



SCOTTISH EXECUTIVE

Environment Group

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Information Letter 3/2006

Dear George,

Disinfection Indices

The majority of complaints about taste and odour received by Scottish Water from consumers in 2004 were directly concerning, or linked to, the taste and smell of chlorine in the water supply. Whilst it is of paramount importance that all drinking water receives adequate disinfection, it is also expected that Scottish Water will take steps to minimise the impact of residual chlorine on the aesthetic acceptability of the water to consumers. Control of the disinfection process is also key to minimising the formation of disinfection by-products such as Trihalomethanes.

This letter sets out a new water quality measurement, the *Disinfection Index*, designed to define the stability of the chlorine residual achieved in the water leaving a water treatment works, and to compare that stability with a predefined standard. The Disinfection Index will be used to determine success, or otherwise, of work carried out to improve disinfection during the Q & S 3 period.

Background

The chlorine residual in water leaving a water treatment works can be influenced by many factors. For example, seasonal changes in raw water quality, degree of treatment applied before disinfection, short-circuiting in the treated water storage reservoir, and even the accuracy of the analysis and recording of the residual, are among the factors influencing the stability shown by chlorine residual data.

Given the number of influencing factors, and the reactivity of chlorine itself, it is perhaps not surprising that chlorine residuals are often erratic. However chlorine residual data from the Regulatory sampling programme does show that some water treatment works produce more consistent data than others and it is these differences that the Disinfection Index defines.

Fundamental Conditions for Calculating the Disinfection Index

1. The chlorine residual data from the Regulatory sampling programme will be used to calculate the Disinfection Index. Specifically, the total chlorine residual measured at the tap for the water leaving the works will be used for the calculation. As this uses existing data it thus avoids an increased workload from additional sampling.
2. A minimum of 52 samples per annum will be required to calculate the Disinfection Index. Where that number cannot be met through the Regulatory programme, operational data, from samples taken at regular intervals throughout the year, must be included until a total of 52 data points is reached.
3. Where operational samples are included they must be from manual tests carried out at the works using a quality controlled chlorine test kit. Calibration and all other AQC checks for the test kit used must be documented and submitted to the DWQR along with the data. Data from on-line instrumentation will not be valid for this purpose.
4. Only total chlorine residual data will be used for the calculation. By adopting this approach it alleviates the need to change methodology, or identify in some way, those water treatment works where chloramination is in use.
5. Water treatment works using UV or Chlorine Dioxide for disinfection are outwith the scope of the Disinfection Index.
6. The Disinfection Index is a measurement of the variation of individual data points round their mean. The usual method for making such a measurement is to calculate the standard deviation of the data. However the Disinfection Index will be calculated on a percentage basis as this is more consistent with existing terminology and approach in Regulatory water quality monitoring.

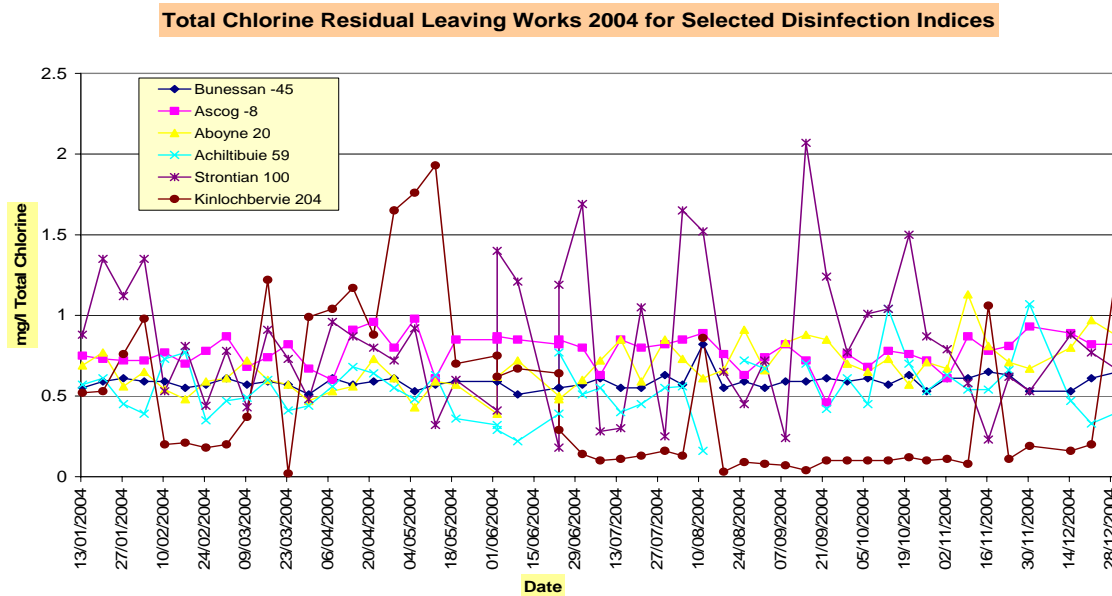
The Disinfection Index Calculation (see Appendix 1. for step by step guide).

It is acknowledged that maintenance of a steady chlorine residual is not easy to achieve and a degree of variation in residual round the chosen value can be expected. However continually changing chlorine residuals are recognised as one element leading to customer dissatisfaction and complaints of chlorine taste and odour while, in its most extreme form, could lead to temporary loss of disinfection or gross over dosing of the water.

The aim of the Disinfection Index is to detect those works where the total chlorine residual is sufficiently unstable on an ongoing basis as to be of concern.

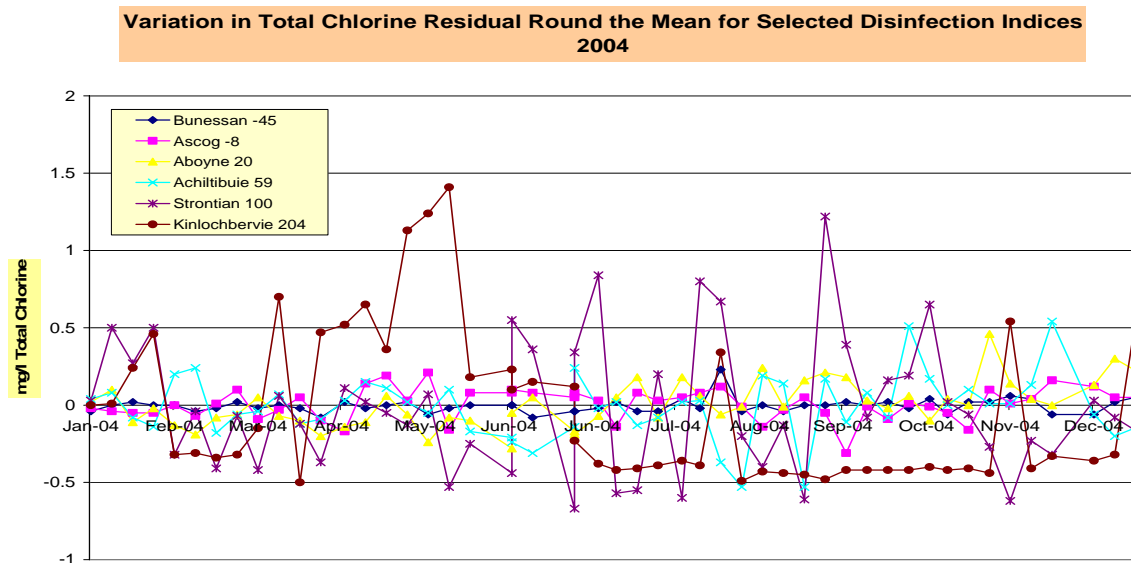
Graph 1 below shows the chlorine residuals at six water treatment works for 2004.

Graph 1.



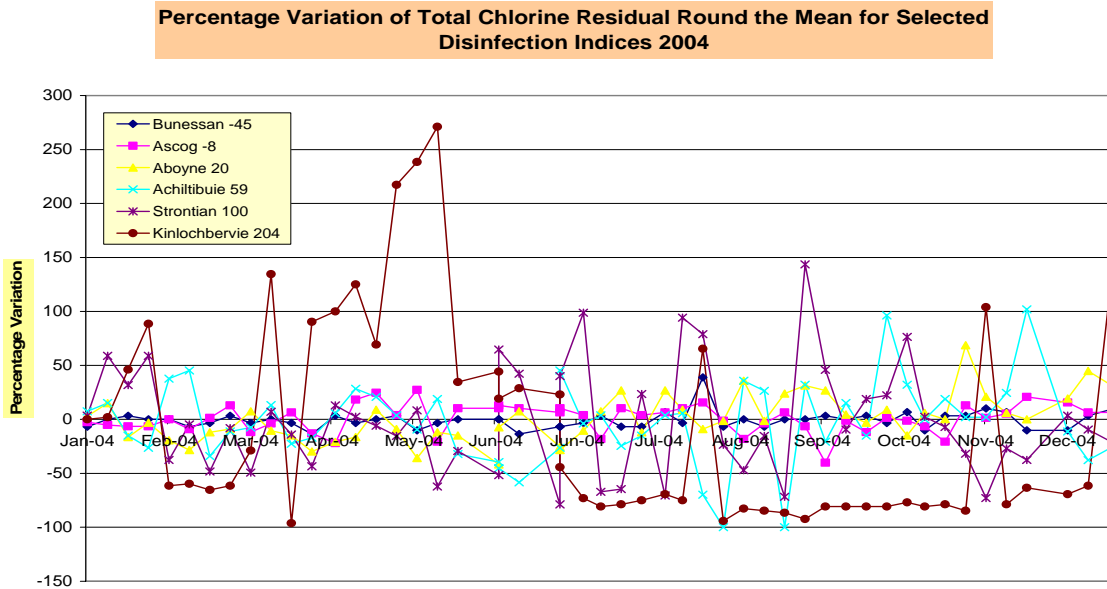
It is apparent from the graph that there is a considerable change in chlorine residual stability across the works. The first step in calculating the Disinfection Index is to calculate the variation in residual with the mean (Graph 2 below).

Graph 2.



The next stage is to calculate the above variation as a percentage of the mean (Graph 3. below).

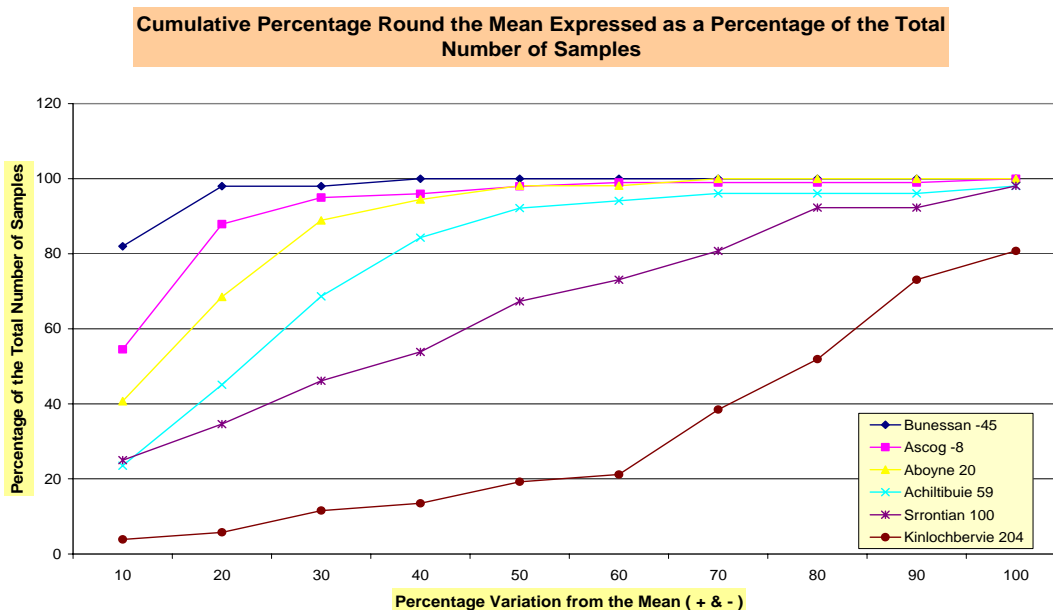
Graph 3.



It is apparent from the above graph that while the data for Bunessan and Ascog stay comfortably within plus or minus 50% of the mean Aboyne exceeds 50% on one occasion, Achiltibuie reaches plus/minus 100% on a number of occasions with Strontian and Kinlochbervie showing even greater and more frequent occurrences of extreme residual variation.

The same data can be shown as the cumulative percentage of samples falling within various variation bands, as given in the following graph.

Graph 4.

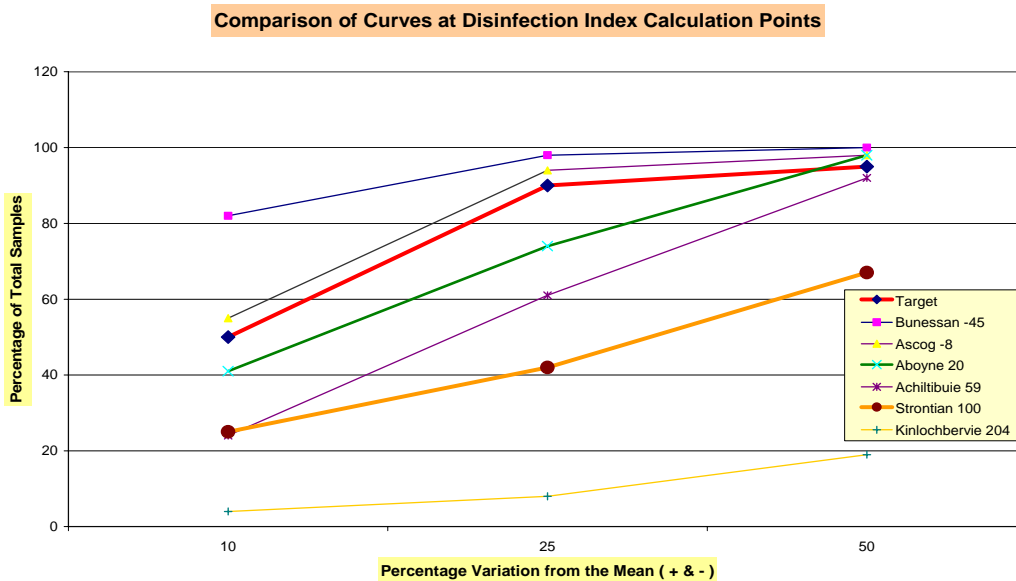


The degree of variation around the mean can be clearly seen from the shape of the curve for each water treatment works and, from studying such curves for a random selection of 80 water treatment works covering the whole range of throughput capacities, the following criteria were selected as conditions which, if achieved, would demonstrate adequate control over the chlorine residual leaving the water treatment works;

1. 50% of all total chlorine residual results should fall within plus or minus 10% of the mean.
2. 90% of all total chlorine residual results should fall within plus or minus 25% of the mean.
3. 95% of all total chlorine residual results should fall within plus or minus 50% of the mean.

The data from each water treatment works can now be compared to the above set of conditions, as shown in the following graph.

Graph 5.



It is clear from the graph that while Bunessan and Ascog meet, and indeed, exceed the target curve the other works do not.

To make the comparison with the target curve easier to handle for the large number of works involved the relationship between the works curve and target curve is reduced to a single number by summing the percentage differences between the curves at 10, 25 and 50% . The number obtained is the **Disinfection Index**.

For example Bunessan has; 82% of its data points within +/- 10% of the mean;
 98% of its data points within +/- 25% of the mean;
 100% of its data points within +/- 50 % Of the mean.

Therefore the Disinfection Index = 50 minus 82 = -32
 + 90 minus 98 = -8
 + 95 minus 100 = -5

Disinfection Index = -45

Fully worked examples are given in Appendix 3 and Appendix 4 .

A positive Disinfection Index indicates that the works fails to meet the target conditions and the higher the value the greater the instability in chlorine residual in the water leaving the works. A works meeting the target conditions will have a Disinfection Index of zero while a negative Index means the residual leaving the works shows a higher degree of stability than the target.

The Disinfection Index has been calculated for each water treatment works for the years 2002, 2003 and 2004. A table of the Indices are given in Appendix 2. It is to be expected that the Disinfection Index will vary from year to year by some degree and it is obvious from Appendix 2 that this does indeed happen. To accommodate this variation the works have been grouped into three *Action Bands*;

A. Those works showing the highest instability and therefore in greatest need of urgent action;

**Disinfection Index of 100 or more;
93 Works – 26% of the total works**

B. Those works with moderate variation in total chlorine residual and in need of some action;

**Disinfection Index between 20 and 99;
147 Works - 41% of the total works**

C. Those works where the target conditions are either met, almost met or exceeded and where action is not required;

**Disinfection Index of 19 or less.
117 Works - 33% of the total works**

The above grouping of the works is based on the score for the calendar year 2004 and may not represent the group they might have belonged to in any of the previous two years.

Application of the Disinfection Indices

1. The Disinfection Index will be calculated on a January to December annual basis.
2. The Disinfection Index for 2004 will be taken as the base value and changes in Index monitored from that year. Index values from earlier years can be used however to determine background trends for improvement purposes etc.
3. Appendix 2 includes a list of sites where data for 2004 is incomplete meaning that the Disinfection Index could not be calculated. Scottish Water is to inform the DWQR whether or not the site is still in service, whether sufficient further operational data is available to enable the index to be calculated for 2004 or whether data gathered in 2005 will enable calculation of the index for these sites.
4. Where improvements have been made to the chlorination system at a water treatment works then that works will be expected to show the desired Disinfection Index in the first full calendar year after the improvement has been made.
5. It is expected that an improvement in Disinfection Index is not to be achieved solely by an alteration of the chlorine set-point. Where it is evident that a change in set-point has occurred, it is expected that Scottish Water will provide a valid justification for such a change.

6. Where Scottish Water is of the opinion that an infrequent change in chlorine set point has adversely affected the Disinfection Index at a site, it may submit a brief explanation for the change for consideration by the DWQR at the same time as the data. Only infrequent changes for valid operational reasons will be considered – these may include a regular seasonal change or one-off boosting of chlorine residual following a water quality event. Changes which occur frequently will not be considered as an acceptable reason for a poor Disinfection Index.

Disinfection Index Investment Targets

The aim of the Drinking Water Quality Regulator for Scotland is to see all water treatment works consistently producing Disinfection Indices of 19 or less (ie within group C above) by the end of the 2014.

However, as a first step towards this ultimate goal, by the end of March 2010 no water treatment works should register a Disinfection Index of 100 or more. In other words no works should appear in Group A above from that date.

Monitoring for compliance against investment made in 2006 will begin with the 2007 data set.

DWQR recognises that major investment may not be required at all works to meet the targets and that “simple” alterations such as moving a sample tap to a more representative position, or cleansing of the database of typing errors may achieve the desired result.

Following meetings between Scottish Water and the DWQR, it has been agreed that a robust solution will be implemented for this driver at 141 sites listed in Appendix 5 in the first part of Q&S 3. No further funding will be supported for this driver at these sites in Q&S3, consequently it is expected that these sites will achieve Disinfection Indices of 19 or less by the end of March 2010.

A further 83 sites have been identified in Appendix 5 which also have the Disinfection Control driver. Scottish Water is expected to use an operational or capital maintenance approach in the first instance in order to achieve the target disinfection index of 20 at these sites. If this approach is not successful, it is expected that Scottish Water will identify these sites as requiring funding in the second half of Q&S 3, and the DWQR is likely to support this approach. In any case, all Scottish Water sites are required to have a Disinfection Index below 100 by the end of March 2010.

It should be noted that although the works have been grouped together in the three action groups based on their 2004 Disinfection Index, the 2002 and 2003 Indices show that some works can “jump” from one group to another. It should be borne in mind that investment to ensure compliance with both the 2010 and 2014 targets should capture all water treatment works likely to break the targets.

In order for the DWQR to sign off work at a site under this driver for Q&S3 financial purposes, DWQR will simply confirm whether it considers that the delivered project should be sufficient to provide the required outputs. It will not be necessary to wait for one full year of data prior to enable sign off at this level. DWQR intends to review data at all sites once one year has passed since the reported completion of the project in order to verify that the target Disinfection Index has been achieved. Where this is not the case, DWQR will expect Scottish Water to investigate and provide a plan for prompt remedial action at the site.

Submission of Data

Total chlorine residual data for water leaving each water treatment works should be submitted to DWQR through the monthly data returns requested in accordance with Information Letter 2/2005. Where a works is sampled at a frequency below that necessary to provide 52 data points per year, the dataset is to be supplemented with operational data. As this operational data will not form part of the monthly data return, **all** total chlorine data for such works for the preceding calendar year is to be provided by 21 March each year in the format shown below:

| FIELD NAME | FIELD DESCRIPTION | FIELD TYPE | FIELD SIZE | FIELD EXAMPLE (for illustration only) |
|------------------|--|-----------------------------|------------|--|
| SiteRef | (As Details table) | Text | 13 | T0500000123 |
| SampleResult | The actual result for individual sample. | Number Floating point | 8 | 0.54 |
| > or < qualifier | Sample greater than or less than limit of detection Note : Leave blank if not applicable. | Text (> or <) | 1 | > |
| SampleDate | Date sample taken in the format DD/MM/YY or DD/MM/YYYY | Date | 8/10 | 04/01/04 |
| SampleTime | Time sample taken in the format HH:MM (24 hour clock) | Time | 5 | 09:45 |

This data may be provided alongside the March monthly return (containing January's data) or separately.

If you have any queries concerning this matter, please contact Matt Bower on 0131 244 0743 or me, otherwise please confirm that Scottish Water is able to comply fully with the contents of this letter.

Yours sincerely,

Colin McLaren

This letter is accompanied by 4 Appendices.
Appendix 1. – The Disinfection Index Calculation
Appendix 2. - List of the Works and their Indices
Appendix 3 & 4 – Worked Examples
Appendix 5 – Site Investment Categories

Appendix 1.

DISINFECTION INDEX CALCULATION

*The Basis of the **DISINFECTION INDEX** is the assumption that individual Chlorine Residual results should not vary wildly from the mean result but instead remain within a fairly tight band round the mean value. The degree of variation considered challenging, but achievable, is given below;*

- 50% of results should fall within + or - 10% of the mean*
and,
90% of results should fall within + or - 25% of the mean
and,
95% of results should fall within + or - 50% of the mean.

The Disinfection Index is a single number that describes the relationship between the actual distribution of total chlorine residual results for a given works and the above set of conditions. A positive Disinfection Index indicates that the works is showing a greater degree of variation than the target values, while a negative Index is the result of lower variation than described by the target ranges. A works absolutely matching the target conditions would have a Disinfection Index of zero.

The Disinfection Index for any given water treatment works is calculated by adding together the percentage difference between the results for the works and the target ranges given above.

*The various steps in the calculation of the **Disinfection Index** are as follows;*

Step No.

1. Add chlorine residuals (x) for a site for the whole year = Sum x for N results
2. $\text{Sum } x / N = \text{mean for the year (M)}$
3. $M - x = \text{variation of each result from the mean (v)}$.
4. $v * 100/M = \text{Percentage variation of each result from the mean (v\%)}$
5. Add together all results within + or - 10% of the mean (A)
6. Repeat for + or – 25% and 50% (B and C)
7. $A * 100/N = \text{percentage of the total results within the first target range (A\%)}$
8. Repeat for 25% and 50% (B% and C%)
9. For each site; Subtract A% from 50% = a
Subtract B% from 90% = b
Subtract C% from 95% = c
10. Sum a + b = c to get the **Disinfection Index**.

Appendix 2 List of Disinfection Indices

| Water Treatment Works | Disinfection Index | | |
|------------------------------|---------------------------|-------------|-------------|
| | 2002 | 2003 | 2004 |
| 100 + | | | |
| Altnahara | | 87 | 223 |
| Diabeg | 159 | 168 | 214 |
| Rousay | 183 | 137 | 205 |
| Kinlochbervie | | 183 | 204 |
| Laid | 189 | 200 | 202 |
| Sanna | 174 | 133 | 190 |
| Sallachy | 154 | 124 | 185 |
| Oykel Bridge | 160 | 163 | 181 |
| Newcastletown | | 114 | 177 |
| Inchlaggan | 181 | 141 | 175 |
| Loth & Portgower | 143 | 133 | 174 |
| Letterfearn | 45 | 70 | 173 |
| Acharacle | 127 | 128 | 172 |
| Balmacara | 156 | 118 | 170 |
| Dalchriechart | 88 | 113 | 168 |
| Drimnin | 143 | 150 | 167 |
| Glenuig | 121 | 160 | 167 |
| Tarskavaig | 112 | 106 | 166 |
| Marrel | | 129 | 163 |
| Achaphubuil | 101 | 145 | 162 |
| Spean Bridge | 96 | 124 | 162 |
| Ardgour | 115 | 112 | 160 |
| Achmore | 121 | 133 | 158 |
| Glendale | 78 | 114 | 156 |
| Habost | | 129 | 156 |
| Melness | | 194 | 156 |
| Waternish | 137 | 120 | 154 |
| Mellon Udrigle | 141 | 129 | 152 |
| Blaich | 123 | 145 | 150 |
| Waterstein | 100 | 117 | 150 |
| Aultbea | 41 | 102 | 147 |
| Inverinate | 84 | 106 | 144 |
| Beasdale | 111 | 137 | 143 |
| Elphin | 123 | 112 | 143 |
| Inverasdale New | 130 | 154 | 143 |
| Bonar Bridge | 79 | 129 | 141 |
| Glenogil | 86 | 102 | 141 |
| Lohcarron | 106 | 122 | 141 |
| Navadale | 111 | 139 | 141 |
| Kylesku | 120 | 99 | 137 |
| Newton Stewart | 108 | 92 | 137 |
| Scourie | 129 | 168 | 136 |

| | | | |
|----------------|-----|-----|-----|
| Balnain | 123 | 72 | 135 |
| Bracadale | 106 | 139 | 135 |
| Isleornsay | 69 | 74 | 135 |
| Kinlochewe | 122 | 133 | 135 |
| Sheil Bridge | 114 | 122 | 133 |
| Dornie | 88 | 122 | 131 |
| Laide | 161 | 100 | 131 |
| Kilchoan | 166 | 131 | 129 |
| Sheildaig | 155 | 135 | 127 |
| Treslaig | 129 | 110 | 126 |
| Claddich | 97 | 103 | 125 |
| Braes | 83 | 85 | 124 |
| Elgol | 97 | 68 | 124 |
| Ardneaskan | 94 | 90 | 123 |
| Fetlar | | 70 | 123 |
| Clarklyhill | 113 | 152 | 120 |
| Glenahullich | 76 | 146 | 120 |
| Invermorrison | 35 | 108 | 120 |
| Torrin | 147 | 125 | 120 |
| Unst | | 70 | 120 |
| Laggan Bridge | 104 | 98 | 118 |
| Maaruig | | 128 | 117 |
| Tyndrum | 109 | 118 | 117 |
| Acreknowe | 62 | 37 | 116 |
| Auchneel | 64 | 96 | 116 |
| Stoer | 152 | 72 | 116 |
| Ratagan | 127 | 104 | 115 |
| Strathcarron | 68 | 58 | 114 |
| Ballachulish | 125 | 139 | 113 |
| Crathie | 113 | 127 | 113 |
| Garve | 104 | 102 | 113 |
| Stromness | 113 | 104 | 113 |
| Lochaline | 106 | 112 | 112 |
| Sullom Voe | 112 | 16 | 112 |
| Kirbister | 42 | 63 | 111 |
| Londornoch | 82 | 109 | 111 |
| Picketlaw | 50 | 77 | 111 |
| Bigton | 67 | 108 | 110 |
| Alligin | 152 | 152 | 108 |
| Nedd | 152 | 129 | 108 |
| Osedale | 113 | 71 | 108 |
| Barra | 169 | 96 | 107 |
| Salen | 135 | 126 | 107 |
| Achnasheen | 131 | 174 | 104 |
| Badcaul | 79 | 127 | 104 |
| Gairloch | 68 | 89 | 104 |
| Kishorn | 72 | 107 | 104 |
| Glencoe | 0 | 62 | 102 |
| Loy | 102 | 84 | 102 |
| Ness | | 41 | 101 |
| North Erradale | 145 | 89 | 101 |
| Strontian | 120 | 141 | 100 |

Water Treatment Works**Disinfection Index****20 to 99**

| | 2002 | 2003 | 2004 |
|------------------|------|------|------|
| Cioltie | 93 | 72 | 99 |
| Melvaig | 113 | 124 | 99 |
| Savalbeg | 106 | 75 | 98 |
| Durness | 104 | 95 | 97 |
| Dores | 111 | 156 | 95 |
| Kettlebridge | | | 95 |
| Strollamus | 45 | 64 | 95 |
| Cannich | 99 | 37 | 94 |
| Lemreway | | 109 | 94 |
| Fort Augustus | 80 | 74 | 93 |
| Glenfinnan | 114 | 104 | 93 |
| Rhenigidale | | 94 | 93 |
| Torridon | 95 | 86 | 93 |
| Carbost | 99 | 88 | 92 |
| Lochend | 51 | 47 | 91 |
| Mid Yell | | 123 | 91 |
| Drumbeg | 139 | 110 | 90 |
| Broadford | 83 | 70 | 89 |
| Dunkeld | 76 | 78 | 89 |
| High Borland | | | 89 |
| Kinlochleven | 122 | 141 | 89 |
| Mallaig | 57 | 35 | 89 |
| Boardhouse | 64 | 56 | 88 |
| Applecross | 104 | 153 | 86 |
| Lochinver | 85 | 56 | 86 |
| Achmelvich | 90 | 95 | 85 |
| Hushinish | | 86 | 85 |
| Kinlochrannoch | 83 | 87 | 85 |
| Kyle of Lochalsh | 153 | 87 | 83 |
| Roybridge | 102 | 106 | 83 |
| Ardvourlie | | 97 | 81 |
| Arnisdale | 85 | 105 | 80 |
| Mor | | 56 | 80 |
| Lerwick | -6 | 82 | 79 |
| Palnure | 19 | 72 | 79 |
| North Ronaldsay | -61 | -28 | 78 |
| Kilmaluag | 79 | 72 | 77 |
| Tweedsmuir | 59 | 47 | 77 |
| Glenelg | 104 | 55 | 72 |
| Tongue | 131 | 188 | 72 |
| Skerries | | 104 | 71 |
| Stornoway | | 33 | 71 |
| Strathyre | 125 | 39 | 71 |
| Penifiler | 79 | 89 | 70 |
| Teangue | 82 | 71 | 70 |
| Tomich | 74 | 63 | 70 |

| | | | |
|--------------------|-----|-----|----|
| Bohuntin | 91 | 29 | 68 |
| Drumfearn | 73 | 29 | 68 |
| Tomnavoulin | | 35 | 67 |
| Braemar | 123 | 64 | 66 |
| Earlish | 104 | 67 | 66 |
| Lochranza | 235 | 29 | 66 |
| Kinnieswood No.3 | 71 | 18 | 65 |
| Yarrowfeus | 19 | 54 | 65 |
| Cowhill | 62 | 59 | 64 |
| Cromarty | 55 | 111 | 64 |
| Calder Mixed Final | | | 63 |
| Sconser | 39 | 35 | 62 |
| Banff | 63 | 62 | 61 |
| Dalmally | 35 | 40 | 61 |
| Tiree | 45 | 33 | 61 |
| Broughton | 58 | 62 | 60 |
| Gravir | | 54 | 60 |
| Invergarry | 91 | 87 | 60 |
| Tighnabruach | 1 | 2 | 60 |
| Achiltibuie | 100 | 66 | 59 |
| Muirlands | 94 | 54 | 58 |
| Uig | | 52 | 58 |
| Kilberry | 112 | 90 | 57 |
| Nielston Low | 94 | | 57 |
| Howdenhaugh | 26 | 25 | 56 |
| Touch | 26 | 17 | 56 |
| Peninver | 49 | 15 | 55 |
| South Muirhouse | 35 | 35 | 55 |
| West Lewis | | 61 | 55 |
| Bonchester | 23 | -7 | 54 |
| Dalwhinnie | 43 | 74 | 54 |
| Glengap | 57 | 125 | 54 |
| Kilmuir | 76 | 50 | 54 |
| Rankinston | 200 | 66 | 54 |
| Glenfarg | 11 | 20 | 52 |
| Gorthleck | 39 | 23 | 52 |
| Lochenkit | 4 | 27 | 52 |
| Cargen Borehole | 39 | 23 | 51 |
| Onich New | 15 | -1 | 50 |
| Rosemarkie | 86 | 43 | 50 |
| Whitehillocks | 34 | 41 | 50 |
| Balquhidder | 4 | -15 | 49 |
| Kenmore | 62 | 37 | 49 |
| Kirkmichael | 31 | 47 | 49 |
| Nielston High | 58 | 85 | 49 |
| Lochearnhead | 84 | -5 | 48 |
| Kaim | 52 | 49 | 47 |
| Ringford | 16 | 61 | 47 |
| Blackpark | 31 | 11 | 46 |
| Rhynie | | 33 | 45 |
| Widford | -3 | 41 | 45 |
| Afton | 15 | 32 | 44 |
| Cliasmol | | 65 | 44 |
| Gourlaw | 55 | -10 | 43 |

| | | | |
|-------------------|-----|-----|----|
| Tomatin | 0 | 8 | 43 |
| Newburgh | 25 | 33 | 41 |
| Storr | 4 | -4 | 41 |
| Alford | 37 | 19 | 39 |
| Badachro | 46 | 93 | 39 |
| Kilmelford | 62 | 72 | 39 |
| Nam Bat | 9 | 20 | 39 |
| Staffin | 22 | -5 | 39 |
| Kilchrennan | 31 | 52 | 38 |
| Badentinnan | 58 | 18 | 37 |
| Brig O'Turk | 6 | -32 | 37 |
| Cullivoe | | 71 | 37 |
| Raasay | 45 | 39 | 37 |
| Balmichael | -23 | -13 | 35 |
| Kinnieswood No. 1 | 26 | 33 | 35 |
| Southdean Mill | | -8 | 35 |
| Orasay | | 31 | 34 |
| Daer No.3 | | | 33 |
| Roberton | 10 | 2 | 33 |
| Killiecrankie | 31 | 10 | 32 |
| Ardeonaig | 95 | 12 | 31 |
| Gigha | 98 | 48 | 31 |
| Knowehead | 47 | 23 | 31 |
| Pateshill | 17 | -3 | 31 |
| Drumelzier | 31 | 135 | 29 |
| Eriskay | 10 | 27 | 28 |
| Corrie | 64 | 21 | 27 |
| Loch Eck | 235 | 38 | 27 |
| Glendye | 8 | 25 | 26 |
| Meavaig | | 89 | 26 |
| North Hoy | 41 | 41 | 26 |
| Ballater | 43 | 19 | 25 |
| Bonnycraig | 16 | -2 | 25 |
| Ullapool | 52 | -2 | 25 |
| Forehill | 21 | 22 | 24 |
| Gartcarron | 28 | 15 | 24 |
| Glenconvinth | -3 | 20 | 24 |
| South Yell | | 35 | 24 |
| Tolsta | | 51 | 24 |
| Carradale | 55 | -3 | 23 |
| Perth | 10 | 19 | 23 |
| Alnwickhill | 10 | 35 | 22 |
| Camps | -2 | -8 | 22 |
| Yarrowford | -8 | 82 | 22 |
| Aboyne | 25 | 14 | 20 |
| Carron Valley Old | 5 | | 20 |
| Papa Stour | | 142 | 20 |

Water Treatment Works**Disinfection Index****19 and Less**

| | 2002 | 2003 | 2004 |
|-------------------|------|------|------|
| Burncrooks | -13 | -7 | 19 |
| Fairmilehead | 4 | 7 | 18 |
| Kinnieswood No. 2 | 126 | 35 | 18 |
| Lomondhills | 9 | 27 | 18 |
| Stronsay | 27 | 14 | 18 |
| Taynuilt | 0 | -5 | 18 |
| Ettrickbridge | 39 | 15 | 17 |
| Carron Valley New | 24 | 12 | 16 |
| Torra | 26 | 21 | 16 |
| Killin | 2 | -16 | 15 |
| Tarbert (W.I.) | | 23 | 14 |
| Bradán | 15 | 132 | 13 |
| Camphill | 29 | 6 | 13 |
| Castle Carrick | -17 | 41 | 11 |
| Penwhirn | | 10 | 11 |
| Black Esk | 3 | -5 | 10 |
| Craigmaddie 1&2 | 57 | 35 | 10 |
| Glendevon | -5 | -16 | 10 |
| Innerleithen | 61 | 31 | 10 |
| Marchbank | -24 | 0 | 10 |
| Overton | -22 | 35 | 10 |
| Invercannie | 45 | 27 | 9 |
| Sanday | 45 | 47 | 9 |
| Amlaird | -25 | 9 | 8 |
| Craigmaddie 3&4 | 30 | 34 | 8 |
| Crianlarach | 15 | -16 | 8 |
| Heriot | 39 | 60 | 8 |
| Hopes | 54 | -11 | 8 |
| Newmore | -4 | 102 | 8 |
| Dougliehill | 21 | 40 | 7 |
| Backies | 78 | 52 | 6 |
| Glenlatterach | 26 | -11 | 5 |
| Saddell | 9 | 1 | 4 |
| Balmore | -35 | 5 | 3 |
| Rawburn | -34 | -17 | 3 |
| Rochomie | 6 | -5 | 3 |
| Tarbert (Argyle) | -3 | -8 | 3 |
| Ashgrove | -3 | 5 | 2 |
| Govig | | 76 | 2 |
| Inverary | -27 | -20 | 2 |
| Shapinsay | 73 | 47 | 2 |
| Clatto | 29 | 16 | 1 |
| Killilour | | | 0 |
| Langholm | 227 | 8 | 0 |
| Larchfield | | | 0 |
| Muirdykes High | | | 0 |

| | | | |
|--------------------|-----|-----|-----|
| Lochinvar | -38 | 9 | -2 |
| Lochmaddy | 23 | 17 | -2 |
| Mugdock 3 & 4 | 27 | 23 | -2 |
| Port Charlotte | 81 | 21 | -2 |
| Mugdock 1 & 2 | 29 | 31 | -3 |
| Turret | -33 | -24 | -3 |
| South Uist | -14 | 0 | -4 |
| Bressay | -23 | 35 | -7 |
| Finlas | -2 | 40 | -7 |
| Geocrab | | 4 | -7 |
| Mugdock 5 | 11 | 31 | -7 |
| Aringour No.2 | 0 | -31 | -8 |
| Ascog 1 & 2 | -14 | 0 | -8 |
| Berneray | 15 | 6 | -8 |
| Dervaig | -5 | -19 | -8 |
| Dykehead (Moffat) | 227 | | -8 |
| Craigmaddie 5 | 31 | 29 | -9 |
| Eday | 45 | 25 | -9 |
| Mannofield | 95 | 7 | -9 |
| Newton of Lathrisk | 87 | 35 | -9 |
| Penwhapple | -16 | 1 | -10 |
| Ballygrant | 97 | 23 | -11 |
| Calder | | -19 | -11 |
| Foula | | 68 | -11 |
| Lumsden | 0 | 18 | -11 |
| Tullich | -15 | -11 | -11 |
| Cambelltown | -17 | -20 | -12 |
| Corsehouse | -4 | 6 | -12 |
| Dhu Loch | -43 | -11 | -12 |
| Dodburn | -12 | 7 | -12 |
| Huntly | -15 | -3 | -12 |
| South Hoy | -14 | -15 | -12 |
| Winterhope | -38 | -11 | -12 |
| Bayhead | -15 | 32 | -13 |
| Glassford | -13 | -11 | -13 |
| Daer No.1 | 33 | -24 | -14 |
| Herricks | -4 | -2 | -14 |
| Muirdykes Low | -14 | -7 | -14 |
| Roseberry | 30 | 1 | -14 |
| Teregles | -47 | -41 | -14 |
| Assynt | 22 | 48 | -16 |
| Lochgoilhead | -5 | 39 | -16 |
| Clunas | 17 | 32 | -17 |
| Killylour | -24 | -52 | -17 |
| Overton Alexandria | -39 | -46 | -17 |
| Castle Moffat | -16 | -27 | -18 |
| Lintrathen | 12 | -12 | -18 |
| Turriff | 23 | 49 | -22 |
| Castlehill | 12 | 35 | -24 |
| Tobermory | -9 | -36 | -24 |
| Daer No.2 | 33 | -16 | -25 |
| Belmore High | -42 | -9 | -26 |
| Benbecula | -18 | -22 | -27 |
| Carspharin | 35 | 0 | -28 |

| | | | |
|-------------------|-----|-----|-----|
| Ardrishaig | -8 | -15 | -30 |
| Kettleton | -5 | -24 | -30 |
| Tomintoul | 10 | 19 | -31 |
| Belmore Loch Sloy | | | -32 |
| Blairlinnans | 39 | -7 | -33 |
| Craighouse | -21 | -25 | -35 |
| Ardfearn | -38 | -42 | -36 |
| Dunside | -29 | -45 | -36 |
| Helensburgh Low | -16 | -1 | -36 |
| Coulter | -35 | -42 | -40 |
| Loch Ashie | 1 | 13 | -44 |
| Bunessan | -60 | -53 | -45 |
| Manse Street | -47 | -54 | -49 |
| Colonsay | -6 | -24 | -58 |
| Craignure | -13 | -12 | -63 |
| Westray | 35 | -27 | -65 |

Summary

| | Number Sites | of Percentage of Total |
|--------------------|-----------------|---------------------------|
| Index Range | | |
| 100 + | 93 | 26% |
| 20 to 99 | 147 | 41% |
| 19 to minus 65 | 117 | 33% |

Incomplete Data Sets - No Data for 2004

| | 2002 | 2003 | 2004 |
|-----------------|------|------|------|
| Achnandarroch | | | |
| Aird of Sleat | 3 | | |
| Appin | 48 | | |
| Aringour No.1 | 235 | -11 | |
| Armadale | | 179 | |
| Balmore | 15 | | |
| Belmore Low | -41 | | |
| Belstane | 43 | | |
| Bomakelloch | 123 | | |
| Bridge of Cally | 117 | 92 | |
| Burnend | 19 | | |
| Cairnborrow | 118 | | |
| Cairngow | 61 | | |
| Coulport | 121 | | |
| Culrain | 154 | | |
| Cunningsburgh | 31 | 14 | |

| | | |
|-----------------------------|-----|-----|
| Dolphington | 235 | |
| Drumbeg | 139 | 110 |
| Drummuir | 153 | |
| Fair Isle | | 132 |
| Ferness | 118 | |
| Galston | | 145 |
| Garshake Tap A | -46 | |
| Garshake Tap B | 233 | |
| Gartly | 45 | 78 |
| Glenkindie | 75 | 76 |
| Inverasdale | 55 | |
| Kilchatan | 48 | |
| Landheads | 54 | |
| Loch Lyoch | -65 | |
| Marchbank New | -34 | |
| Marchbank Old | -14 | |
| Maryland Garshake | -65 | |
| Meadie | | 165 |
| Melvich | 101 | 133 |
| Melvich No.2 | | 133 |
| Muasdale | 21 | |
| Oldtown | 34 | |
| Onich Old | 105 | |
| Picketlaw No.2 | | 77 |
| Poolewe | 106 | |
| Rosehall | 131 | 135 |
| Sandwick | 28 | 72 |
| Shebster | 89 | 108 |
| Skerray | 81 | 166 |
| Strathdon | | 41 |
| Strathhalladale | 153 | 123 |
| Strathnaver | 162 | 191 |
| Sumburgh (Chlorine Dioxide) | | |
| Tayvallich | 24 | |
| Toftcarl | 28 | 80 |
| Wantonwalls | -3 | -31 |
| Whalsay | | 17 |
| West Burrafirth | 82 | 85 |