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Loch Ken Water Quality Monitoring Report 2023

For Loch Ken Trust

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1 INTRODUCTION

Loch Ken is 14 km long, flowing from New Galloway to Glenlochar and is up to 19 m deep. The loch's main inflows are the Water of Ken and Black Water of Dee and the loch outflows into the River Dee at the Glenlochar barrage. The function of the barrage is to regulate the height of the loch and the amount of water released down the river towards Tongland Power Station (part of the Galloway Hydro Scheme). The site is a RAMSAR designated wetland, meaning it is protected for its ability to conserve biological diversity and the potential to host rare or unique wetland types. Accommodating angling, water sports and numerous visitors, Loch Ken is a popular site even for just a walk as it is host to many species of bird, fish and insects. The landscape is diverse around the loch with moorland, marshes, pasture, woodlands and commercial forestry.

Water quality is influenced by natural and anthropogenic processes which in turn affects what lives there and how the water can be used. It can be quantified and analysed through surveys carried out at different points across the catchment which will indicate the present health of the water body, and future monitoring can record if any changes are occurring over time. There are four main burns that flow into Loch Ken separate from the two major inflows that may also affect the overall water quality of the loch.

We are not aware of any detailed water quality surveys being carried out on Loch Ken previously, which this project aims to address. The project aims to conduct an examination of water quality in and around Loch Ken to establish the present conditions using easily repeatable methods which will allow future monitoring to identify any improvements or deterioration in water quality.

There are two suitable techniques to assess water quality at Loch Ken, spot sampling analysed with an EX01 sonde and calculating biological indicators. Spot sampling was considered most appropriate to sample Loch Ken and involved manually collecting water samples and then analysing them the same day to give accurate readings for multiple parameters. Biological indicators can help classify water quality based on the number of families of aquatic invertebrates found and how many individuals of each family is present due to the sensitive nature of some communities and low tolerance of different species to varying conditions. This information is used to work out a WHPT (Walley Hawkes Paisley Trigg) index. Employing various methods of analysis can provide data on the short-term and long-term status of water quality which given the lack of data will be useful.

2 METHOD

2.1 Site selection

Sites were initially selected based on where the main inflows and outflows reach the loch along with random points selected around the loch itself. The points were discussed with the Loch Ken Trust and were adjusted accordingly. Access was also kept in mind in terms or permission from landowners and ability to get to the sites (see map 1). Sites for kick sampling must be carried out in running water e.g. on a burn or river.

2.2 Water Quality Monitoring

Water quality monitoring was carried out using an EX01 sonde, a sonde is a piece of equipment with interchangeable sensors that need to be calibrated. For this project all that was needed was one water sample, and it will record the pH, temperature, Dissolved Organic Matter (DOM), conductivity and dissolved oxygen. The sonde can gather constant monitoring data or be used to analyse spot samples. Depending on which sensors are being used, calibration is required either monthly or quarterly. If the handheld device is available, this can be done in the field, otherwise the sondes need to be calibrated on a PC. Each sensor measures its parameter via a variety of electrochemical, optical, or physical detection methods.

Acidification is a significant issue around Galloway and its impacts can be amplified by surrounding land use, so it is important to monitor any of the water bodies flowing into the loch as this may affect the main body of water and its ecology if highly acidic waters were flowing in. Dissolved Organic Matter represents a direct measure of the levels of suspended solids within watercourses and can indicate things like soil erosion and surrounding land use. Dissolved Oxygen is a measure of how much oxygen is in the water, which is important for anything living in it, if water is above saturation level (Dissolved Oxygen ≥100%) there should not be any issue. Conductivity represents the ease at which an electric current can pass through water and is directly related to the level of particulate matter in the watercourse. As such conductivity represents another method of recording the amount of suspended solids and can indicate pollution or eutrophication.

Picture 1: Diagram of an EX01 sonde

Water samples are collected in a 1,000 ml bottle, which is rinsed in the body of water from which a sample will be collected three times to remove any contaminants or previous sample water. Then the bottle is submerged fully and shaken under water to remove any bubbles. The lid is fixed on underwater to further prevent bubbles. Samples must be analysed as soon as possible to keep the sample as close to the state in which it was collected. They are analysed with an EX01 sonde for pH, conductivity, dissolved organic matter and dissolved oxygen. Part of the sample is washed over the sensors to remove contaminants and previous sample water. A container that fits to the sonde is rinsed with the sample before it is filled with the sample. The sonde is then placed in the container and given time to settle before results are noted. This water sampling process was carried out in both high and low flows because this study is focused on collecting baseline data and how flow affects the concentration of components in the river along with dissolved oxygen. It is important to establish a suitable baseline to create a benchmark for comparison in case of changes in the future. High flows tend to be more acidic and low flows tend to be less diluted with pollutants and so it is important to measure parameters during both flow events. All 15 sites had spot samples taken during low and high flows (see table 1) as this sampling technique can be carried out in both flowing and still water.

2.3 Aquatic Invertebrate kick sampling

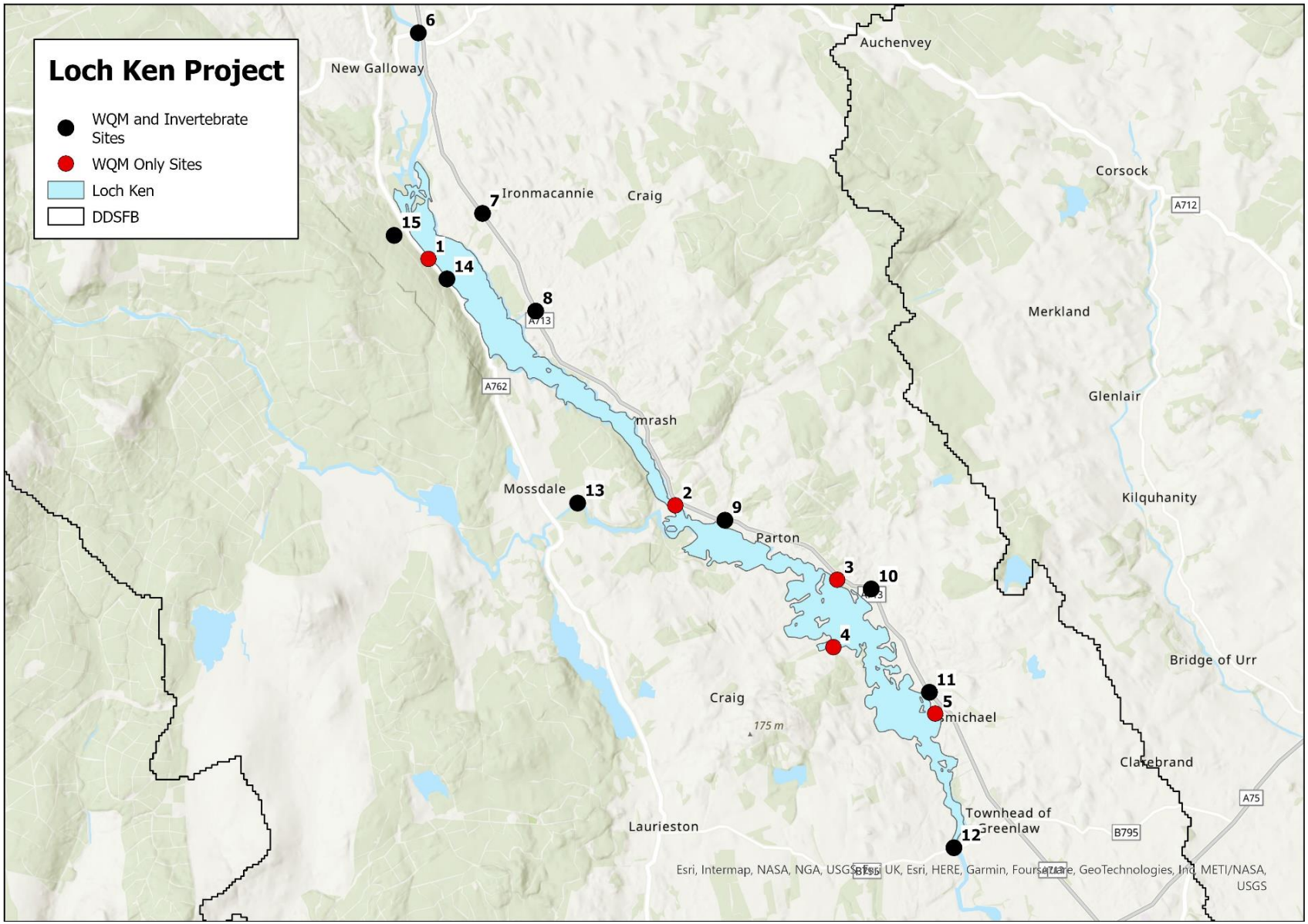
Standard three-minute kick samples were carried out with a one-minute manual search using a 1 mm mesh kick sample net. The surveyor held the net downstream with the bag of the net flowing with the water. They then kicked the substrate in front of the net for three minutes, dislodging any invertebrates in this area, covering a range of habitats by moving in a zig-zag pattern upstream collecting any disturbed material. The time being divided proportionally based on the different aquatic habitats in the sample area. A manual search then took place whereby the underside of rocks, emergent vegetation and surface film was searched for attached macroinvertebrates. Everything collected was placed in a labelled container and preserved in 70% isopropanol. Only ten of the 15 sampling sites could be kick sampled as it must be done in flowing water, so it was only carried out in the burns and rivers.

Back at the Galloway Fisheries Trust (GFT) office, each sample was identified by a trained GFT staff member using a low powered microscope with x10 to x40 variable magnification and using the Freshwater Biological Association Guide to British Freshwater Macroinvertebrates for Biotic Assessment identification guide. For this analysis, invertebrates were identified down to family level as that is what is needed to calculate biotic indices. Many indices can be generated from this that indicate different conditions surrounding the site sampled, for this report the WHPT Average Score Per Taxa, WHPT Number of Taxa, Proportion of Sediment Sensitive invertebrates and Acid Water Indicator Community will be used. ASPT predicts the tolerance to water quality of the invertebrates present, whereas NTaxa predicts the composition of invertebrates that should be present. They are considered as a pair as they work on the same scoring system.

Table 1: Sites and methods that were sampled

Site	Watercourse	NGR	Easting	Northing	Water Quality Monitoring	Kick Sampling
1	Side of Loch Ken	NX	264220	574559	✓	-
2	Side of Loch Ken	NX	268529	570369	✓	-
3	Side of Loch Ken	NX	271165	569175	✓	-
4	Side of Loch Ken	NX	271100	567834	✓	-
5	Side of Loch Ken	NX	272992	566923	✓	-
6	Water of Ken	NX	264047	578412	✓	✓
7	Maukinhowe Burn	NX	265143	575332	✓	✓
8	Shirmirs Burn	NX	266049	573666	✓	✓
9	Boreland Burn	NX	269280	570098	✓	✓
10	Craichie Brun	NX	271773	568925	✓	✓
11	Mill Burn	NX	272710	567200	✓	✓
12	River Dee	NX	273131	564495	✓	✓
13	BWoD	NX	266769	570388	✓	✓
14	Lowran Burn	NX	264537	574212	✓	✓
15	Clone Burn	NX	263636	574960	✓	✓

Map 1: Illustrates the Loch Ken boundary along with the sample sites, water quality monitoring only and both WQM and invertebrates



3 RESULTS

Water quality samples at all sites and kick samples from sites 6 to 15 were collected and examined. Water quality samples were taken for high river flows on April 5th and low river flows on April 24th and analyzed on the respective day of using an EX01 sonde (see table 1) where the pH (see map 2 and 3), dissolved organic matter (see map 4 and 5), conductivity (see map 6 and 7) and dissolved oxygen (see map 8 and 9) were recorded. Kick samples for sites 6 through to 15 were identified and from that data the number of taxa and average score per taxa were calculated using the WHPT method (see table 3) and the PSI and AWIC scores were calculated (see table 5). Boundaries regarding what the scores mean for water quality (see table 4), sedimentation (see table 6) and acid in water (see table 7) are colour coded to relate to each map accordingly to visually represent what the different values mean for water quality. The WHPT scores are categorised by boundaries that quantify water quality (see table 4) along with PSI and AWIC scores using different boundaries according to each score. Only two sites were considered bad from the NTaxa score, two poor, two moderate, three good and one high. No sites were considered bad from the ASPT score, two poor, one moderate, four good and three high. All sites were minimally or slightly sedimented and the AWIC scores somewhat overlapped with the pH scores recorded with the two most acidic sites reflecting the same and the others sitting at neutral or alkaline.

Table 2: Sonde results from water samples taken during high and low flows at all 15 sites

	High flow				Low flow			
Site	**pH**	**fDOM**	**Conductivity**	**DO%Sat**	**pH**	**fDOM**	**Conductivity**	**DO%Sat**
1	6.47	94.22	31.5	107.3	6.61	93.51	33.8	107.7
2	6.49	100.47	32.5	105.9	6.58	107.27	32.3	105.1
3	6.15	98.15	42.8	112.4	6.67	34.55	32.8	102.3
4	7.12	97.9	53.5	109.4	6.83	98.96	36	107.4
5	6.76	103.47	37.5	106.3	6.73	104.44	36.8	101.7
6	6.33	98.7	30.8	101.5	6.82	90.01	44.6	106.6
7	7.08	169.74	71.5	108.3	7.15	161.07	75.9	107.7
8	7.37	134.53	56.4	110	7.5	120.87	62	109.6
9	7.36	111.63	59.7	109.4	7.55	95.65	68	108.2
10	7.44	117.6	85.9	108.7	7.63	98.16	98.9	107.9
11	7.32	78.19	88	107.8	7.5	80.52	93.7	107.2
12	6.78	104.85	34.1	105.7	6.79	102.5	36.6	103.4
13	6.41	123.53	34.4	111.7	6.66	102.12	32.7	107.6
14	4.95	154.48	34.4	109.9	5.55	137.08	35.5	110.2
15	5.09	147.07	31.4	113.3	5.5	141.58	30.9	113.1

Table 3: Invertebrate data from the 10 sites that were kick sampled

Site	WHPT ASPT	WHPT Ntaxa
6	0.67	0.41
7	0.88	0.86
8	0.89	0.48
9	0.99	0.77
10	0.9	0.72

11	0.79	0.65
12	0.69	0.54
13	0.9	0.74
14	1	0.63
15	0.99	0.44

Table 4: Table for WHPT scores regarding water quality parameters

Status boundary	EQR WHPT-ASPT	EQR WHPT-Ntaxa
High	0.97+	0.8 +
Good	0.86 - 0.96	0.68 - 0.79
Moderate	0.72 - 0.85	0.56- 0.67
Poor	0.59 - 0.71	0.47 - 0.55
Bad	< 0.59	< 0.47

Table 5: Table for proportion of sediment sensitive invertebrates and acid water indicator community

Site	PSI score	AWIC score
6	100	4.6
7	75.9	4.3
8	85.7	4
9	96.2	3.5
10	81.8	4.9
11	86.4	5.2
12	86.7	3.8
13	95	4.6
14	82.4	2.9
15	100	3.6

Table 6: Table for Proportion of Sediment Sensitive Invertebrate scores and boundaries regarding water quality parameters

PSI Score	Riverbed Condition
81 to 100	Minimally Sedimented/Unsedimented
61 to 80	Slightly Sedimented
41 to 60	Moderately Sedimented
21 to 40	Sedimented
0 to 20	Heavily Sedimented

Table 7: Table for Acid Water indicator Community scores and boundaries regarding water quality parameters

AWIC	Mean pH
2	5.46
2.5	5.84
3	6.22

3.5	6.69
4	6.98
4.5	7.36
5	7.74
5.5	8.12
6	8.5

3.1 pH

Of all the sites, two were of a pH considered acidic, the other sites sat around neutral or were slightly alkaline. There is a clear difference in pH between burns along the west side of the loch (average pH of west side burns in; high flow: 6.01, low flow: 6.23) and the burns along the east side of the loch (average pH of east side burns in high flow: 7.00, low flow: 7.16). Clone Burn (site 15) and Lowran Burn (site 14) are the two most acidic sites in both high and low flows. The main inflow site (site 6) differs from 6.82 in low flow to 6.33 in high flow indicating it is more acidic when there is higher volumes of water flow through and the outflow site shows no significant change between flows indicating that by the time the water from the top flows down there is no change in concentration. There is no significant difference between the average pH in high and low flows (high: 6.61, low: 6.80) of every site.

3.2 Dissolved organic matter

Dissolved organic matter varied across all sites along with conductivity, the differences are likely to relate to things like run off from agriculture, land use and soil erosion as they can both act as a measure of suspended solids. The west side also had a higher average for dissolved organic matter (high flow: 123.44, low flow: 114.65), the east side has a lower average percent (high flow: 114.22, low flow: 100.32). For both sides DOM levels are lower in low flows. They are also lower at the inflow site than they are at the outflow site in both flows. High flows had a higher average than low flows on both sides. In high flows dissolved organic matter was significantly higher (high: 115.64, low: 104.55).

3.3 Conductivity

Burns along the east side (high flow: 37.04, low flow: 59.29) of the loch have a higher average conductivity than the west side (high flow: 33.78, low flow: 62.55), the burns in general were higher than the loch side. The main outflow had a higher conductivity than the inflow but given the direction of the flow, everything will congregate at the lowest site, as shown with the dissolved organic matter. However, in the low flow, the conductivity was higher which may be a result of particulate matter not being pushed down by the water. Similarly, to the dissolved organic matter, the loch side sites have a lower conductivity than the burns. The dissolved organic matter was also lower at the top and higher at the bottom there was not too much of a difference between high and low flows (high: 48.3, low: 50.03).

3.4 Dissolved oxygen

Dissolved oxygen levels were higher at the bottom of the loch than at the top during high flows and higher at the top of the loch and lower at the bottom during low flows, however all sites were above 100% saturation which is above saturation point. There is no significant difference between west and east side of the loch. There is nothing clearly impacting dissolved oxygen at the time of sampling. There is also no major difference between high and low flows (high: 108.51, low:107.05).

3.5 WHPT ASPT and NTaxa

WHPT ASPT was lowest at three sites (site 6, 7 and 8), all burns located on the east side of the loch. All other sites reflected good or high tolerance. However, the NTaxa shows four sites (site 6, 7, 10 and 13) with communities of invertebrates lower than what is predicted for each site. Predominantly reflecting 'bad' condition of burns along the east side of the loch.

3.6 PSI and AWIC

Only one (site 7) of the ten sites was slightly sedimented, all the other burns were minimally sedimented at the time this survey was carried out. The acid prediction score aligns relatively similarly to the water quality monitoring pH with the sites 14 and 15 being acidic and the others being alkaline/neutral, however the predicted scores were higher than the pH scores recorded with the sonde.

4 DISCUSSION

Fifteen sites were surveyed to gather baseline data on the water quality around Loch Ken which can be referred to and compared with future surveys to monitor any changes.

- Both sites 15 and 14 are significantly more acidic than the other burns and loch side. They are situated along the northwest side of the loch below Ken bridge.

- Both dissolved organic matter and conductivity varied a lot which is likely a result of different surrounding land use, but baseline data is important for future comparison. fDOM only records organic material whereas conductivity can detect inorganic matter which may be what caused it to differ.

- Dissolved Oxygen was above a saturation point of 100% at all sites in both high and low flow conditions and of no concern.

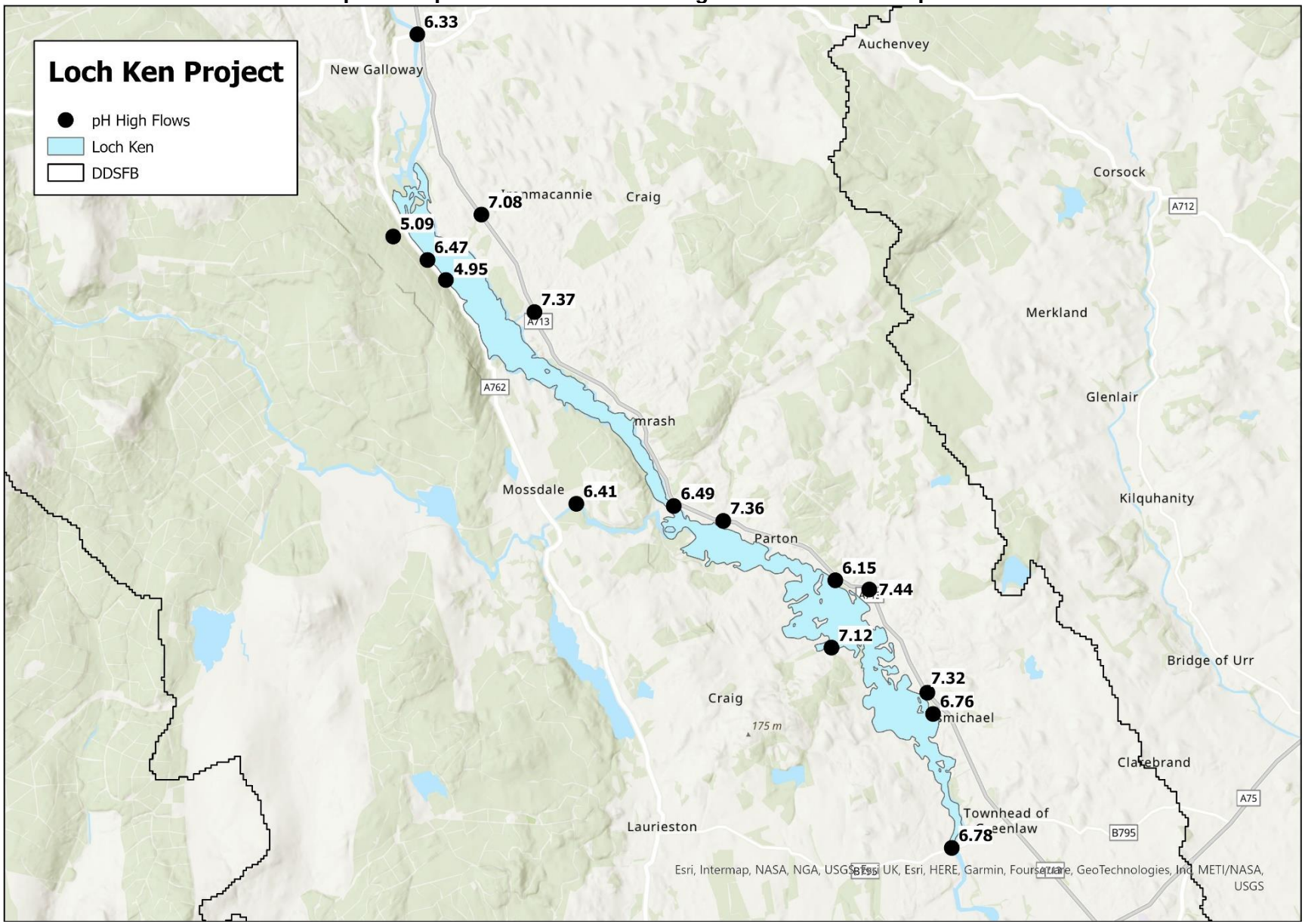
- WHPT ASTP reflects low water quality tolerance at two sites at the top of lock which is probably a result from surrounding land use. WHPT NTaxa indicates four sites had lower than predicted Community compositions invert communities depleted - also land use.

- Sediment levels were fine across all sites at the time of the survey according to PSI Score indicating they are not affecting invertebrate populations, however there may still be elevated levels of silt entering watercourses. The burns surrounding Loch Ken are typically fast flowing and high energy causing a potential for significant quantities of silt to be deposited in backwaters and slow flowing areas not typically sampled for invertebrates.

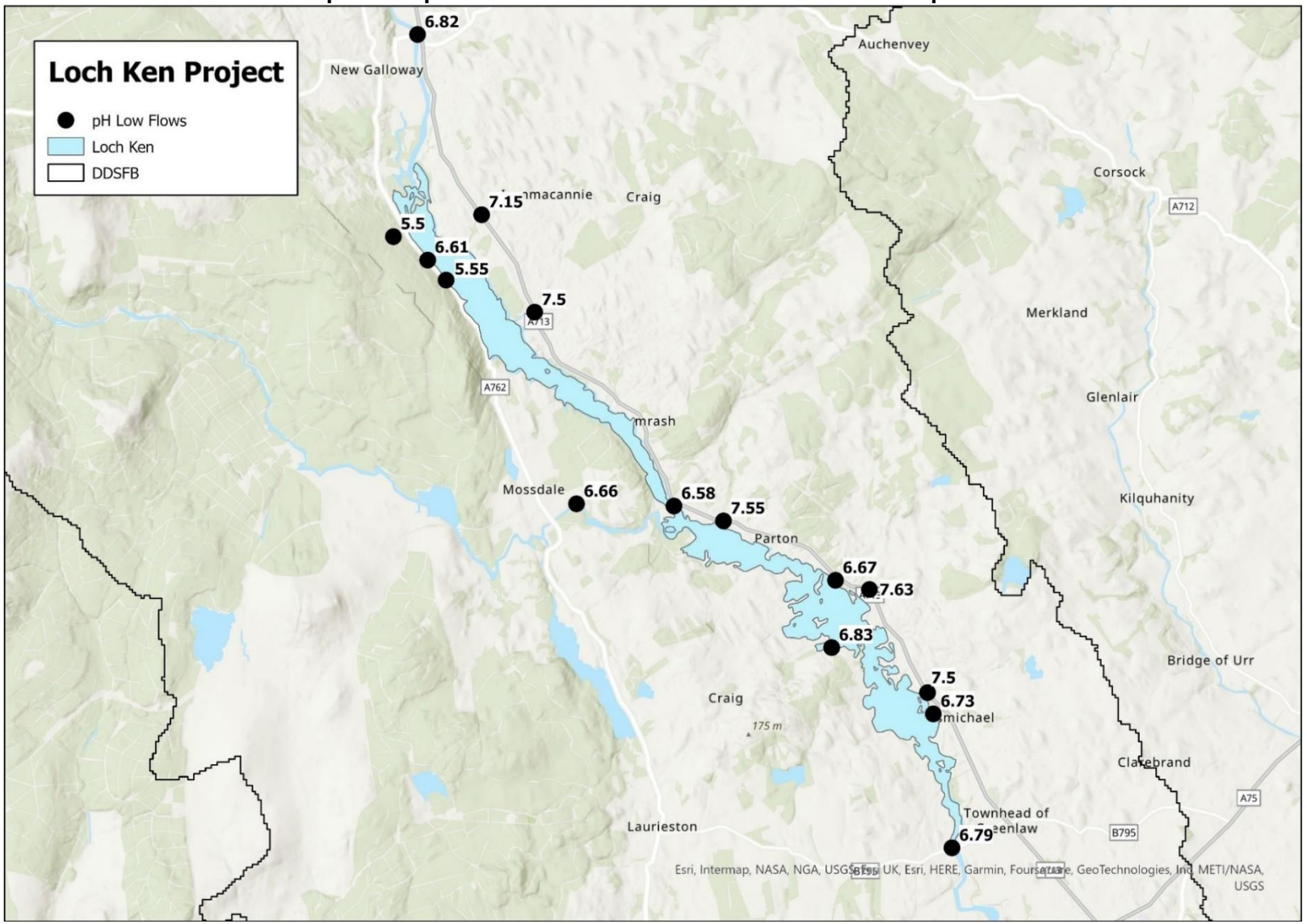
- AWIC overlaps mostly with pH sonde data showing two top sites significantly acidified and no issue with any others, variation can be explained by the fact the sonde data reflects recordings from the time they were taken under the influence of the condition they were taken in, AWIC scores produce an average pH score.

Given that invertebrates have different life cycles that start different stages at different times, it is advised to carry out another survey in autumn for WHPT, AWIC and PSI scores. If needed further data can be mapped out illustrating surrounded land uses, geology and such. This study is just a snapshot of what is going on around Loch Ken, which represents important baseline data that has been gathered.

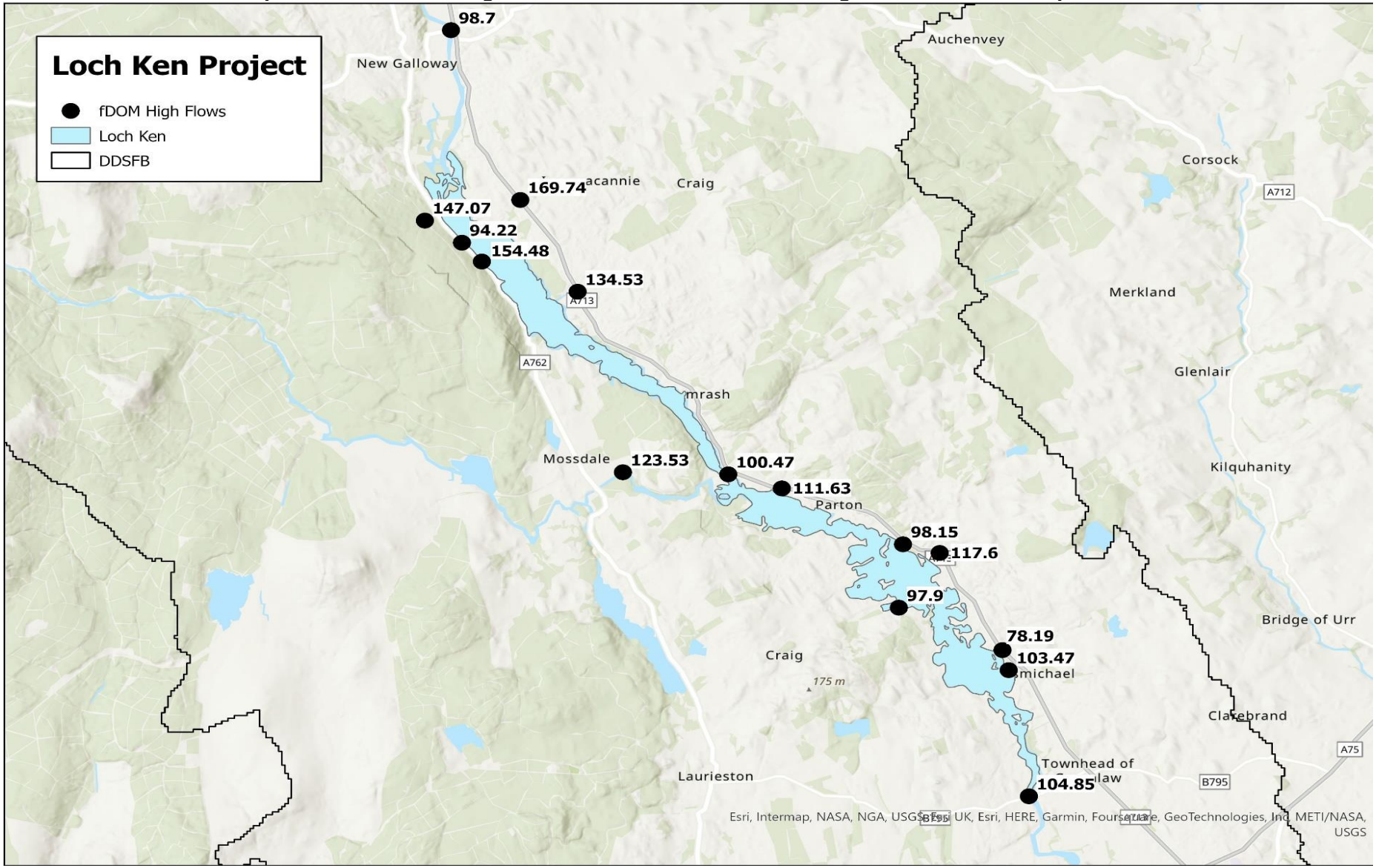
Map 2: The pH sonde results from high flows at each sample site



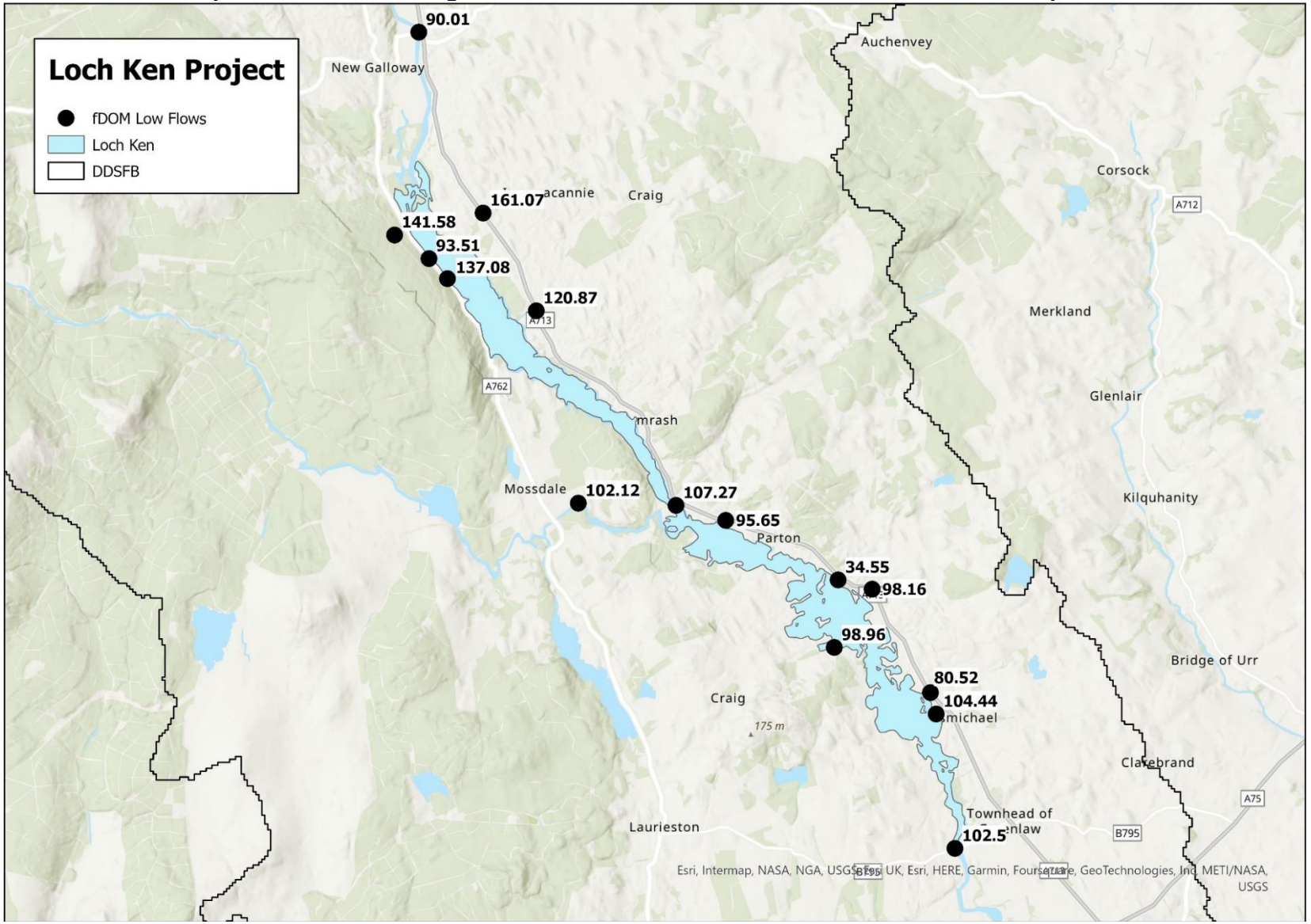
Map 3: The pH sonde results from low flows at each sample site



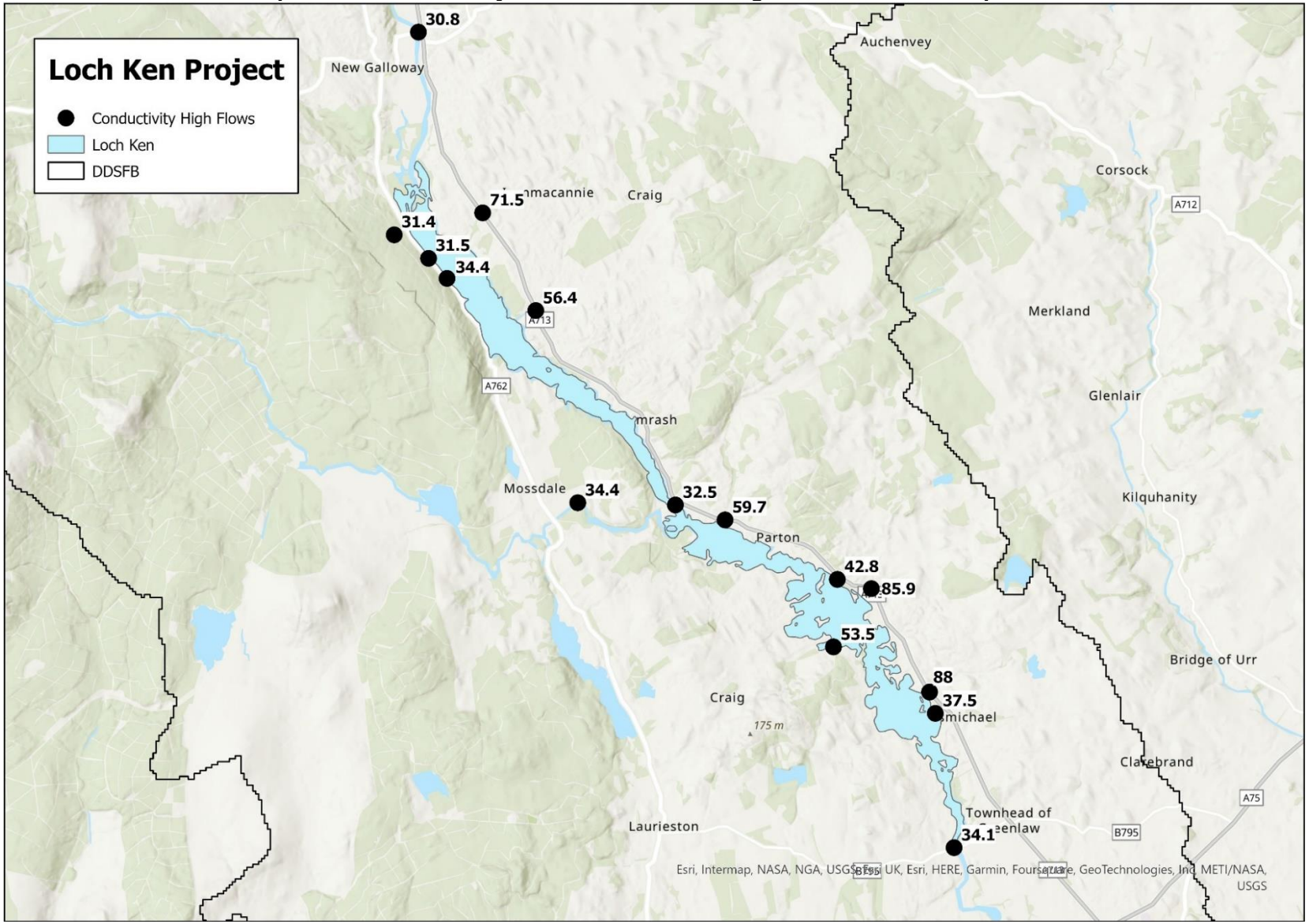
Map 4: The dissolved organic matter sonde results from high flows at each sample site



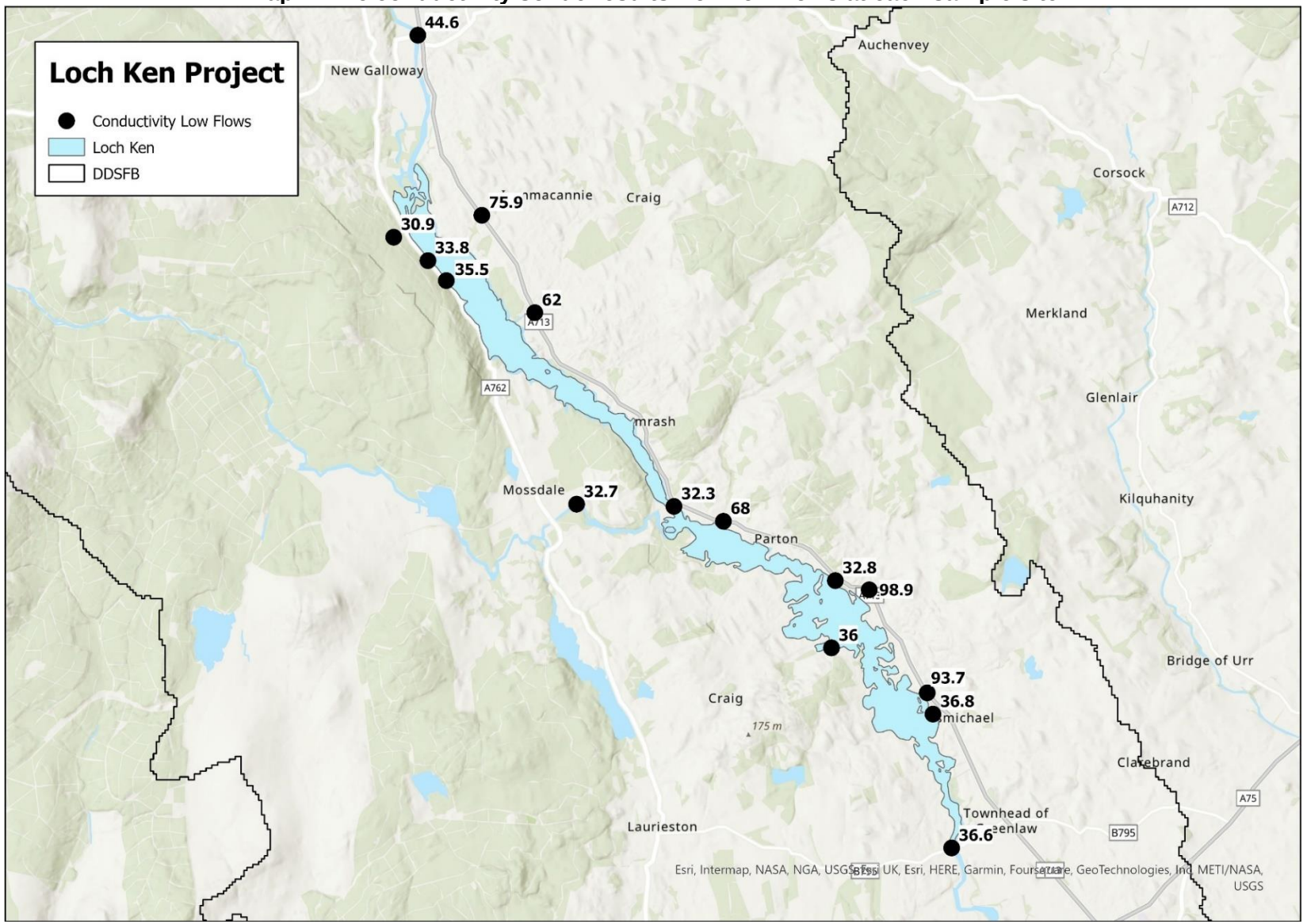
Map 5: The dissolved organic matter sonde results from low flows at each sample site



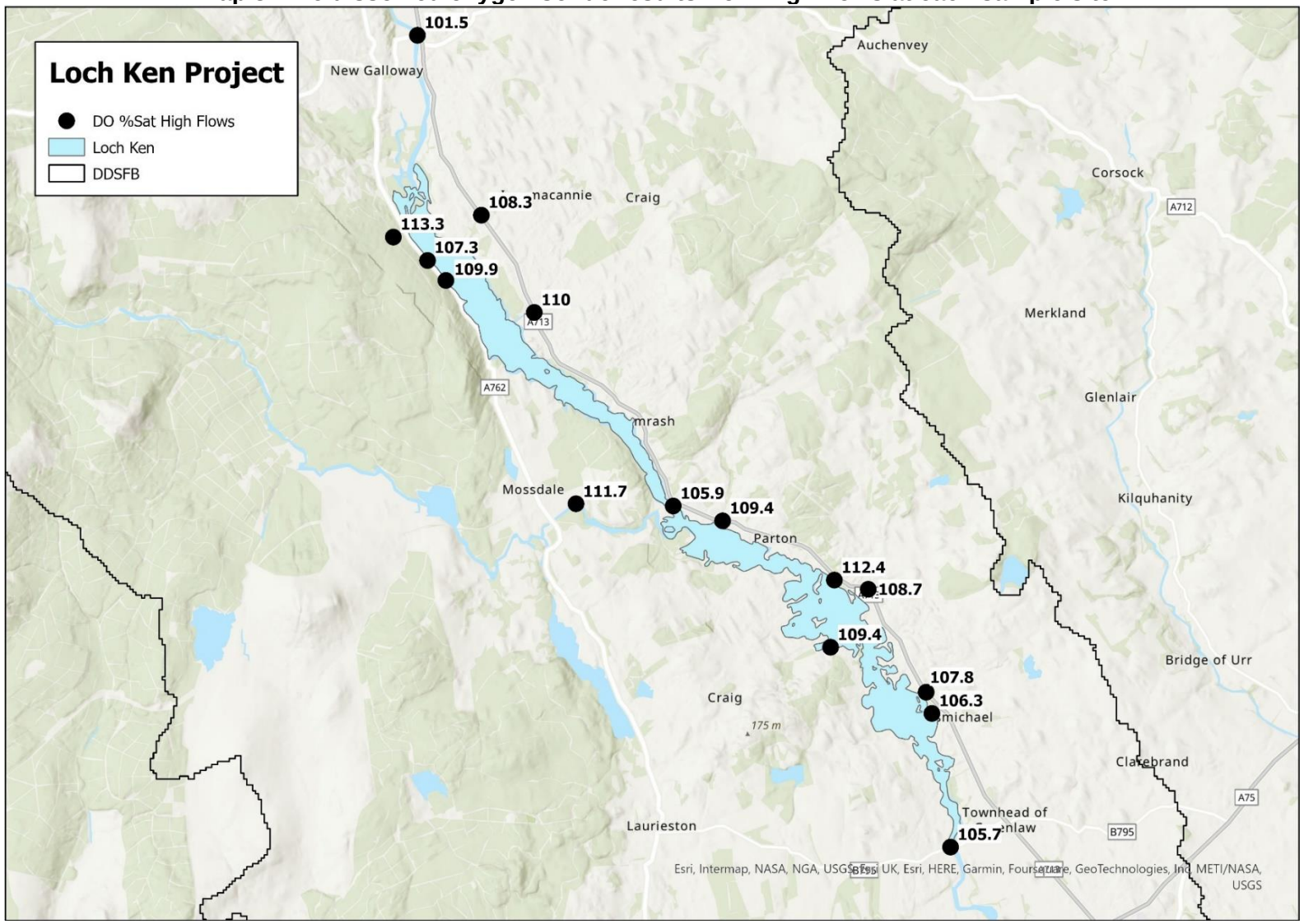
Map 6: The conductivity sonde results from high flows at each sample site



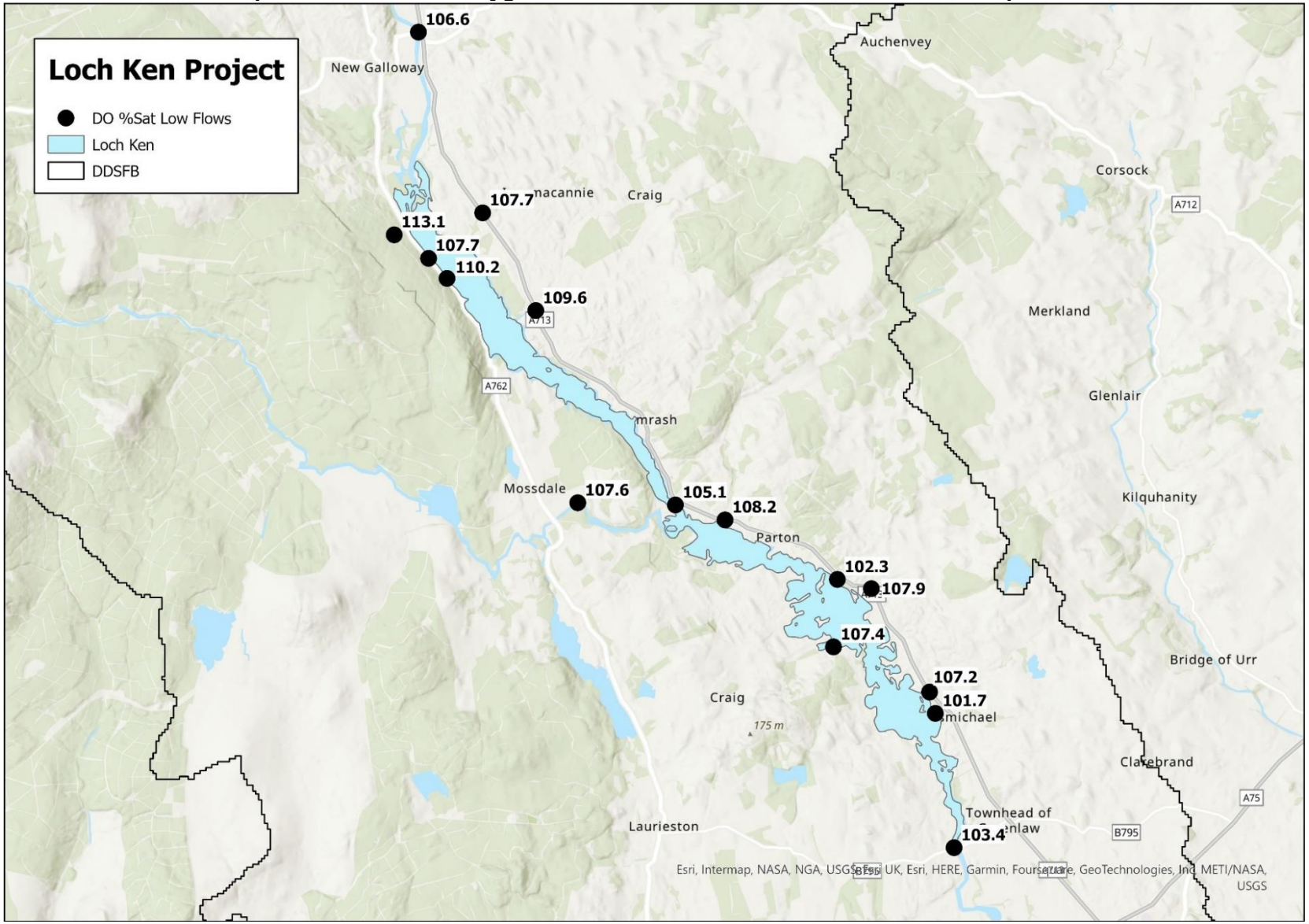
Map 7: The conductivity sonde results from low flows at each sample site



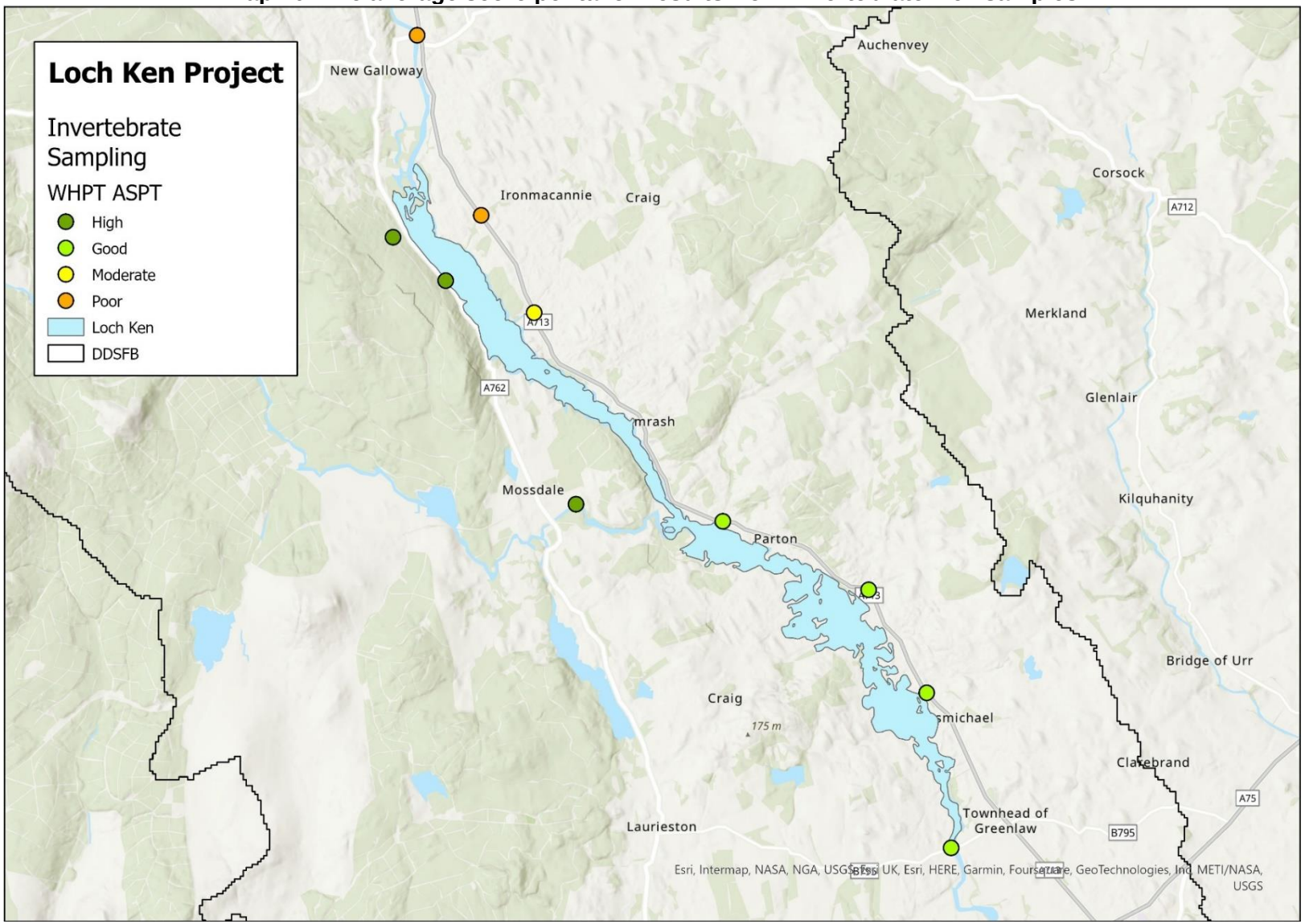
Map 8: The dissolved oxygen sonde results from high flows at each sample site



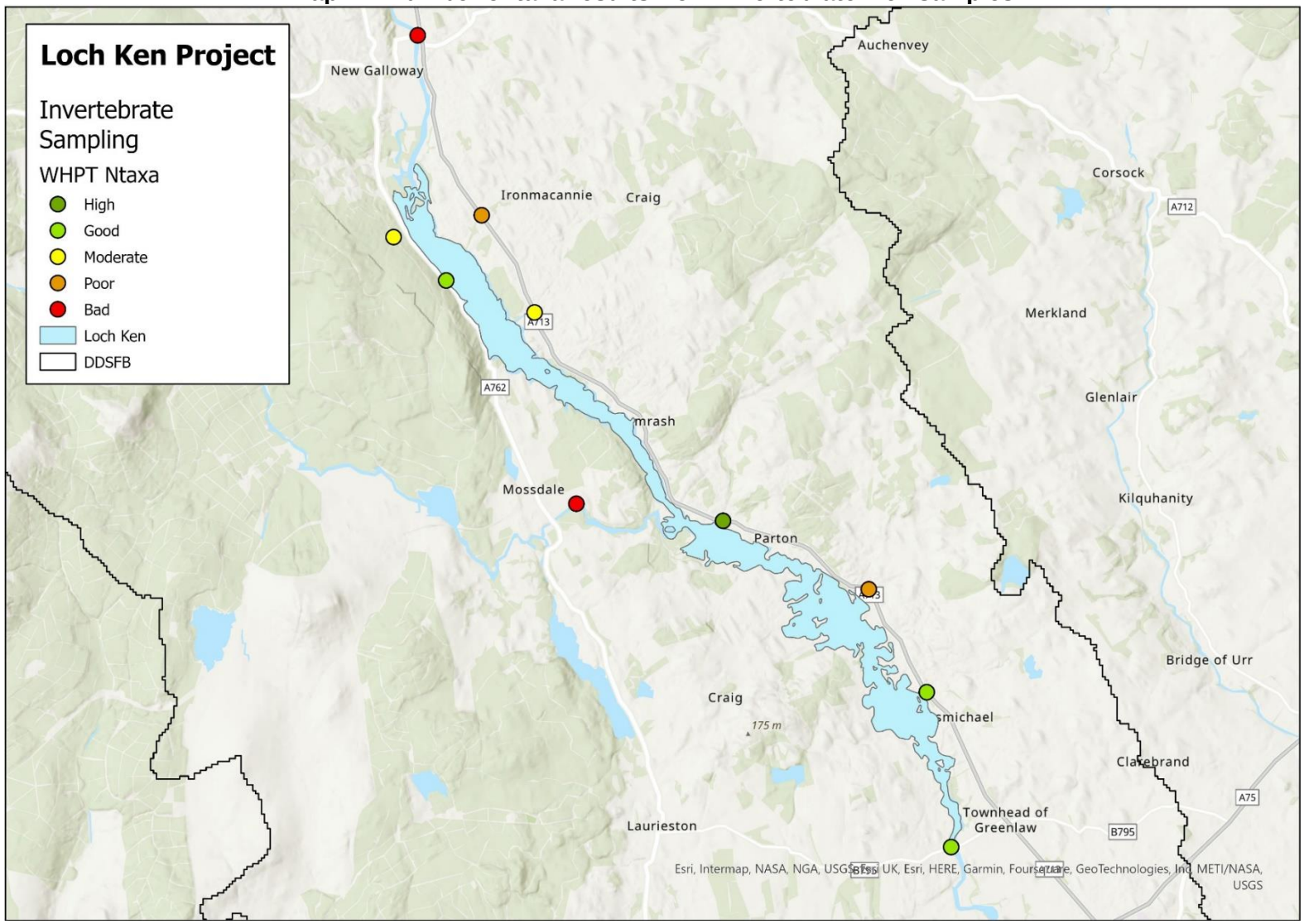
Map 9: The dissolved oxygen sonde results from low flows at each sample site



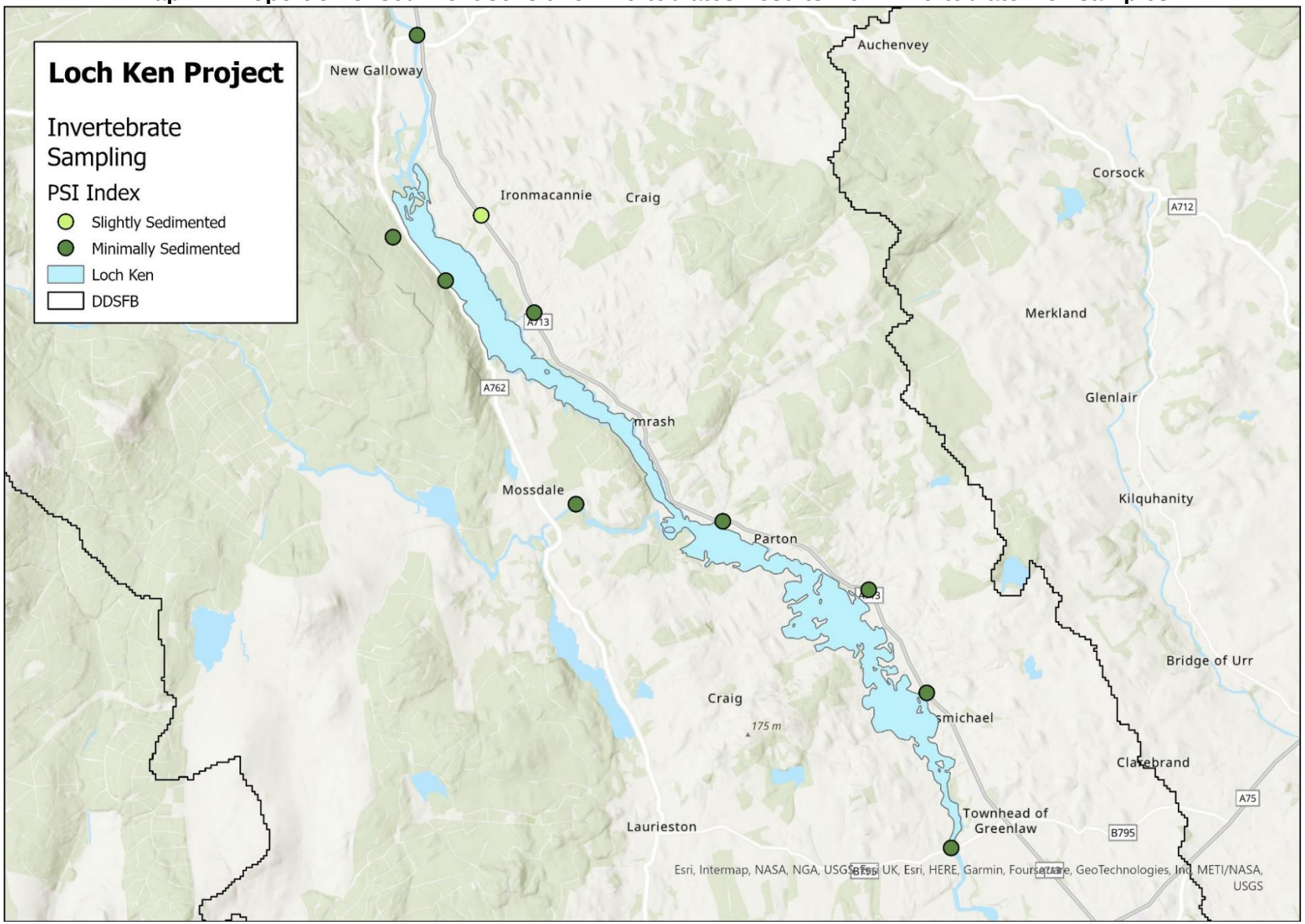
Map 10: The average score per taxon results from invertebrate kick samples



Map 11: Number of taxa results from invertebrate kick samples



Map 12: Proportion of sediment sensitive invertebrates r esults from invertebrate kick samples



Map 13: Acid in Water Indicator Community results from invertebrate kick samples