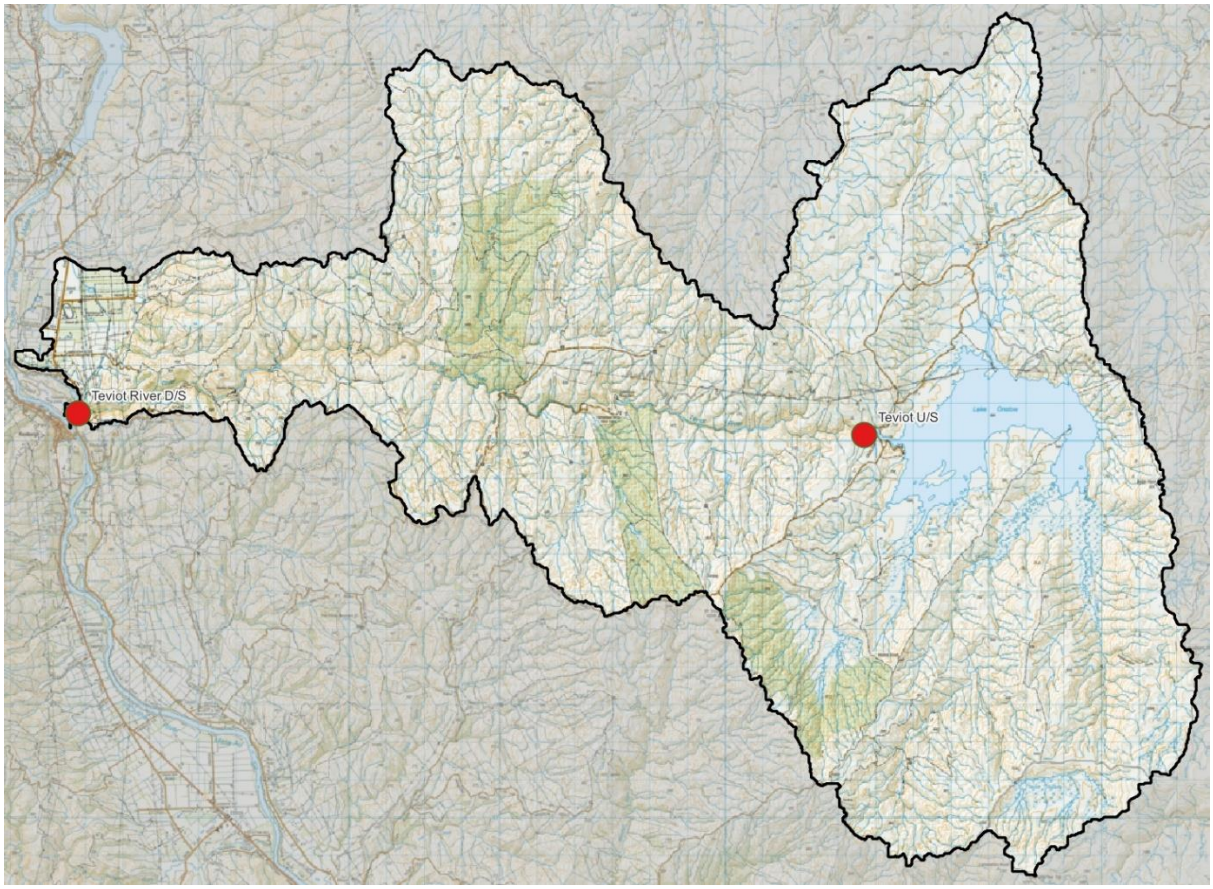

Figure 4. Sampling sites on the Teviot River

As can be seen from Table 5. Ammonia and Nitrate toxicity, are both in the A band for both sites, highlighting the lack of nitrate loss from the Teviot River catchment. Likewise, both sites had low bacteria levels with both consistently in the A band, and the highest level recorded at the upstream site of only 100 (MPN/100mL).

The upstream site is situated in the C band, and the downstream site is situated in the B band for suspended fine sediment, which indicates that at times there is some sediment movement. These levels were impacted by three rounds of particularly high readings – all when the representative flow site was above median levels – in Oct. 21, April 22 and Nov. 22, see Figure 5. The upstream site never had a result in the A band, while the downstream site did have one in March 2021.

Table 5. Teviot River water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change

Site	Teviot River U/S	Teviot River D/S	Variance
Dissolved Reactive Phosphorus	0.031	0.025	–
Ammonia Toxicity	<0.03	<0.03	–
Nitrate toxicity	0.635	0.53	–
Suspended fine sediment	3.99	3.56	▲
E. coli Bacteria	100	100	–

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

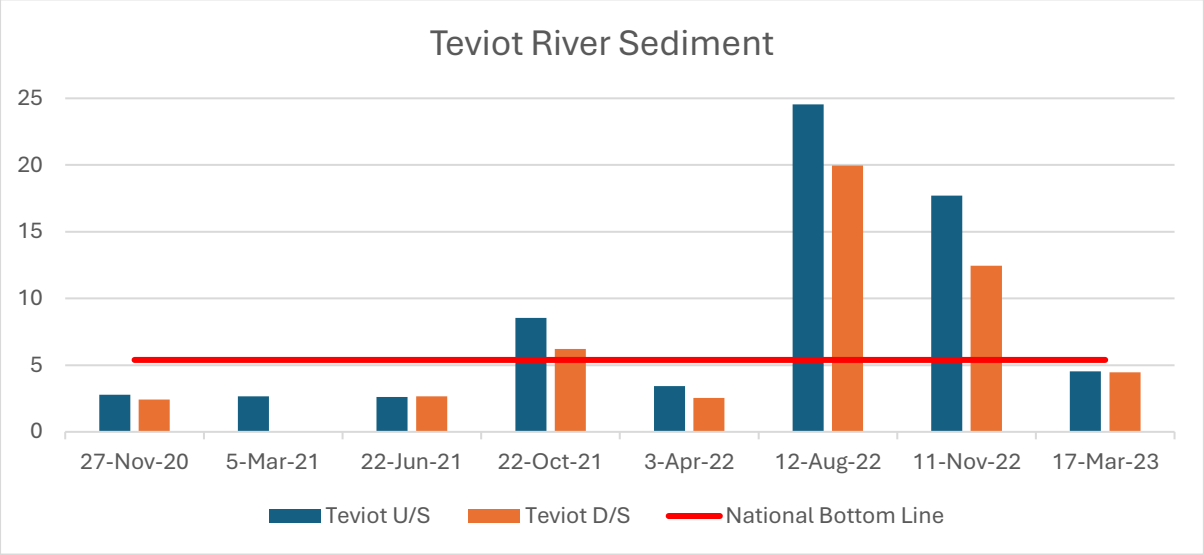

Figure 5. Showing Teviot River Sediment levels, with the national bottom line marked for reference

Phosphorus results were similar at both sites, with both in the D Band. There were occasions when both sites recorded levels in the C band, and the upstream site had a record in the B band in March 2021. Phosphorus generally binds and moves with sediment; however, this particular test analyses the dissolved form which has separated from the associated sediment.

Discussion

The results highlight one main area of concern – elevated sediment levels at both catchment sites. As discussed, three of the eight sampling rounds captured very high sediment levels – all of these occurrences were when the representative flow sites were above median flow. However, there was no corresponding elevation in bacteria levels, and there was a mixture of correspondence with phosphorus levels. This is potentially due to the nature of the extensive land use in the area, with lower stocking rates, and less other human impacts.

Particularly for upstream areas, the main contaminant risks are likely those that move in overland flow, such as microbes, sediment, and sediment bound nutrients (phosphorus), therefore in these environments extra care needs to be taken to minimise direct inputs from land to water e.g. to avoid higher levels of sediment such as we have recorded. The following mitigations can be used to effectively minimise impacts from land to water in these environments:

- Where possible maintain vegetation cover especially on sloping land
- Use low solubility phosphate fertilisers
- Trap sediment in sediment traps
- Think about impeding direct flow from land to water e.g. where practical direct water from farm and stock tracks to filter in vegetation rather than directly to a waterway

Tima Burn

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 6.

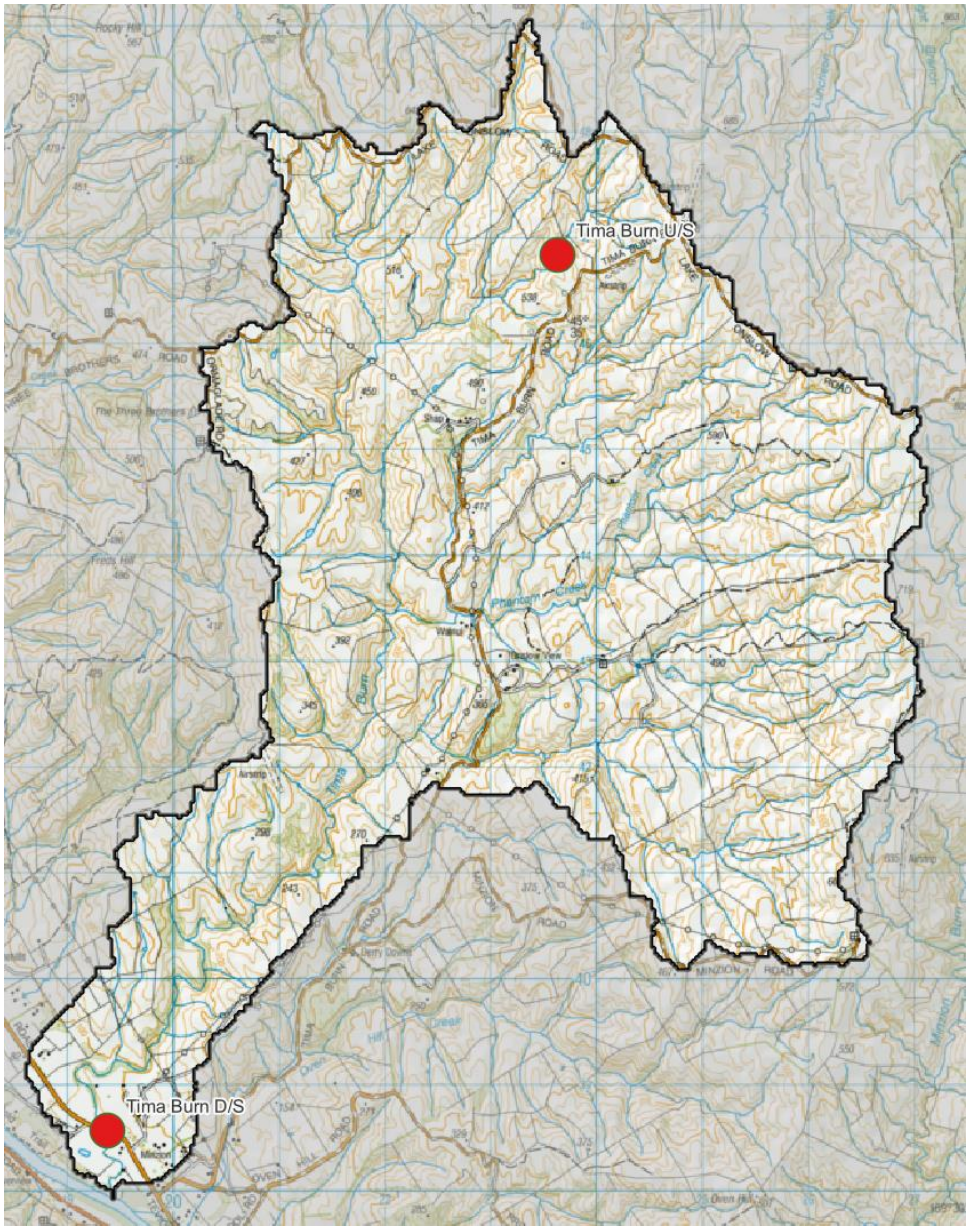

Figure 6. Sampling sites on the Tima Burn

As can be seen from Table 6. Ammonia and Nitrate toxicity, are both in the A band for both sites, highlighting the lack of nitrate loss from the Tima Burn catchment.

Bacteria levels were in the B band for the upstream site, while the downstream site recorded levels in the D band indicating some microbial contamination. Figure 7 shows a graph of these results and illustrates the relatively high bacteria levels at times. On one occasion the upstream site had a higher result than the downstream site (March 2021). The elevated levels at the downstream site in March 2023, may well be associated with high rainfall at that time after a long dry spell.

Table 6. Tima Burn water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change

Site	Tima Burn U/S	Tima Burn D/S	Variance
Dissolved Reactive Phosphorus	0.058	0.123	▼
Ammonia Toxicity	<0.03	<0.03	—
Nitrate Toxicity	0.720	0.610	—
Suspended fine sediment	3.74	5.82	▼
E. coli Bacteria	200	400	▼

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

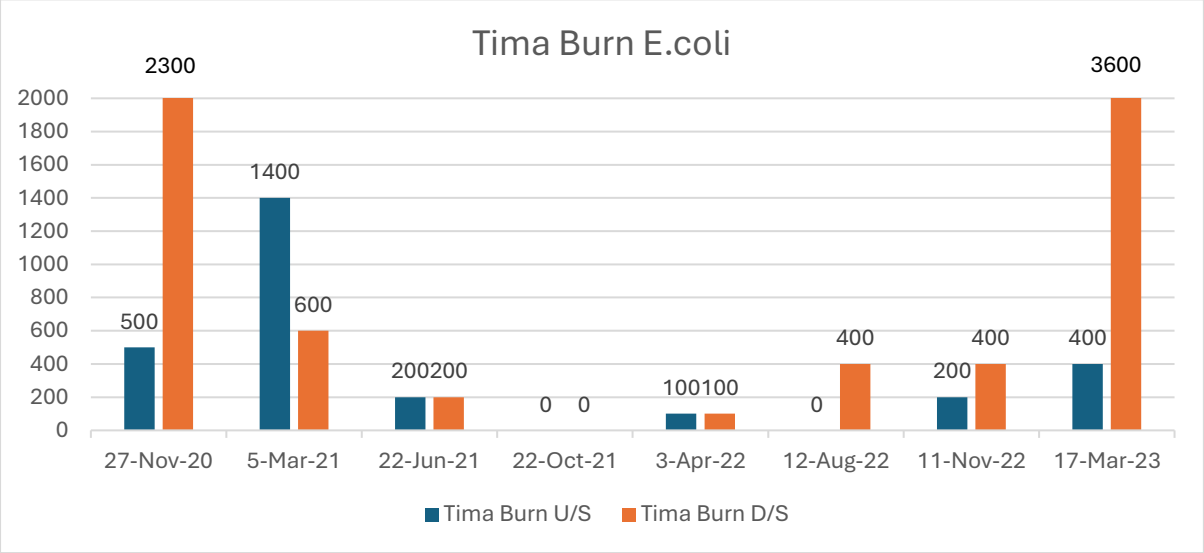

Figure 7. E.coli levels in the Tima Burn

The upstream site is situated in the C band, and the downstream site is situated in the D band for suspended fine sediment, which indicates high sediment movement at times. As can be seen from Figure 8, the downstream site had levels above the national bottom line for the final three samples analysed, it also had a higher reading in November 2020.

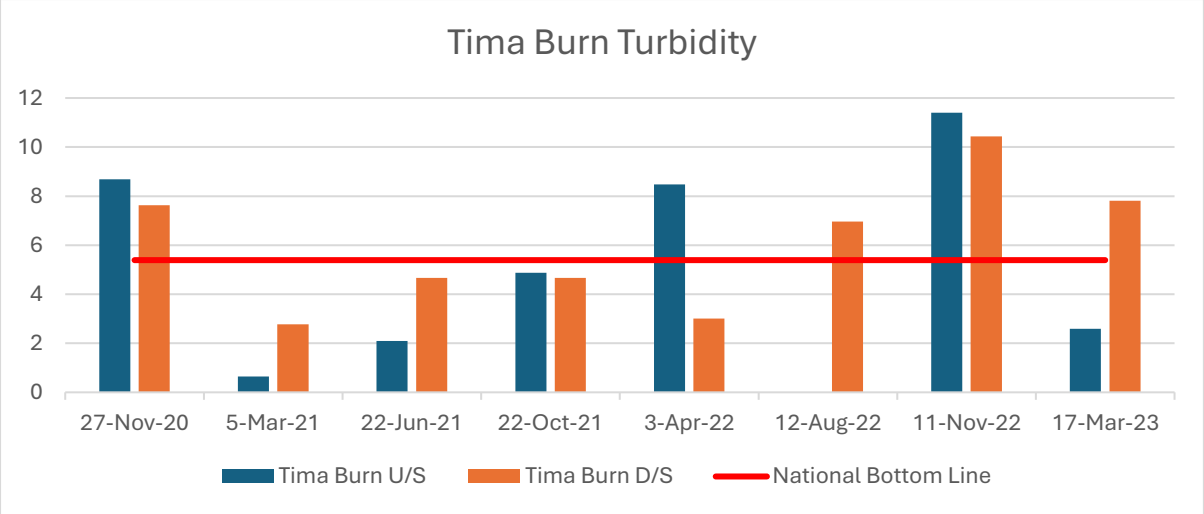

Figure 8. Turbidity levels in the Tima Burn

While both sites were in the D band for phosphorus, the levels were over double at the downstream site, with one reading as high as 1ppm in August 2022. On two occasions, both in November, the upstream site recorded higher phosphorus levels than the downstream site, see Figure 9. A comparison with Figure 8 shows that on both occasions the upstream site also had higher sediment levels than the downstream site.

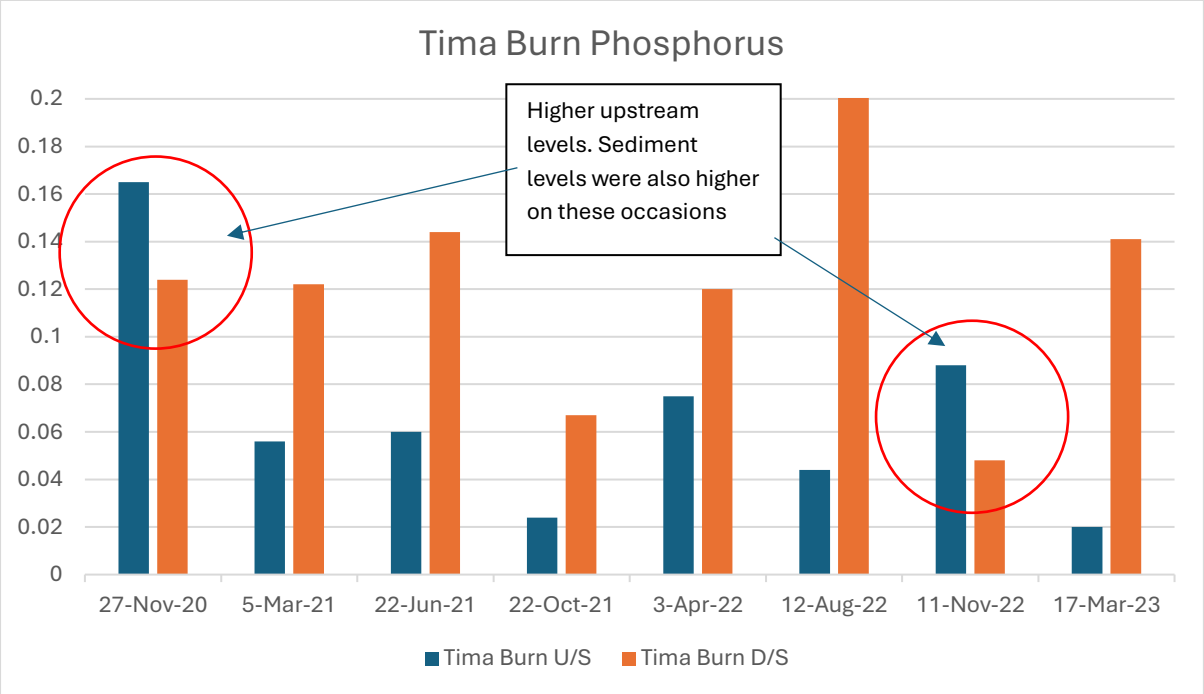

Figure 9. Phosphorus levels in the Tima Burn

Discussion

The results highlight three main areas to investigate further - elevated sediment, bacteria and phosphorus levels at both catchment sites. In areas of strong bedrock such as this, the main contaminant risks are likely those that move in overland flow, such as microbes, sediment, and sediment bound nutrients (phosphorus).

While it is unclear where the sources of elevated levels come from, the levels are sufficient to suggest the possibility of some human influences. Two actions could be taken in this catchment. Firstly, investigate the probable causes of elevated bacteria, sediment and phosphorus levels. Secondly, once testing highlights a problem, go back to the landowners in the catchment and discuss the results with them. For example, elevated phosphorus at the upstream site in November – is this related to fertiliser application? What was going on in March 2021, and November 2022 to lead to higher bacteria levels?

In addition to this enquiry, the likely vulnerability of the catchment as associated with its soils and underlying geology, care should be taken where possible to minimise inputs from land to water. The following mitigations can be used to effectively minimise impacts from land to water in these environments:

- Where possible maintain vegetation cover especially on sloping land
- Use low solubility phosphate fertilisers
- Trap sediment in sediment traps
- Think about impeding direct flow from land to water e.g. where practical direct water from farm and stock tracks to filter in vegetation rather than directly to a waterway

Minzion Burn

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 10.

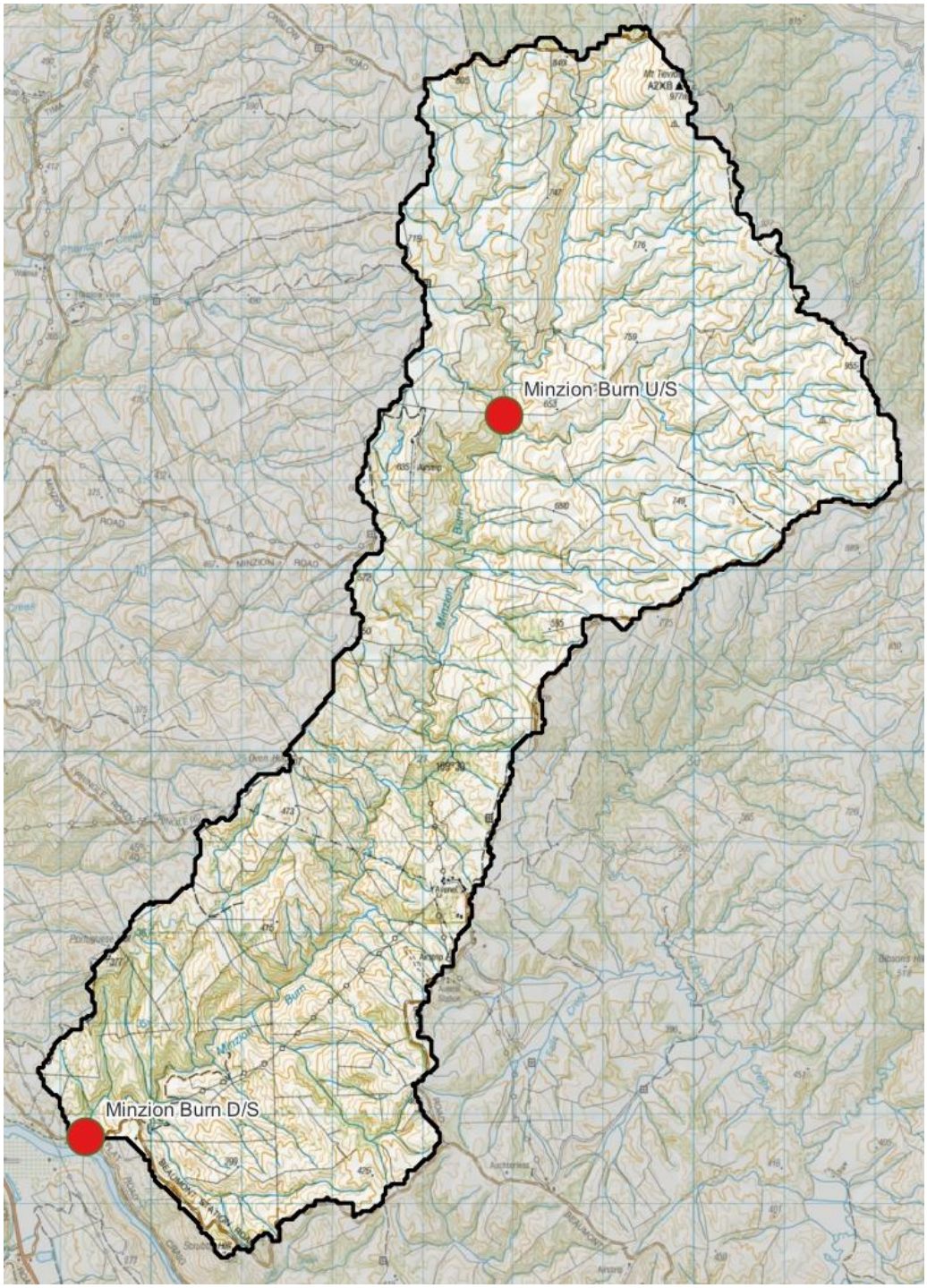

Figure 10. Sampling sites on the Minzion Burn

As can be seen from Table 7. Ammonia and Nitrate toxicity, are both in the A band for both sites, highlighting the lack of nitrate loss from the Minzion Burn catchment.

Table 7. Minzion Burn water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change

Site	Minzion Burn U/S	Minzion Burn D/S	Variance
Dissolved Reactive Phosphorus	0.099	0.061	▲
Ammonia Toxicity	<0.03	<0.03	—
Nitrate Toxicity	0.635	0.590	—
Suspended fine sediment	8.33	3.65	▲
E. coli Bacteria	400	350	—

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

Both sites had bacteria levels in the C band. The upstream site only had one event exceeding the National Bottom Line, while the downstream site had three readings exceeding this level, see Figure 11. The elevated levels at the downstream site in March 2023, may well be associated with high rainfall at that time after a long dry spell.

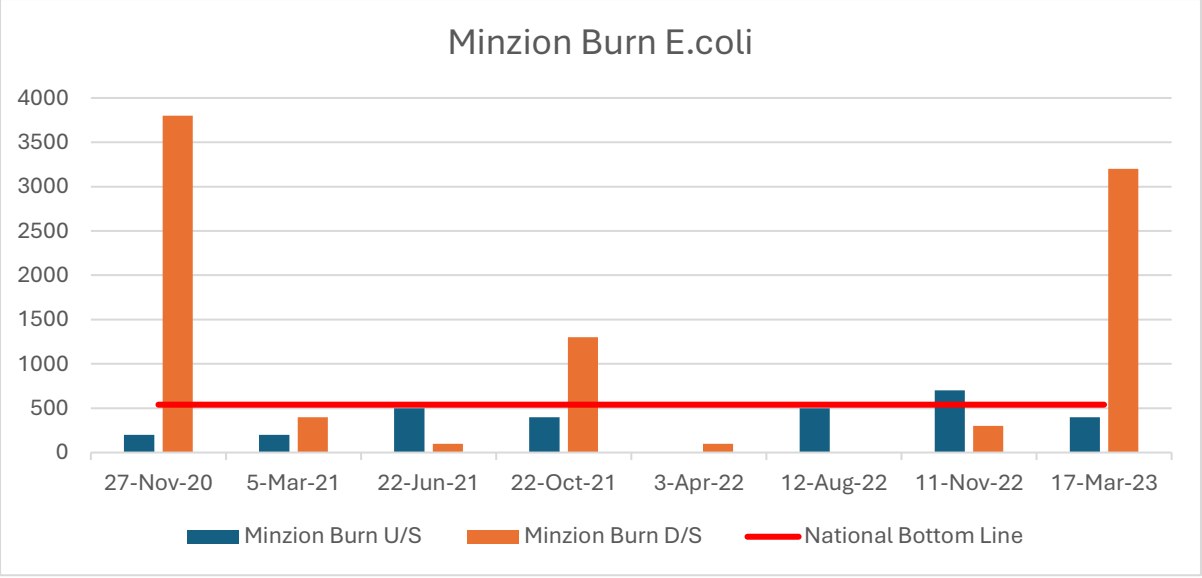

Figure 11. Minzion Burn E.coli

The upstream site is situated in the D band for suspended fine sediment, with the majority of samples exceeding the national bottom line, and the results after March 2021 are relatively consistent, as can be seen from Figure 12. While the downstream site usually sits in the B band, with only two occasions recording results in the C band (Nov. 2022, and March 2023), and once in the D band (Nov. 2020).

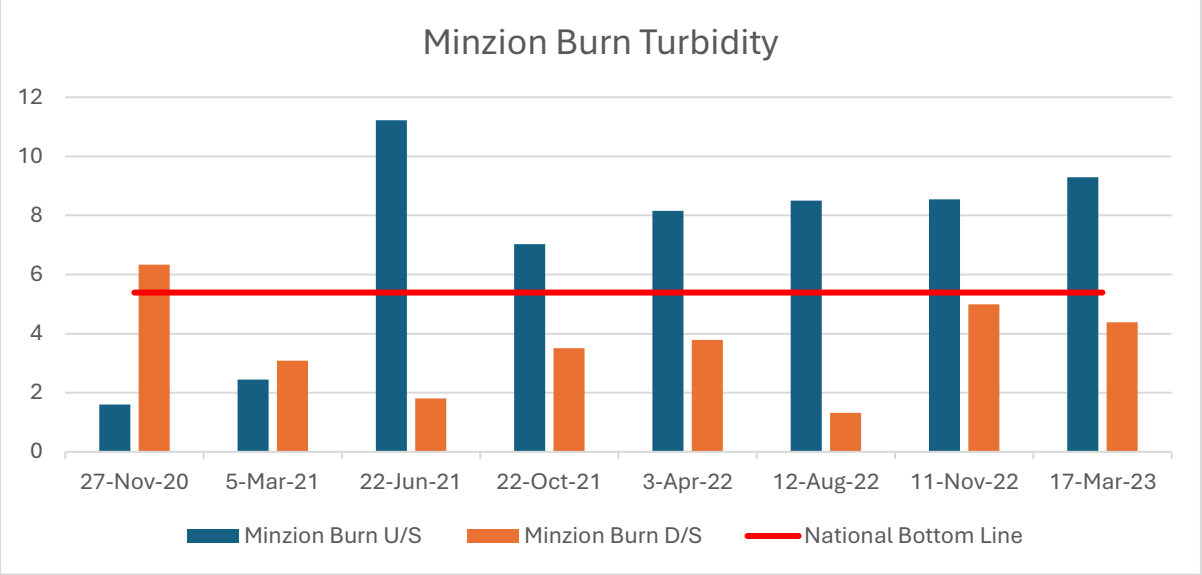

Figure 12. Minzion Burn turbidity

Phosphorus results for both sites were in the D Band, however the upstream site recorded much higher levels than the downstream site.

Discussion

The results highlight a potential problem at the upstream site on the Minzion Burn with both suspended sediment and phosphorus being much higher at this site than the downstream site. In addition, the bacteria levels are higher at this site as well. In areas like this with bedrock underlying the soils, there is the tendency for the loss of sediment, particulate phosphorus and microbes, therefore in these environments extra care needs to be taken to minimise direct inputs from land to water e.g. to avoid higher levels of sediment such as we have recorded. It may be that an investigation into the land use in the area, may uncover why the upstream site has higher levels of these contaminants. As discussed previously mitigations in these areas include:

- Where possible maintain vegetation cover especially on sloping land
- Use low solubility phosphate fertilisers
- Trap sediment in sediment traps
- Think about impeding direct flow from land to water e.g. where practical direct water from farm and stock tracks to filter in vegetation rather than directly to a waterway

In addition, any further monitoring should seek to address the cause of elevated levels of bacteria throughout the catchment. For example, it would be useful to have information on the likely causes of the two higher readings at the downstream site.

Coal Creek

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 13.

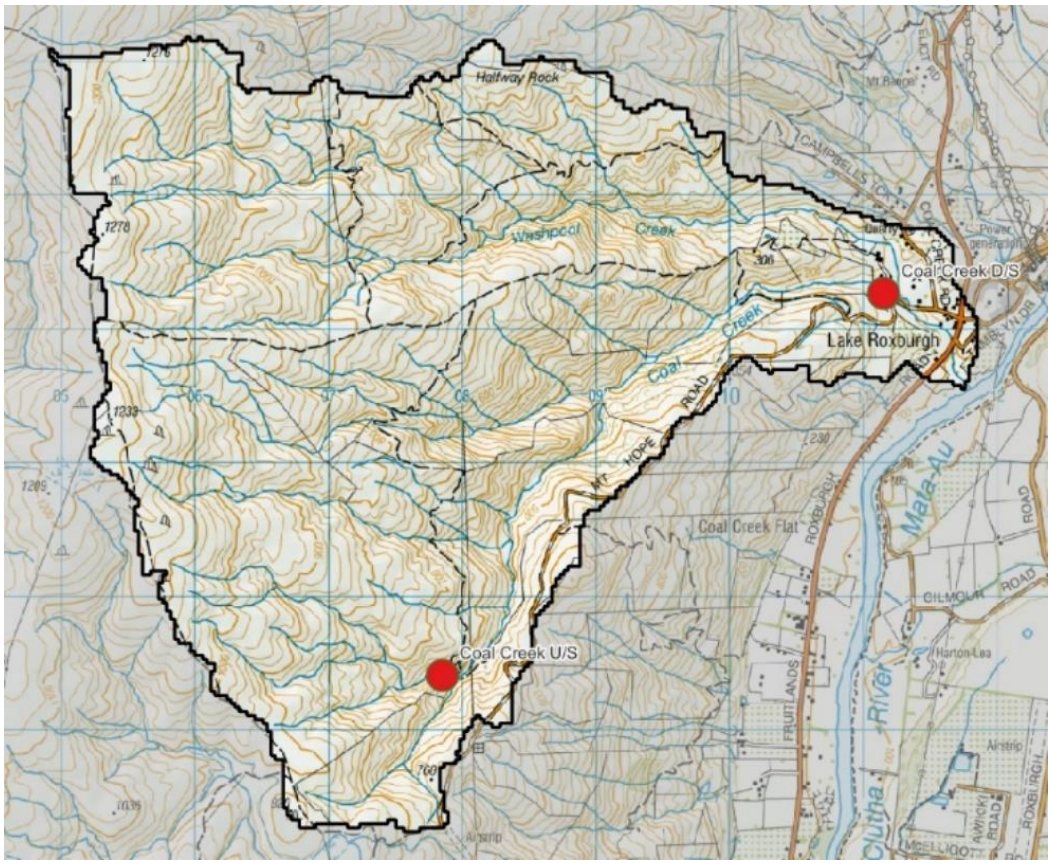

Figure 13. Sampling sites on Coal Creek

As can be seen from Table 8. Ammonia and Nitrate toxicity, bacteria and suspended fine sediment are all in the A band for both sites, highlighting the lack of contaminant loss throughout the Coal Creek catchment.

Phosphorus levels were in the D band at both sites, with consistent results throughout the sampling programme.

Table 8. Coal Creek water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change

Site	Coal Creek U/S	Coal Creek D/S	Variance
Dissolved Reactive Phosphorus	0.038	0.026	—
Ammonia Toxicity	<0.03	<0.03	—
Nitrate Toxicity	0.390	0.475	—
Suspended fine sediment	<0.96	<0.96	—
E. coli Bacteria	50	100	—

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

Discussion

These higher readings may highlight the difference in analytical testing procedures, and likely highlight the difficulty of comparing the Teviot Water Care Group's testing programme to the National Standards. This also serves to highlight to the Group to consider the reason behind the monitoring programme. If results at Coal Creek are consistently in the A band is there a need to continue to monitor this site? Can we take learnings from the testing being undertaken?

Benger Burn

Two sampling sites were assessed, the sampling locations are shown on the map in Figure 14.

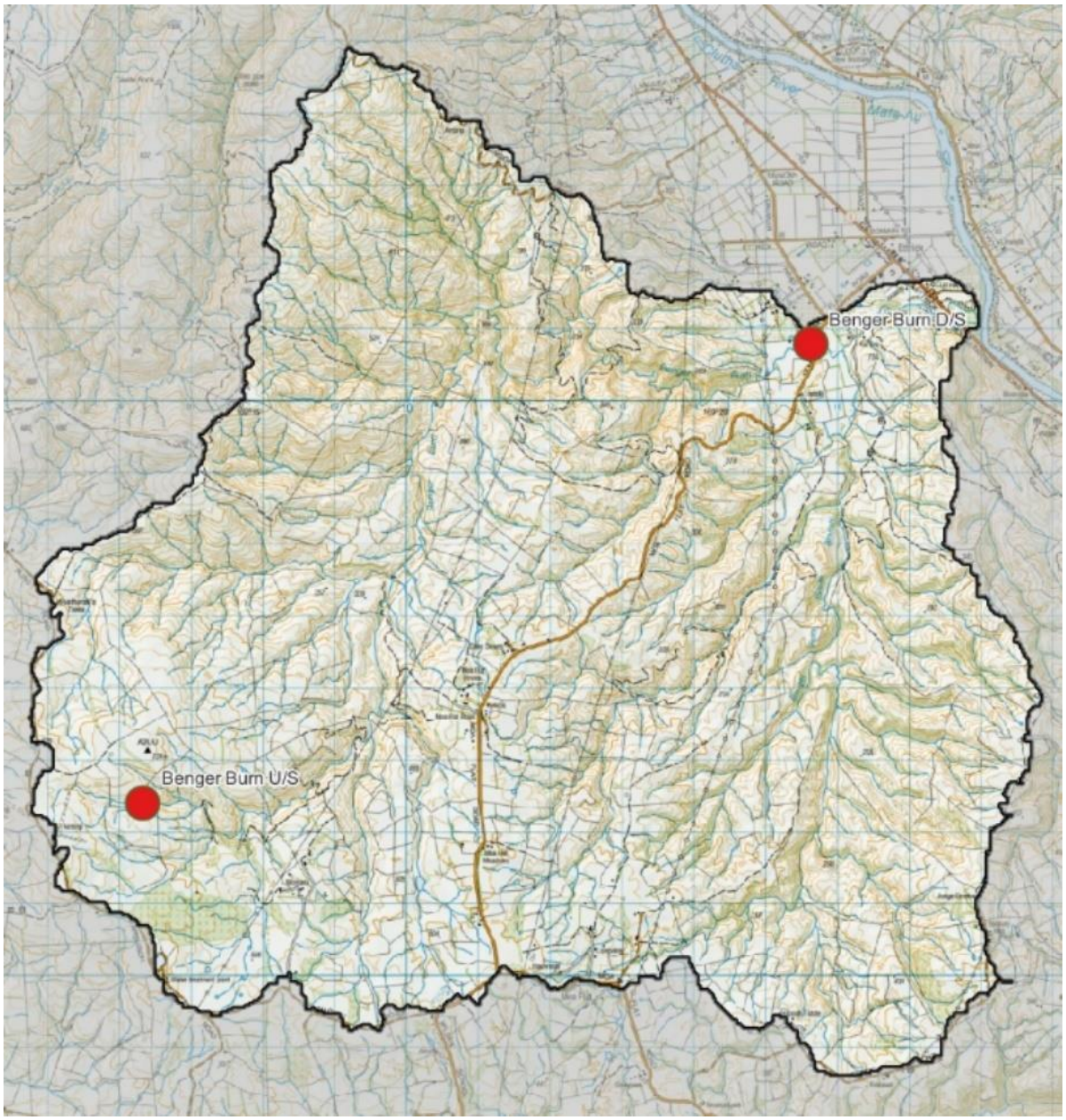

Figure 14. Sampling sites on the Benger Burn

Table 9 presents the Benger Burn results and compares them to the National standards. In addition, the ORC's State of the Environment results are also presented in Table 9, with median results presented both from 2017 – 2024, and also for the same months that the TWCG's sampling covered, i.e. the March 2021 sample, June 2021 sample etc. This was done in order to present as closely as possible the results for a full comparison. It should be noted that a direct comparison is unable to be made as the sampling sites are different, and the dates of sampling were different (e.g. TWCG 5 March 21 cp. ORC 16 March 21), but the overall median results present an interesting comparison.

Table 9. Benger Burn water quality results, showing median results for the different tests and coloured according attribute bands from the NPS-FM (Green = A Band (best), Yellow = B Band, Orange = C Band, Red = D Band (national bottom line)). The variance column shows whether there was a significant variance between the upstream and downstream site, a downward arrow = levels getting worse, upward arrow shows levels improving and a stroke no significant change. ORC @ Booths column shows median levels of tests between 2017-2024, while ORC Same Months presents the ORC's sampling results for the same months as TWCG's sampling

Site	Benger Burn U/S	Benger Burn D/S	Variance	ORC @ Booths	ORC Same Months
Dissolved Reactive Phosphorus	0.052	0.037	—	0.0102	0.0111
Ammonia Toxicity	<0.03	<0.03	—	0.006	0.006
Nitrate Toxicity	1.15	0.59	▲	0.135	0.19
Suspended fine sediment	7.84	2.59	▲	1.56	1.56
E. coli Bacteria	100	400	▼	249	345

Notes: Graded based on National Policy Statement for Freshwater Management 2020 attribute bands from 8 water quality samples taken 2021-2024. Suspended fine sediment is visual clarity, estimated from measurements of turbidity.

As can be seen from Table 9. Ammonia is low at both sites.

Nitrate is higher at the upstream site compared to the downstream site, see Figure 15, indicating a source of introduced nitrate in this area. The results are often over 1ppm, which while not high on a national scale, are quite high for the area. In contrast, the downstream site had two readings above this level.

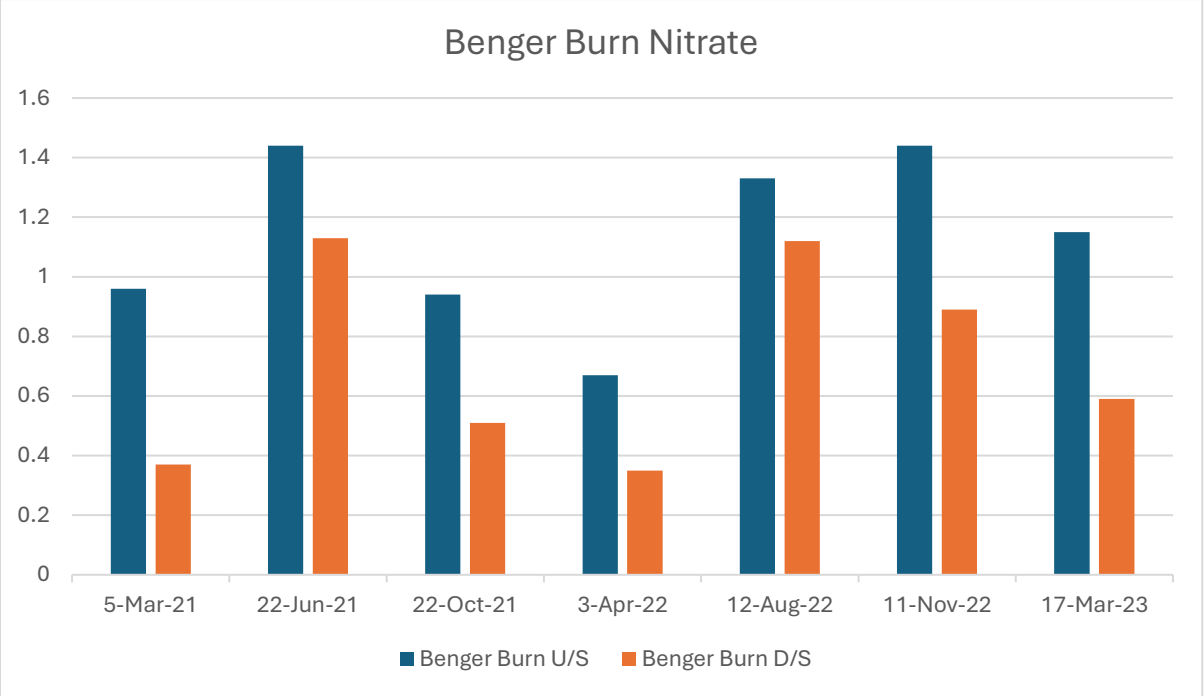

Figure 15. Nitrate results for the Benger Burn

In contrast, bacteria results were higher at the downstream site, compared to the upstream site, see Figure 16. On two occasions the results were particularly high, with the March 2023 round being one of them at the downstream site and discussed previously with the higher rainfall after a long dry period. The other occasion was April 2022 at the downstream site.

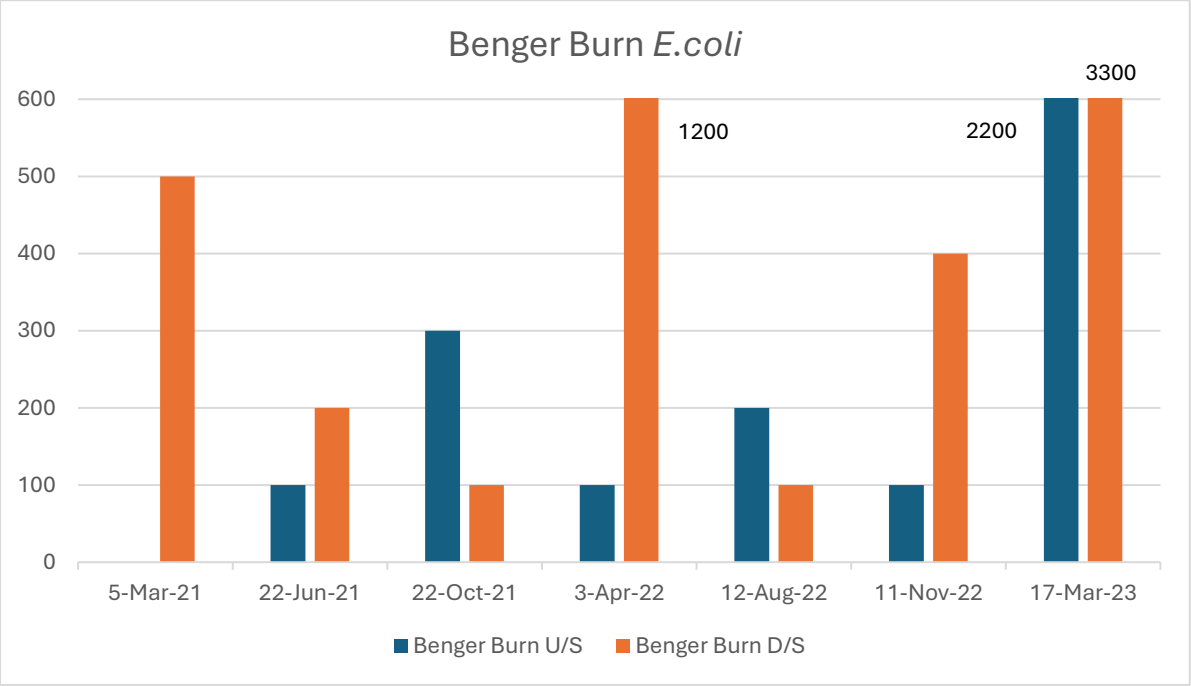

Figure 16. *E.coli* results for the Benger Burn

The upstream site is situated in the D band for suspended find sediment, while the downstream site was situated in the B band. As can be seen from Figure 17, the results for the upstream site are generally much higher than the downstream site, apart from one reading in June 2021. Five of the eight samples were higher than the national bottom line, and only one (August 2022) result was less than this out of the past five samples.

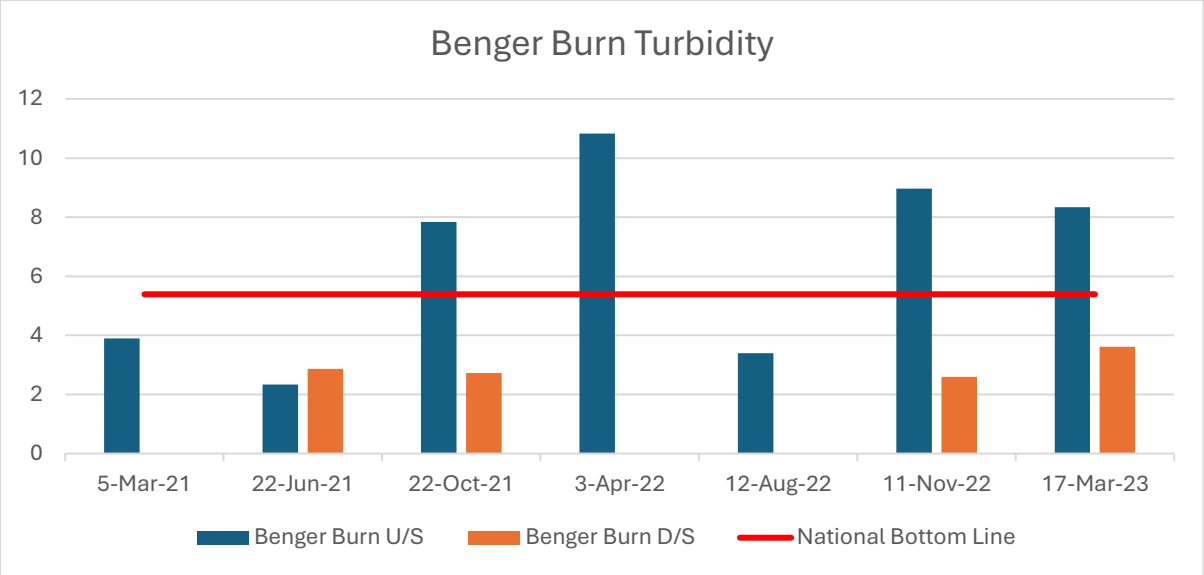

Figure 17. Turbidity results for the Benger Burn

Phosphorus results were similar at both sites, with both in the D Band. There were occasions when both sites recorded levels in the C band, and the upstream site had a result in the B band in March 2021. Phosphorus generally binds and moves with sediment; however, this particular test analyses the dissolved form which has separated from the associated sediment.

Discussion

The results highlight elevated bacterial levels at the downstream site on the Benger Burn. One of the reasons for the higher readings at the downstream site was probably due to the higher flows causing higher levels in March 2023, with this result likely skewing the overall results, as there were a limited number to derive our median levels. This being said, a good outcome from this monitoring programme, would be to investigate the probable reason for the elevated levels at this site for any future high levels and immediate discussion with catchment landowners may highlight a possible cause.

The upstream site, while having relatively low bacterial levels, did have high levels of turbidity, nitrate and phosphorus when compared to the downstream site. This was the only site in the TWCG's monitoring programme, where the nitrate levels were in the B band. The fact that the upstream site always had higher nitrate suggests a source of nitrate being introduced. Generally, elevated nitrate is from fertiliser, or animal excreta, but it can be a naturally occurring in some areas. It was noted that the underlying geology of the Benger Burn catchment was quite different compared to the other catchments in the area, and this

may well contribute to these results. A recommendation would be to investigate the likely source of nitrate at this site further, and the results of this investigation could lead to management suggestions for landowners in the area, and lead to improvements in the downstream receiving environment.

Both the higher sediment and phosphorus levels may be linked together, and once again the probable cause should be investigated further. As opposed to other catchments in the area, these results were not necessarily expected, due to the nature of soils and geology in this catchment, and there is a possibility that they are linked to land management decisions in the area. Mitigation options to reduce nitrate, phosphorus and sediment loss are:

- Maintain soil structure
- Maintain vegetated buffer strips,
- Consider riparian planting particularly where water from swales and depressions can enter water,
- Trap sediment in sediment traps