A water quality analysis of the River Lee and major tributaries within the perimeter of the M25, from Waltham Abbey to Bow Locks.

Client: Thames21

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Executive summary

This report was commissioned to assess the biological, physical and chemical water quality of the London River Lee and its main tributaries within the M25 perimeter, from the M25 near Waltham Abbey to Bow Locks in Bow, London. A pilot water quality investigation was developed to assess 38 sites within seven watercourses, including the London River Lee. Common physical and chemical water quality parameters were measured in the field and analysed by means of representative samples in a laboratory. Samples and measurements were taken during a period of 'reference' water levels within the watercourses. Results were compared and analysed against existing water quality classifications from the EU Water Framework Directive amongst others.

The investigation determined that the overall water quality within the London River Lee and its tributaries is very poor. Excessive concentrations of reactive phosphate (orthophosphate) in combination with low saturation of dissolved oxygen were common place within many of the sampled sites, as well as high counts of total coliforms and the presence of considerable levels of faecal coliforms. Values for chemical oxygen demand were also found to be excessively high within the majority of sample sites. A simple water quality index determined that the most deteriorated watercourse in the investigation was Stonebridge Brook, while the most deteriorated sample sites were located on the Pymmes Brook and Salmons Brook. The most 'healthy' watercourse was the Ching, while a sample site on Cobbins Brook had the greatest water quality score.

There are a large number of possible sources for inorganic (e.g. sediment) and organic pollutants (e.g. effluent) within the investigated watercourses. This investigation has possibly determined a number of pollutant sources on the watercourses, but these have still not been verified fully. This pilot investigation has located some potential areas on watercourses where overall physical and chemical water quality is low to poor. Further investigations are required to analyse their source, magnitude, variance and possible ecological and biological impacts. Currently, the impact of high precipitation and high levels of channel flow on the water quality of these watercourses is unknown and should be investigated further.

The investigation that was conducted has some limitations. The greatest of these is that there is no insight into how biological, physical and chemical water quality parameters vary over time within these streams and rivers. Regular or repeated sampling over time should be considered, although this will require further investment of finance and time. Other water quality parameters and pollutants such as heavy metals were not incorporated within this initial pilot study. The inclusion of other parameters should be considered in future assessments. Further biological and ecological measurements (e.g. invertebrate sampling and taxonomy) and analyses could compliment future water quality investigations on the London River Lee and its tributaries.

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Abbreviations

^{o}C – Degrees centigrade

BOD – Biochemical Oxygen Demand

CFU – Coliform Forming Units

COD – Chemical Oxygen Demand

DO – Dissolved Oxygen

EA – Environment Agency

EC – European Community

EEC – European Economic Community

EU – European Union

FTU – Formazine Turbidity Units

FAU - Formazine Attenuation Units

GQA – General Water quality Assessment

km – Kilometres

L - Litre

mg – milligram

ml – millilitres

NTU - Nephlometric Turbidity Units

P - Probability

PAH – Poly aromatic hydrocarbons

STW – Sewage Treatment Works

TDS – Total Dissolved Solids

TNT – Test 'N Tube

WFD – Water Framework Directive

Contents

1. Introduction and brief history of the River Lee

The River Lee (or Lea) has been described as a large lowland river system (1000 km^2) (Snook & Whitehead, 2005) that originates from a spring located near Well Head inside Waulud's Bank at Marsh Farm, Bedforshire (TL061244). From here it has a course length of 68 km that flows through Hertfordshire and north east London to its confluence with the River Thames, London near Blackwall (TQ395806). The River Lee catchment encompasses some 1420 km^2 (Snook & Whitehead, 2005).

The majority of the northern part of the watercourse flows over Cretaceous Chalk geology with the southern part flowing through Cenozoic deposits of London Clay and Thannet beds that overlay chalk (British Geological Survey, 1993). Land-use within the River Lee catchment varies between the northern and southern part of the watercourse. Arable and pastoral agriculture is dominant within the north of the catchment, while south of the watercourse flows through predominantly urban areas.

The river has had a long history of use and modification by humans, there are approximately 2,000,000 people currently living within the riparian areas of the River Lee (Snook & Whitehead, 2005). There are sections within the London area where the flow of the river is distributed into two or more parallel channels. Canalized sections of the river have been utilized for commercial transport over the last 900 years (e.g. Lee Navigation) and more recently flood relief channels (e.g. Lee Flood Relief Channel) have been constructed within the London part of the course with flow in some areas controlled by a series of locks. Further to this there are many tributaries, drainage ditches and culverts of varying size discharging into the London River Lee. A number of tributary streams and brooks of the River Lee within the London area have been culverted for the majority of their course to prevent flooding and impacts on human health. The Moselle Brook is perhaps the best example of this as the majority of its course is culverted.

The hydrology and flow regime of the River Lee is highly modified with several sewage and wastewater plants dotted along its course from Luton to London (Environment Agency, 2001a & b). The Deephams Sewage Treatment Works (STW) is the sole treatment plant located within London area of the River Lee that discharges treated effluent into the Lee from Pymmes Brook via Salmons Brook. Previous industrial, commercial and agricultural practices within the London part of the River Lee catchment have resulted in contamination of the river and its associated aquifers within urban areas (Environment Agency, 2001b).

Water abstraction remains a significant pressure on the River Lee. Previous over-abstractions of water for human consumption have also presented hydrological and ecological problems for the river (Environment Agency, 2005). Further problems within the London part of the catchment are many highways and local roads that cross or run near to the River Lee including the M25. Periods of heavy precipitation wash litter, leaves, animal faeces, mineral oils and road grit into urban rivers (Snook & Whitehead, 2005).

Development within the London area also presents some challenges and problems for the River Lee. One major recent development within the London part of the River Lee catchment is the London 2012 Olympic Park located in Stratford. A considerable portion of the River Lee flows through this area and there has been growing concern regarding the impact of the development on the river.

2. Objectives of this investigation and report

The main objective of this report is to provide insight into the water quality of the River Lee and its main tributaries within the M25 perimeter using a pilot investigation approach, the purpose of which was to produce a ‘snapshot’ of water quality parameters within the water bodies between 22 and 29 November 2011 subject to reference conditions being present. The generated measurements could be used to compare the water quality of the London River Lee against that of its tributaries, and also to compare water quality results between tributaries. An additional outcome of the investigation is to highlight sections of tributary streams and brooks as well as sites on the River Lee with possible sources of nutrients, contaminants and other pollutants. It was proposed that this report acts as a pre-cursor to help determine and design further and future investigative work on the River Lee and its tributaries regarding water quality.

3. Location of the River Lee within the M25

The section of the London River Lee and its tributaries that is the subject of investigation in this report is highlighted in Figure 3.1.

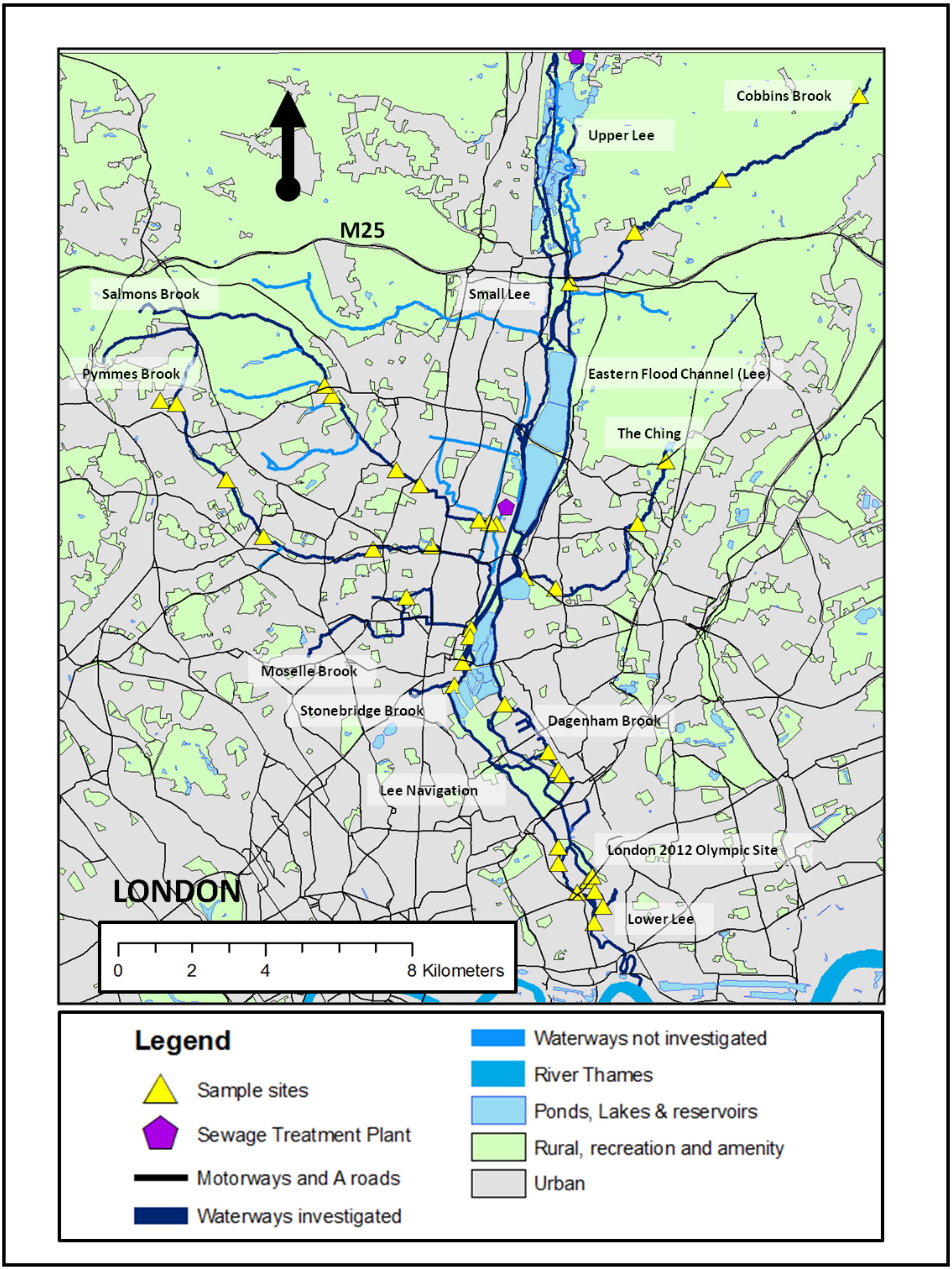

Figure 3.1 – A map of the River Lee (or Lea) and its main tributary streams and brooks within London. Sample sites that were used in the study are also illustrated.

4. Brief descriptions of water quality parameters

4.1. Nitrate and reactive phosphate

Both nitrogen and phosphorus are the essential elements that photosynthesising organisms such as plants and some micro-organisms require for growth. Phosphorus is usually the limiting element as nitrogen is more soluble in water compared to than phosphorus. The most readily available forms of nitrogen and phosphorus that can be used by organisms within aquatic habitats are nitrate (NO_3^--N) and reactive phosphate or orthophosphate (PO_4^{3-}). Nitrogen can also be present as ammonia and nitrite, but it is often present as nitrate because it is the most stable of all three forms.

Excessive amounts of nitrogen and phosphorus can cause eutrophication. This is the general deterioration of a waterbody due to increased microbial respiration resulting in reduced dissolved oxygen levels in the water, therefore depriving other organisms of oxygen. Increased levels of these nutrients have also been known to cause toxic algal blooms. Phosphorus is not toxic to humans or animals, but excessive concentrations of nitrate (>10 mg/L) can cause methemoglobinemia or blue baby syndrome.

Sources for both of these nutrients can either be diffuse or from a single point. These can include fertiliser and agricultural run-off, failing septic systems, faulty or inadequate waste water treatment plant discharges, wastes from domestic and livestock animals in addition to commercial wastes.

4.2. Dissolved Oxygen

The saturation (%) or concentration (mg/L) of dissolved oxygen within water is vital for organisms that permanently live within aquatic habitats such as fish and aquatic invertebrates. The saturation or concentration of dissolved oxygen is very much dependant on the temperature of water. With increasing temperature the saturation of dissolved oxygen decreases proportionally. Aquatic aerobic micro-organisms can consume a considerable proportion of dissolved oxygen within the water column, especially when there are higher temperatures present and organic matter is abundant. Dissolved oxygen can also be replaced into the water column by photosynthesising organisms, such as water plants or macrophytes.

4.3. Biochemical Oxygen Demand

Allochthonous and autochthones organic detritus can enter river and streams from the riparian fringe from wastewater treatment plants, failing septic systems, agricultural pastures and urban runoff. Organic matter within the water column is a food source for water-borne bacteria and other micro-organisms. Bacteria decompose these organic materials using dissolved oxygen, thus reducing the dissolved oxygen present for other aquatic organisms. Biochemical oxygen demand (hereafter as BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter within aerobic conditions. Biochemical oxygen demand in mg/L is usually determined by incubating a sealed sample of water for five days and measuring the loss of oxygen from the beginning to the end of the test. The main function of sewage and wastewater treatment plants is to reduce levels of BOD in the effluent that is discharged into natural waters.

4.4. Chemical Oxygen Demand

Chemical oxygen demand (hereafter as COD) is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. Measurements of COD include measures of BOD in addition to the used of oxygen by pollutant compounds. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days.

4.5. pH

pH is a measure of the amount of free hydrogen ions in water. Specifically, pH is the negative logarithm of the molar concentration of hydrogen ions devised by the following equation:

$$pH = -\log[H^+] \qquad [1]$$

In layman’s terms it is referred to as the measure of either acidity (pH 0-6) or alkalinity (8-14) within a sample of water, with pH 7 referred to as the pH of ‘pure’ water. In general, humans can consume liquids that fall within a wide range of pH. Aquatic organisms that permanently live within water are particularly sensitive to sudden or graduated changes in pH. Decreasing levels of pH into acidic conditions can also cause complications with the mobility of other pollutants including heavy metals.

4.6. Turbidity

Turbidity is an indicator of the quantity of matter suspended within a water sample. This can be organic (e.g. microbes, plankton, plant and animal detritus) and inorganic (e.g. silts, clays and sands). It is determined by the amount of light that is scattered or absorbed by a sample, or the level of transparency a water sample possesses. This is roughly, but not always, related to the concentration of total suspended solids within water. It was traditionally measured using Formazine Turbidity Units (FTU), but is now commonly measured by Formazine Attenuation Units (FAU) and Nephlometric Turbidity Units (NTU). Turbidity can be an indicator of water quality problems such as erosion, the transport of contaminant particles (e.g. heavy metals), excessive growth of micro-organisms (e.g. algal blooms) and the reduction of light wavelengths into the water that are required for photosynthesis. Generally, most people consider very turbid water ‘unclean’, aesthetically displeasing and unsuitable for consumption.

4.7. Faecal and total coliforms

Faecal coliforms are found within the digestive systems of warm-blooded animals and are passed into the environment through animal faecal waste. Faecal coliform bacteria do not cause disease themselves, but they are used as an indicator for the presence of other disease causing pathogens in the aquatic environment. Faecal coliforms from human and animal wastes can be transported or seeped into streams and rivers from faulty septic tanks, faulty sewage treatment plants, untreated or incompletely treated sewage effluent, agricultural wastes and domestic pets. Faecal coliform tests are usually typified by the presence and absence of *Escherichia coli* colonies within water and food samples.

Other coliform bacteria can be included with counts of faecal coliforms to produce a ‘total coliform’ count. Coliform bacteria are described as rod-shaped gram-negative bacteria that are usually found within the environment. Coliform genera include *Citrobacter, Enterobacter, Escherichia, Hafnia, Klebsiella, Pseudomonas, Salmonella* and *Serratia.* Total coliform counts are used as a general indicator of sanitary conditions within many industries, including food-processing, water supply and leisure recreation.

Coliform colonies are normally reported Colony Forming Units (CFU) per 100 ml.

4.8. Water temperature

The temperature of water is a physical parameter that can vary considerably over time and between places. Within static or lentic waterbodies such as lakes and ponds temperature regimes do not usually change rapidly over time, so temperature regimes that change seasonally or with depth can be analysed easily. The temperature of ephemeral or lotic surface waters such as streams and rivers is more problematic and is usually governed by a number of processes. Streams and rivers that drain from aquifers usually possess very stable temperature regimes throughout an annual cycle. Large rivers and watercourses with culverted or channelised courses (e.g. urban streams) can possess highly variable temperatures. In addition to this, water draining into water courses from sewages treatment plants as well as domestic and commercial sources can cause variation in the water temperatures within a water course. However, this is very hard to assess over the short-term, with long-term datasets providing greater insight into possible causes and impacts.

Aquatic organisms from temperate regions such as Europe and in particular the UK are sensitive to rapid changes in temperature gradients, and normally require water temperatures below 20^{o}C with 8-10^{o}C usually being an optimum for most species. The level of dissolved oxygen within water is temperature dependant, and therefore it is important to know what the long-term variances of temperature are within a watercourse.

4.9. Conductivity and total dissolved solids

Conductivity is the ability of a substance to conduct electricity. The conductivity of water is a more-or-less linear function of the concentration of dissolved ions. Conductivity itself is not a human or aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problems. If the conductivity of a stream suddenly increases, it indicates that there is a source of dissolved ions nearby. Conductivity measurements may be used as a quick way to locate potential water quality problems when no other tests are available.

All natural waters contain some dissolved solids due to the dissolution and weathering of rock and soil. Many but not all dissolved solids act as conductors and contribute to conductance. Waters with high total dissolved solids (hereafter TDS) are unpalatable and potentially unhealthy. Water treatment plants use flocculants to aggregate suspended and dissolved solids into particles large enough to settle out of the water column in settling tanks.

5. Methods of sample collection

The number of samples to be taken on the River Lee and its tributaries was designed in coordination with staff at Thames21 who included some sites that were of interest[1]. An Ordnance Survey map (1:25,000) was used to determine possible sampling sites for the River Lee and each tributary stream. Following this consultative process Thames21 staff and volunteers conducted site reconnaissance visits to determine the best locations for sampling sites on the River Lee and its tributaries based on practicality and accessibility. The distribution of sample sites is outlined in Figure 3.1, and a list of the sites analysed can be found in the **Appendix**.

The sampling of water was undertaken by Thames21 staff and volunteers following some additional equipment and field training by G. Davies. Additional training included the use of some field meters and instructions of how to obtain the best representative water sample at a site.

Representative samples were taken from accessible points on each watercourse. Samples were retrieved from the middle of the channel at 0.5D. A retractable grab sampler was occasionally used to obtain samples from the bankside to ease sampling protocol on larger river cross-sections. Water samples were decanted into labelled 500 ml plastic containers with screw top lids. Sample bottles were 'washed-out' three times prior to a sample being taken. Samples were kept in a chill bag and transported back to the Thames21 Bow Locks laboratory at Three Mills, London immediately after being sampled.

6. Analysis of parameters in the field

Site measurements of water temperature, conductivity, TDS and pH were taken using a Hanna HI98129 probe. Dissolved oxygen concentrations (mg/L) and saturation (%) within the water column was measured using a Jenway 970 Portable DO_2 Meter.

[1] Turkey Brook and Quinton Hill Brook were excluded from this investigation by discretion of Thames21.

7. Analysis of parameters in the laboratory

Retained water samples were taken back to the laboratory and analysed as soon as possible on the day, or no more than 24 hours afterwards. The concentration of nitrate (NO_3^--N), reactive phosphate (or orthophosphate, PO_4^{3-}), COD and values of turbidity were measured using a Hach DR2010 spectrophotometer.

Nitrate concentrations (mg/L) within samples were determined through a cadmium reduction method using Hach NitraVers V powder pillows. Reactive phosphate concentrations (mg/L) were determined using the Hach 'amino acid' method. Values of COD in mg/L were determined using the Hach 'Test'N Tube' (TNT) digestion (dichromate) method. The turbidity of water samples was determined using the Hach 'absorbtometric' method and reported as Formazine Attenuation Units (FAU). Links to all three methods can be found within the **Appendix** section.

BOD was also measured in addition to the above analyses. This involved filling the entire volume of a 25 ml glass vial with a sub-sample of each water sample. Samples were then sealed, placed in the dark and left at room temperature for 5 days. Values of BOD are determined by subtracting the initial measurement of dissolved oxygen concentration (mg/L) by the resulting concentration of dissolved oxygen after the 5 day period.

Faecal coliform and total coliform counts were conducted using Millipore paddle samplers. Faecal and total coliform paddle sampler mediums was inoculated using 18 ml of water sample, these was then incubated in a Millipore incubator for 24 and 48 hours respectively at 35 ^{o}C. After incubation the numbers of bacterial colonies present on each paddle are counted by eye with result expressed as the number of colonies per 100 ml. Further information regarding Millipore Paddle samplers can be found in the **Appendix** section.

8. Assessing water quality and classifications

Water quality was assessed using recognised and comparable parameters for surface waters, and the UK and EU Water Framework Directive (WFD) classifications. These are illustrated in Table 8.1.

Table 8.1 – A table of the water quality parameters used within the investigation together with their appropriate criteria and classification scales. There are no applicable classification scales available for total dissolved solids or water temperature. The source for each classification is also given. The European Union Water Framework Directive does not actually stipulate a classification for turbidity as a parameter. The classification values for turbidity in this report are conversions from a classification scale for total suspended solids (mg/L), which is included within the Water Framework Directive. Total suspended solids and turbidity share a strong linear relationship within most watercourses.

Parameter	Values and classifications for parameters						Source of Classification
Biochemical Oxygen Demand (mg/L)	2.5 Very Good	4 Good	6 Fairly Good	8 Fair	15 Poor		EA General Quality Assessment (GQA) scheme
Chemical Oxygen Demand (mg/L)	5.88 High	7.35 Good	9.55 Moderate	13.23 Poor			Protection of Surface Waters Intended for the Abstraction of Drinking Water now Water Framework Directive (2000/60/EC)
Dissolved Oxygen (% saturation)	≤20 Bad	20-49 Poor	50-59 Fair	60-69 Fairly Good	70-79 Good	≥80 Very Good	EA General Quality Assessment (GQA) scheme
Reactive phosphorus (orthophosphate) (mg/L)	0.02 Very Low	0.06 Low	0.1 Moderate	0.2 High	1 Very High	>1 Excessively High	Water Framework Directive, 2000/60/EC
Nitrate (mg/L)	5 Very Low	10 Low	20 Moderate	30 High	40 Very High	>40 Excessively High	Water Framework Directive, 2000/60/EC
pH	<6 Too Low	≥6 - ≤9 Good				>9 Too High	Freshwater Fish Directive, 78/659/EEC
Total coliforms (CFU)	≤500 Guideline	≤10000 Imperative	>10000 Over Imperative				EC Bathing Water Directive, 76/160/EEC and its proposed revision
Faecal coliforms (CFU)	≤100 Guideline	≤2000 Imperative	>2000 Over Imperative				EC Bathing Water Directive, 76/160/EEC and its proposed revision
Turbidity freshwaters (FTU)	<3 Clear	3 < 29 Intermediate	29 - 88 Medium turbidy	>88 Very Turbid			Water Framework Directive, 2000/60/EC
Total Dissolved Solids (mg/L)	Not Accessed						-
Temperature of water °C	Not Accessed						-

9. Assuring 'reference' flow conditions

Samples were taken during a seven day period of clear weather with little or absent precipitation. During the sampling period light precipitation did occur but this was deemed not sufficient enough to impact the results of the investigation. Reference flow conditions were observed using the daily river and sea level data on the Environment Agency website for the Thames area, the results of which can be seen in Table 9.1.

Table 9.1 – The water level taken at 9 am for each watercourse within the London River Lee investigation area on the date specified together with the usual range for water level within each watercourse. Source: (http://www.environment-agency.gov.uk/homeandleisure/floods/riverlevels/120557.aspx).

Site	Usual range (m)	23/11/2011	24/11/2011	25/11/2011	26/11/2011	27/11/2011	28/11/2011	29/11/2011	30/11/2011
		Water Level (m)							
Lee, Lea Bridge	5.78-6.10	5.79	5.79	5.79	5.79	5.79	5.79	5.80	5.80
Lee (Lower) Walthamstow, Low Hall	0.01-1.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
Ching, Walthamstow	0.93-2.10	1.25	1.11	1.03	1.11	0.92	1.22	0.89	1.15
Ching, Chingford	0.15-0.75	0.16	0.16	0.16	0.16	0.16	0.15	0.16	0.16
Pymmes Brook, Silver Street	0.04-1.30	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Pymmes Brook, Arnos Park	2.51-2.70	2.51	2.51	2.54	2.51	2.55	2.54	2.57	2.55
Pymmes Brook, New Barnet	0.02-0.90	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.13
Salmon Brook, Edmonton	0.07-0.60	0.07	0.07	0.07	0.07	0.06	0.06	0.07	0.06
Salmon Brook, Enfield	0.95-1.10	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Turkey Brook, Bulls Cross	0.31-0.96	0.44	0.42	0.40	0.40	0.39	0.40	0.40	0.41
Turkey Brook, Albany Park	0.05-1.10	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06
Small River Lee, Enfield	0.11-1.10	0.11	0.11	0.13	0.11	0.15	0.17	0.15	0.14
Cobbins Brook, Stewardstone Road	0.07-1.00	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Cobbins Brook, Waltham Abbey	0.03-1.48	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05

10. Constraints of the report

The results of this pilot investigation are intentionally limited in the sense that they cannot provide temporal variability of the measured parameters at each site. Furthermore, no replicate measurements or samples were taken at each sample site. This was also done intentionally as the main objective of the investigation was to observe and compare the difference in water quality parameters geographically within the same relative timeframe at reference conditions of flow. The results within this investigation do not account for the ephemeral nature of the watercourses and the variability of water quality parameters during spates, 'high' or above reference flow conditions.

11. Results

11.1. Nitrate

Concentrations of nitrate within water samples were between ‘excessively low’ (≤5 mg/L) and ‘moderate’ (11-20 mg/L) on the European Union Water Framework Directive (2000/60/EC) classification scale (Figure 11.1). Sites on the River Lee possessed concentrations of nitrate between 2 mg/L (very low) and 11.9 mg/L (moderate). Values of nitrate on all sample sites of the Dagenham Brook and The Ching were ‘very low’ (≤5 mg/L). The Dagenham Brook possessed the least mean nitrate concentration in water samples of 2.3 ± 1.8 mg/L. The least nitrate concentrations measured during the investigation were 0.6 mg/L at the North Access Road site on the Dagenham Brook, and at the Pymmes Pond Park on the Pymmes Brook. All other sites within the investigation were ≥1 mg/L of nitrate within their water samples.

Sites where nitrate concentrations were noticeably higher (>10 mg/L) included the first two sites on Moselle Brook and Salmons Brook in addition to the last site on the Pymmes Brook (the confluence between the Pymmes Brook and the River Lee) and site 6 on the River Lee (Prescott Channel). Even though these six sites are conspicuous when compared between the other sites in the investigation they are still not excessively high in nitrate concentrations when compared with the WFD classifications. The Moselle Brook possessed the greatest mean value of nitrate concentration within the investigation of 9.6 ± 6.1 mg/L.

A Kruskal-Wallis one-way test was used to further compare nitrate concentration between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was no significant statistical difference in nitrate concentration between the different watercourses in the investigation (***P*** = 0.06).

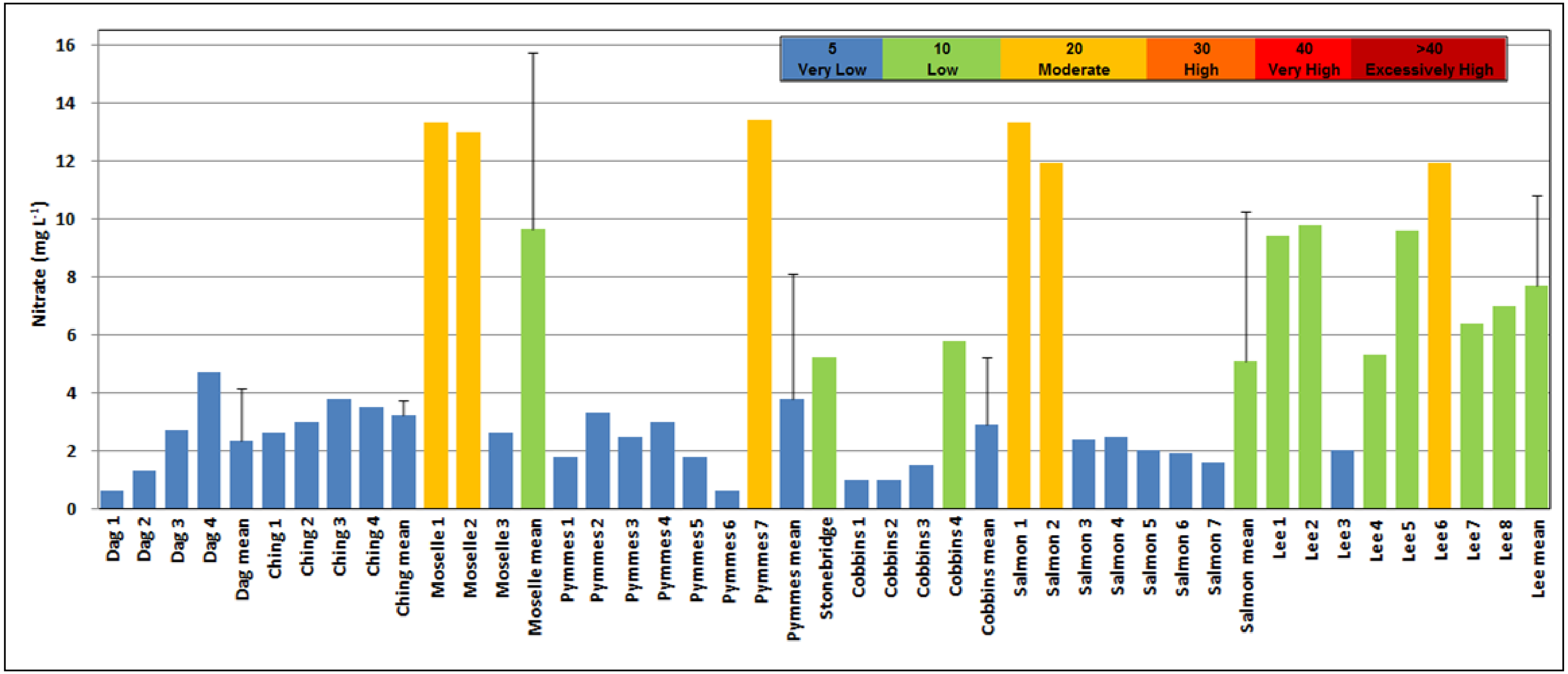

Figure 11.1 – Concentrations of nitrate (mg/L) determined at each sample site within the investigation. The mean value of nitrate concentration for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the European Union Water Framework Directive (2000/60/EC).

11.2. Reactive phosphate

The concentration of reactive phosphate within water samples were between ‘high’ (0.2-1.0 mg/L) and ‘excessively high’ (≥1 mg/L) according to the European Union Water Framework Directive (2000/60/EC) classification scale. All sites on the River Lee were ‘excessively high’ for reactive phosphate between 5.07 mg/L and 15.75 mg/L. Only the first sample site on the Pymmes Brook (Baring Road/Fordham Road) and the second site on Cobbins Brook (Upshire at Cobbinsend Road) were observed to be ‘high’ in phosphate concentration (0.2-1.0 mg/L), with Upshire at Cobbinsend Road possessing the least reactive phosphate concentration in the dataset at 0.56 mg/L. All other samples were found to possess significantly higher concentrations of phosphate (>1.0 mg/L). The Ching had the least mean value of reactive phosphate concentration at 3.17 ± 0.56 mg/L.

Seven sample sites possessed noticeably greater concentrations (>12 mg/L) of reactive phosphorus (Figure 11.2). The greatest concentration found within a single sample was 15.75 mg/L which was observed at the site downstream of the confluence between the Hertford Union Canal and the River Lee Navigation. Second to this were the first two sites on the Moselle Brook and Salmons Brook which possessed reactive phosphate concentrations of ≥14 mg/L. The waterway with the greatest mean value of reactive phosphate concentration was the Moselle Brook with 11.08 ± 5.15 mg/L.

A Kruskal-Wallis one-way test was used to further compare reactive phosphate concentration between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was a highly significant statistical difference in reactive phosphate concentration between the different watercourses in the investigation ($P = 0.01$).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were significant statistical differences in reactive phosphate concentration between the River Lee and Cobbins Brook ($P < 0.01$), the River Lee and Pymmes Brook ($P = 0.02$), the River Lee and The Ching ($P < 0.01$) in addition to a statistical difference being found between Pymmes Brook and the Moselle Brook ($P = 0.04$).

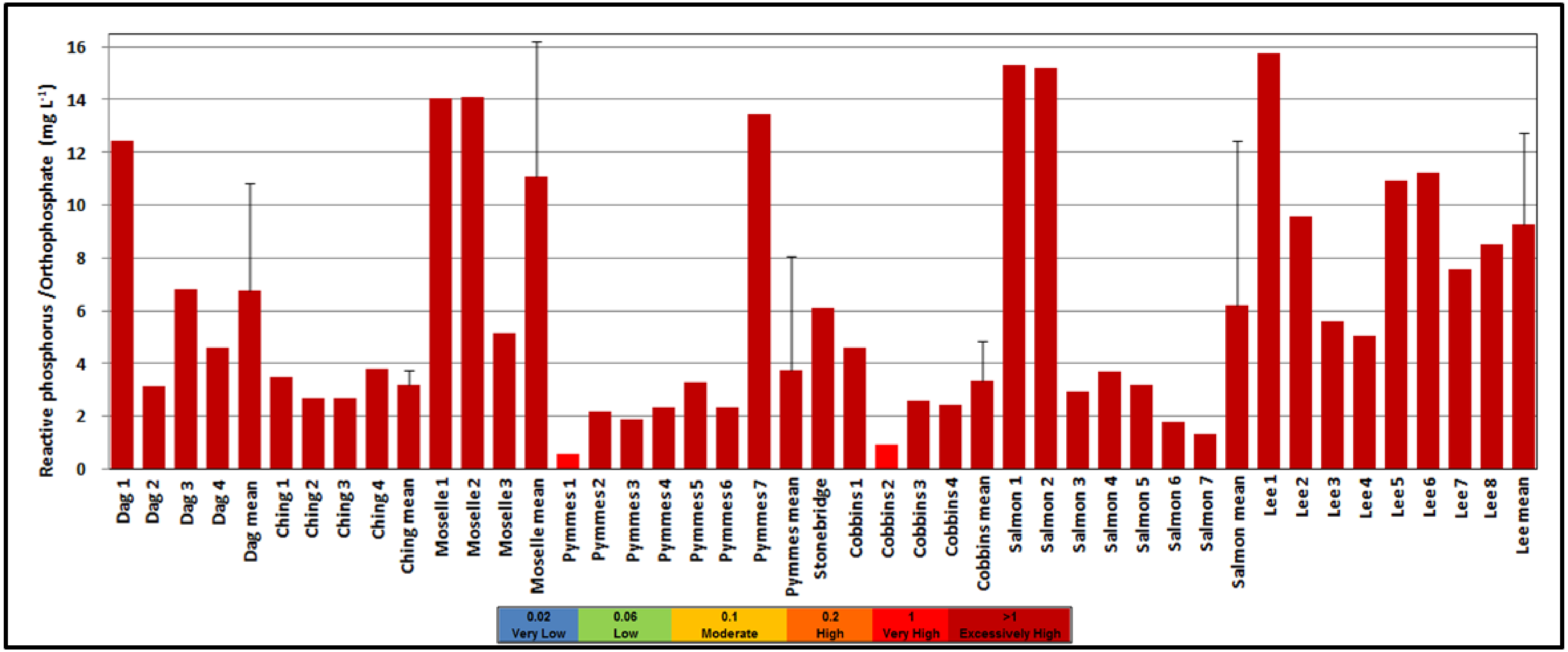

Figure 11.2 – Concentrations of reactive phosphate (mg/L) determined at each sample site within the investigation. The mean value of reactive phosphate concentration for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the European Union Water Framework Directive (2000/60/EC).

11.3. Dissolved oxygen

The percentage saturation of dissolved oxygen within samples were between ‘poor’ (≤20 %) and ‘very good’ (80 %) according to the Environment Agency General Quality Assessment (GQA) scheme (Figure 11.3). Samples on the River Lee ranged between 50 % (fair) and 69 % (fairly good).The single site with ‘poor’ dissolved oxygen was site 3 on the Moselle Brook at Tottenham Cemetery with 14 %. The majority of other sites within the investigation possessed between 21 % (bad) and 68 % (fairly good) dissolved oxygen, with seventeen of the thirty-nine sites (44 % of sites) possessing ‘bad’ levels percentage dissolved oxygen (21-50 %).The waterway with the least mean % dissolved oxygen was the Moselle Brook with 31 ± 17 % dissolved oxygen.

The first sample site on the Pymmes Brook (Baring Road/Fordham Road) was the single site with ‘good’ % dissolved oxygen within the water column at 76 %. The other two sites with ‘very good’ % dissolved oxygen within the water column were site 2 and 3 on Cobbins Brook which was at 92 and 91 % respectively. The waterway with the greatest mean % dissolved oxygen was Cobbins Brook with 66 ± 21 %.

A Kruskal-Wallis one-way test was used to further compare the percentage saturation of dissolved oxygen between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. Values were transformed into arc-sine values prior to statistical analyses. The analysis found that there was a highly significant statistical difference in the percentage saturation of dissolved oxygen between the different watercourses in the investigation (P <0.01).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were significant statistical differences in % saturation of dissolved oxygen between the River Lee and Dagenham Brook (P = 0.03), the River Lee and Pymmes Brook (P = 0.02), the River Lee and Moselle Brook (P = 0.02), the River Lee and Salmons Brook (P <0.01) in addition to a statistical difference being found between Salmons Brook and The Ching (P <0.01) and also between Salmons Brook and Cobbins Brook (P = 0.03).

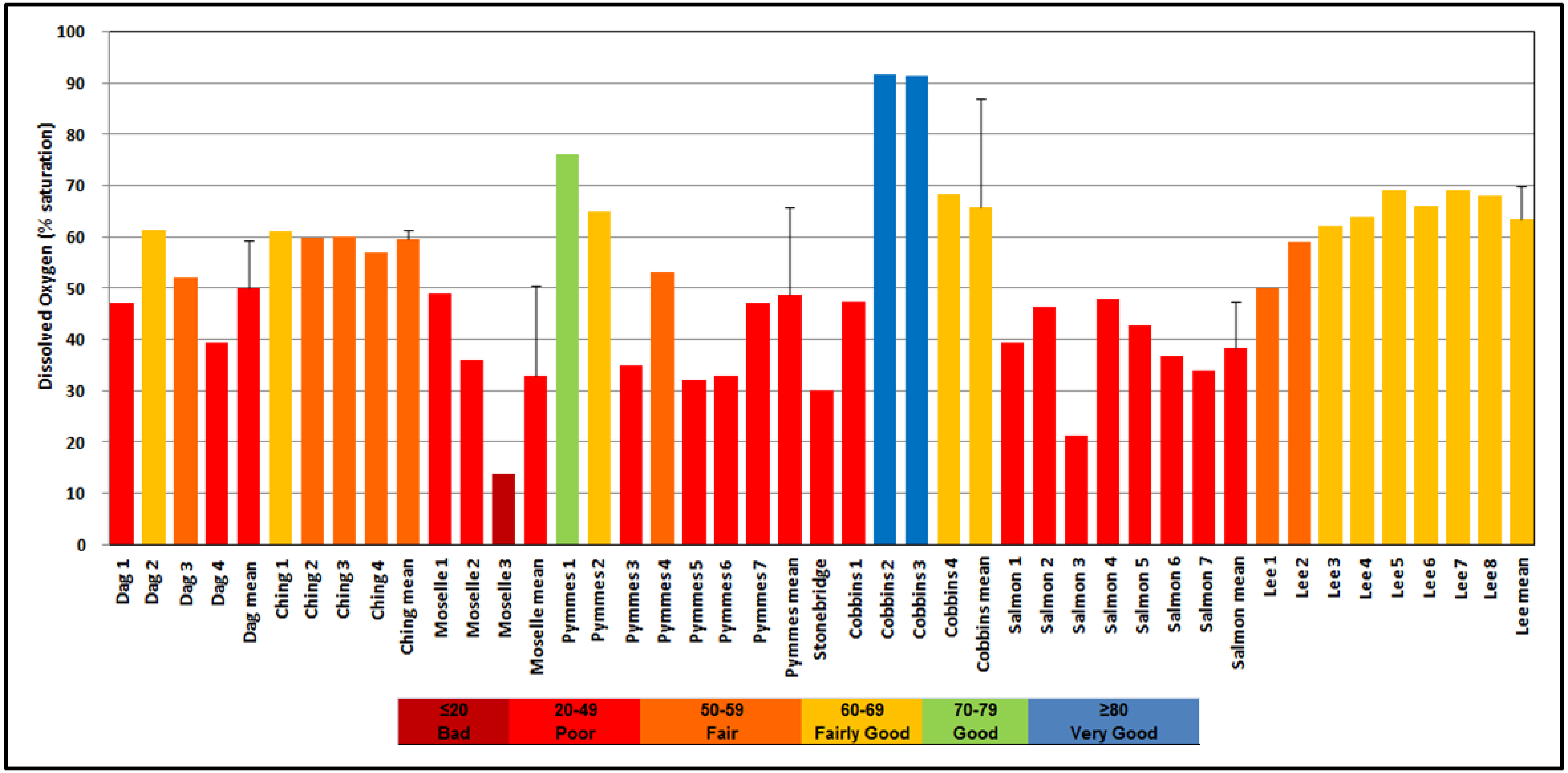

Figure 11.3 – Values for dissolved oxygen saturation (%) determined at each sample site within the investigation. The mean value of dissolved oxygen saturation for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the Environment Agency General Quality Assessment (GQA) scheme.

11.4. Biochemical oxygen demand (BOD)

Values of BOD (mg/L) within samples ranged between ‘very good’ and ‘fair’ according to the Environment Agency General Quality Assessment (GQA) scheme (Figure 11.4). Sites on the River Lee ranged from 2.14 mg/L (very good) to 4.81 mg/L (fairly good). Eleven of the sites (29 %) measured were within the ‘very good’ category between 0.09 mg/L and 4.43 mg/L, while eleven sites (29 %) were within the ‘good’ category between 2.67 mg/L and 3.89 mg/L. Twelve of the sites within the investigation (31 %) were within the ‘fairly good’ category between 4.04 mg/L and 6 mg/L, and four sites (11 %) were within the fair category between 6.04 mg/L and 7.06 mg/L.

All sites on the The Ching and the Moselle Brook were within the very good BOD category. The waterway with the least mean value of BOD was the Ching with 0.94 ± 0.52 mg/L while the waterway with the greatest was Cobbins Brook with 5.75 ± 1.06 mg/L. The site with the least BOD value was the first site on the Dagenham Brook (North Access Road) with 0.09 mg/L, while the site with the greatest value of BOD was Stonebridge Brook with 7.06 mg/L.

A Kruskal-Wallis one-way test was used to further compare values of BOD between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was a highly significant statistical difference in BOD values between the different watercourses in the investigation ($\boldsymbol{P}$ <0.001).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were statistically significant differences between the River Lee and all other watercourses for values of BOD, with the exception of the Pymmes Brook and Salmons Brook. The Ching and Dagenham Brook had significant statistical differences in the values of BOD with all watercourses with the exception of each other and the Moselle Brook. Furthermore, values of BOD on the Moselle Brook were not significantly different with those from Cobbins Brook.

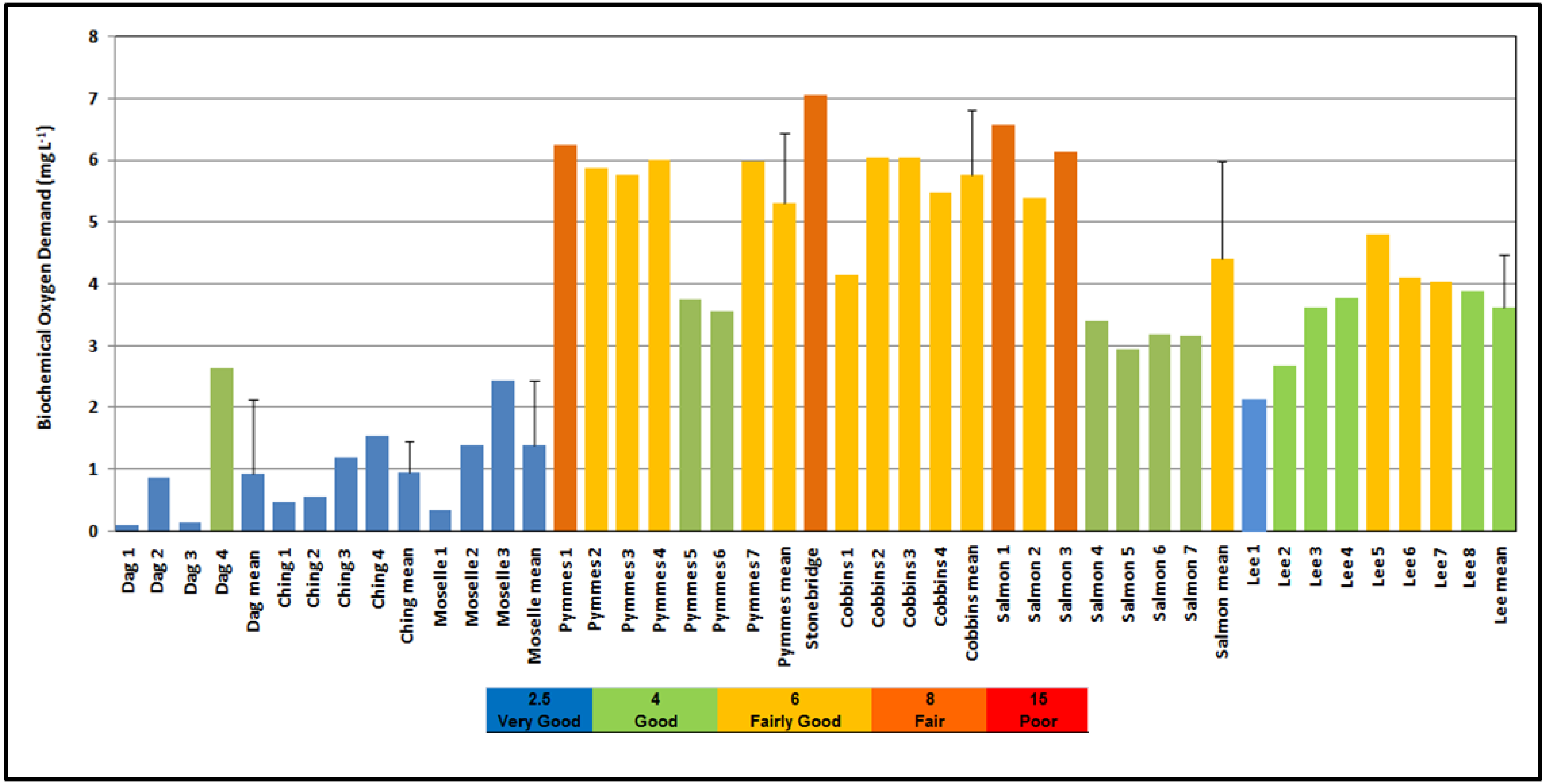

Figure 11.4 – Values of biochemical oxygen demand (BOD) (mg/L) determined at each sample site within the investigation. The mean value of BOD for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the Environment Agency General Quality Assessment (GQA) scheme.

11.5. Chemical oxygen demand (COD)

Values of COD (mg/L) within all samples fell within the ‘poor’ category according to the classification taken from the European Union Water Framework Directive (2000/60/EC) (Figure 11.5). Sites on the River Lee varied between 14 mg/L to 55 mg/L for COD. The greatest value of COD within the investigation was 236 mg/L which came from site 4 (outfall site) on the Dagenham Brook. The waterway with the greatest mean value for COD was the Dagenham Brook with 137 ± 93 mg/L, while the waterway with the least mean value for COD was the Ching with 23 ± 5 mg/L. The site in the investigation with the least value of COD was the confluence of the River Lee with the Hertford Union Canal with 14 mg/L.

A Kruskal-Wallis one-way test was used to further compare values of COD between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was a highly significant statistical difference in COD values between the different watercourses in the investigation (***P*** = 0.04).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were statistically significant differences in values of COD between the Dagenham Brook and the River Lee (***P*** = 0.04), between Dagenham Brook and the Ching (***P*** = 0.03), between Dagenham Brook and Pymmes Brook (***P*** = 0.01), and between Salmons Brook and Pymmes Brook (***P*** = 0.04).

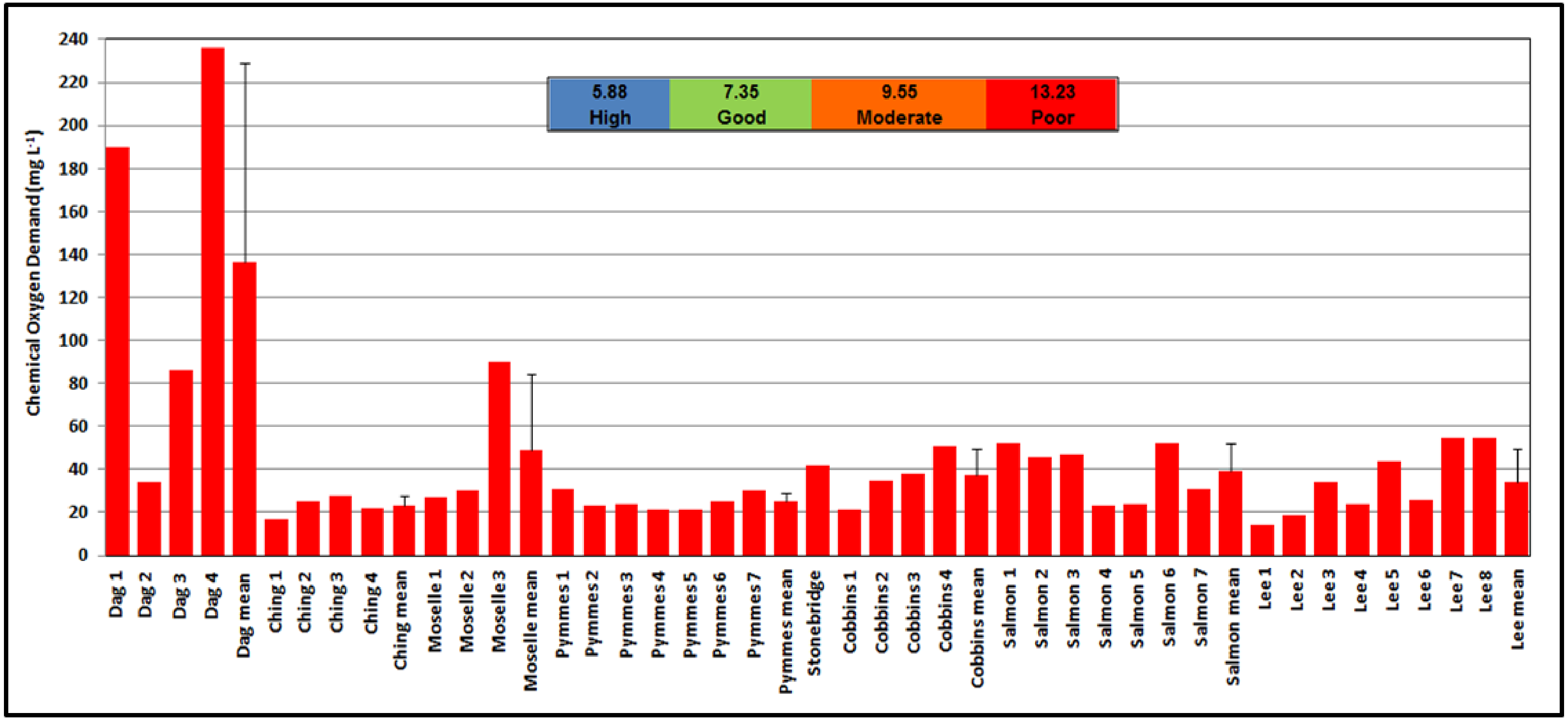

Figure 11.5 - Values of chemical oxygen demand (COD) (mg/L) determined at each sample site within the investigation. The mean value of COD for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the Protection of Surface Waters Intended for the Abstraction of Drinking Water, now Water Framework Directive (2000/60/EC).

11.6. pH

All of the pH values for water samples were within the ‘good’ category according to the European Union Council Directive Freshwater Fish Directive (Figure 11.6). Sites on the River Lee possessed pH values between pH 7.76 and 7.88. The Moselle Brook possessed the least mean pH value in its water samples of pH 7.55 ± 0.23. The least pH value measured during the investigation was pH 7.41 at the Tottenham Lock on the Moselle Brook. The Salmons Brook possessed the greatest mean value pH within the investigation of pH 8.06 ± 0.49. The greatest pH value in the investigation of pH 8.95 came from Salmons Brook at Slade Rise.

A Kruskal-Wallis one-way test was used to further compare pH values between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was no significant statistical difference in pH values between the different watercourses in the investigation ($\boldsymbol{P} = 0.05$).

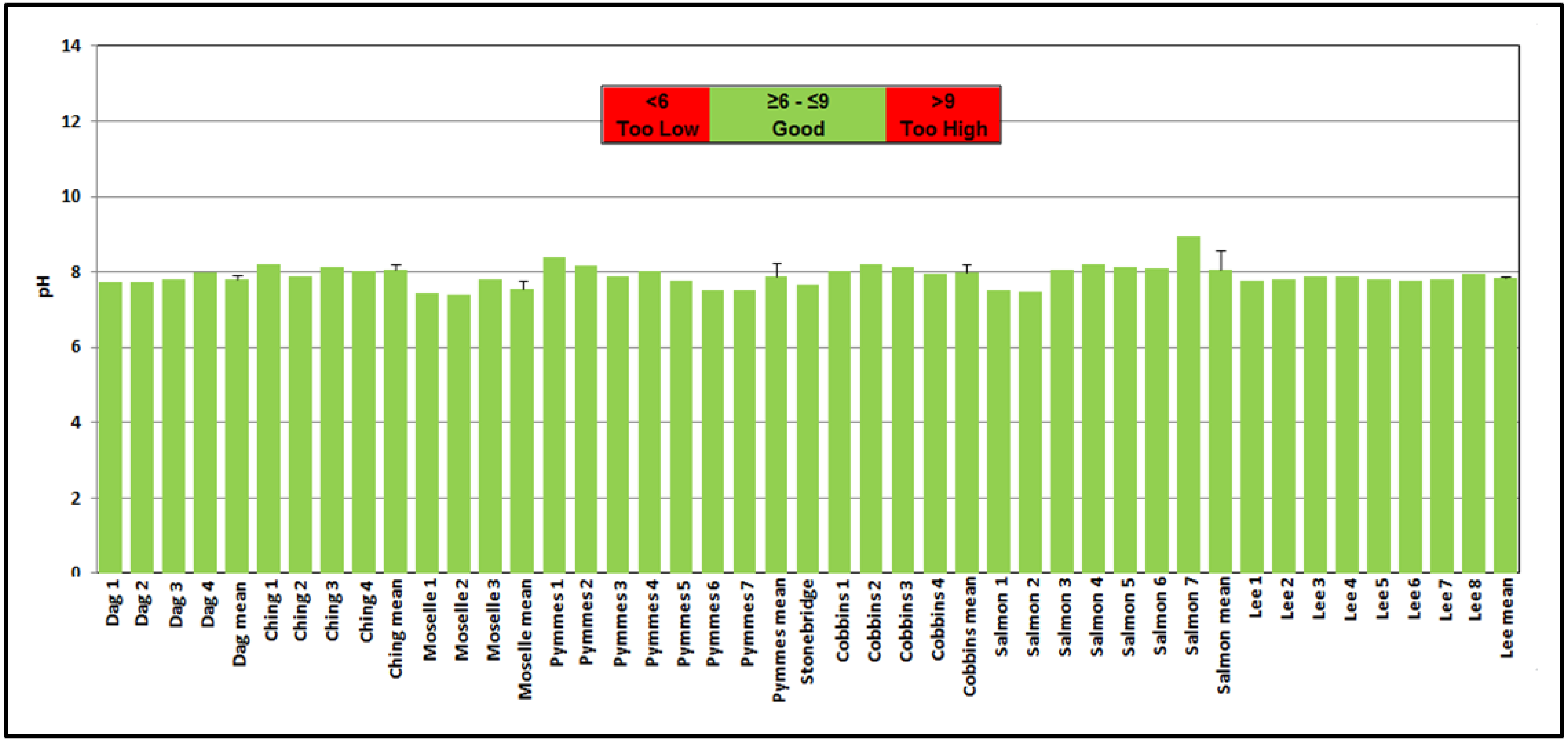

Figure 11.6 - Values of pH which were determined for each sample site within the investigation. The mean value of pH for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the Freshwater Fish Directive, 78/659/EEC.

11.7. Turbidity

Turbidity within samples ranged between 1 FAU (clear) and 258 (very turbid) FAU according to the European Union Water Framework Directive (2000/60/EC) (Figure 11.7)[2]. Sampled sites on the River Lee varied between 17 FAU (intermediate) and 258 FAU (very turbid). Only six sites (16 %) within the investigation possessed 'clear' values for turbidity. The majority of sites (58 %) possessed intermediate values for turbidity, while four sites (10 %) possessed medium turbidity and six sites (16 %) possessed 'very turbid' values of turbidity.

All samples taken from the Ching, Pymmes Brook, Stonebridge Brook and Cobbins Brook possessed turbidity that was 'clear' to 'intermediate'. Samples with the least values of FAU included site 2 (Victoria Recreation Ground) on the Pymmes Brook, sites 1 and 2 (Haley's Farm and Cobbinsend Road) on Cobbins Brook as well as sites 2, 4 and 5 (south of the confluence Deephams STW, Churchfield and Blakeswane Gardens respectively) on Salmons Brook. Cobbins Brook was found to possess the least mean value of turbidity at 6.2 ± 2 FAU. The Dagenham Brook possessed some of the greatest values of turbidity and possessed the greatest mean value of turbidity at 105 ± 103 FAU. Both site 1 (North Access Road) on the Dagenham Brook and site 3 (Bow Backs River by the A12) on the River Lee had the greatest values of turbidity in the investigation of 258 FAU.

A Kruskal-Wallis one-way test was used to further evaluate values of turbidity between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found that there was a highly significant statistical difference in values of turbidity between the different watercourses in the investigation ($\boldsymbol{P} = 0.001$).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were statistically significant differences for values of turbidity between the River Lee and the Ching ($\boldsymbol{P} < 0.01$), between the River Lee and Pymmes Brook ($\boldsymbol{P} = 0.03$), between the River Lee and Cobbins Brook ($\boldsymbol{P} < 0.01$) and between the River Lee and Salmons Brook ($\boldsymbol{P} < 0.01$). Additionally, turbidity samples from the Dagenham Brook were also significantly different to

[2] The European Union Water Framework Directive does not actually stipulate a classification for turbidity as a parameter. The classification values for turbidity in this report are conversions from a classification scale for total suspended solids (mg/L), which is included within the Water Framework Directive. Total suspended solids and turbidity share a strong linear relationship within most watercourses.

those from Salmons Brook (***P*** = 0.03), Cobbins Brook (***P*** = 0.03), Pymmes Brook (***P*** = 0.01) and the Ching (***P*** = 0.03). There was also a statistically significant difference in turbidity values between the the Ching and Cobbins Brook (***P*** = 0.04).

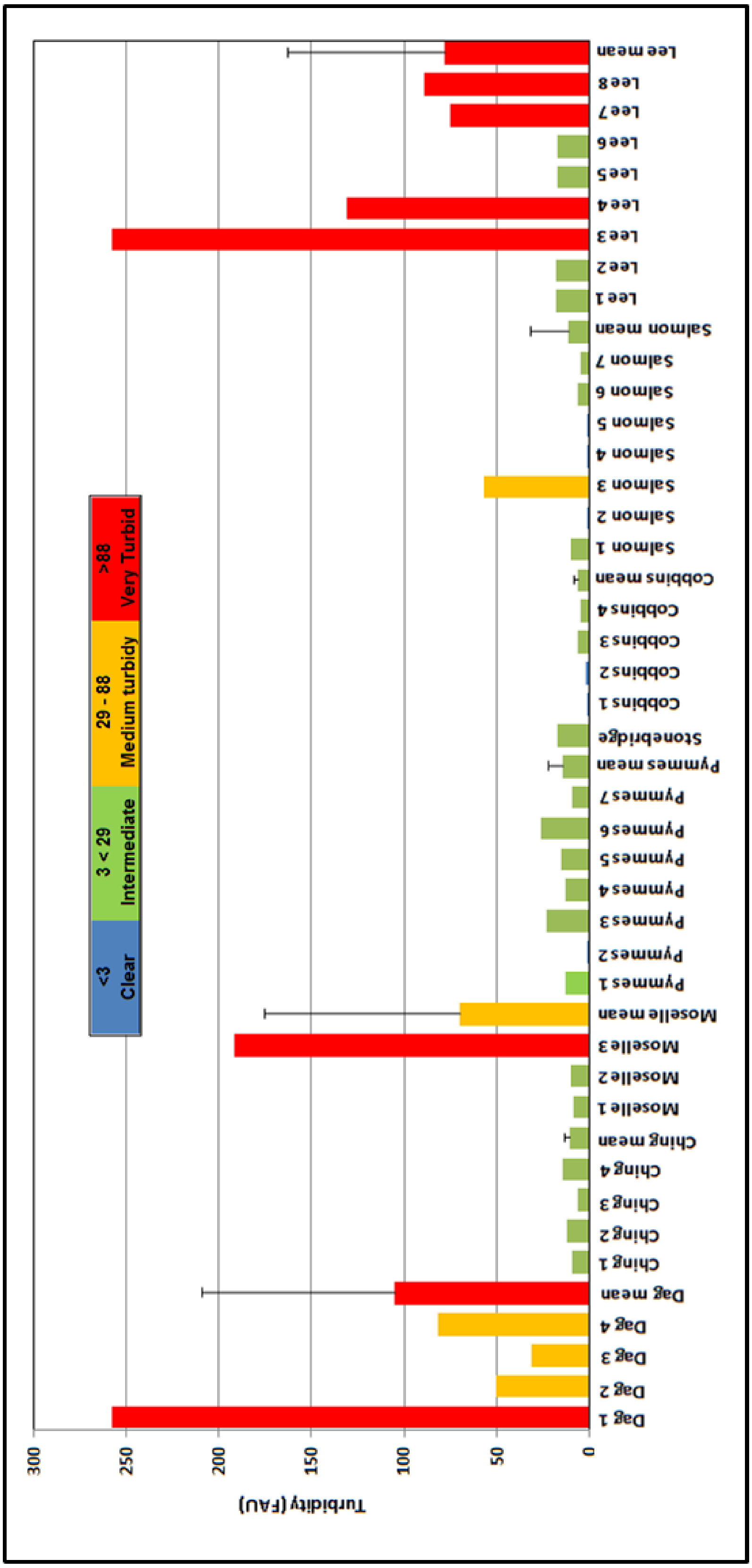

Figure 11.7 - Values for turbidity (FAU) which were determined for each sample site within the investigation. The mean value of turbidity for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the European Union Water Framework Directive (2000/60/EC).

11.8. Faecal coliforms

Faecal coliforms were completely absent within seven of the sites (18 %) in this investigation. There were twelve sites (32 %) found to be between the 'guideline' and 'imperative' levels (≤2000 CTU per 100 ml), and the remainder of sites (50%) were over the set 'imperative' level (>2000 CTU per 100 ml) according to the European Community Bathing Water Directive 76/160/EEC (Figure 11.8). Faecal coliforms were only absent on one site of the River Lee (site 3 Bow Backs River), while five sites were between the guide and imperative level for faecal coliforms; and two sites were over the imperative level for counts of faecal coliforms. The waterway with the least mean number of faecal coliforms was the Dagenham Brook 125 ± 250 CTU, while the waterway with the greatest mean number of faecal coliforms was the Ching with 17950 ± 20450 CTU. Of all sites in the investigation there were three with conspicuous numbers of faecal coliforms. These were site 4 (Harbett Road) on the Ching, site 1 (Stonebridge Lock) on the Moselle Brook and site 1 (Hertford Union confluence) on the River Lee with 48600, 47800 and 47900 CTU respectively.

A Kruskal-Wallis one-way test was used to further analyse counts of faecal coliforms between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found there was a statistically significant difference in counts of faecal coliforms between the different watercourses in the investigation ($P = 0.04$).

Further post-hoc Mann-Whitney U-tests (See **Appendix**) revealed that there were statistically significant differences between the River Lee and the Dagenham Brook ($P = 0.04$) and also between the River Lee and the Ching ($P = 0.03$) for values of CTU for faecal coliforms. Counts of faecal coliforms on the Ching were statistically significant different from those on the Dagenham Brook ($P = 0.03$), Salmons Brook ($P = 0.04$), and Cobbins Brook ($P = 0.03$). There was also a significant statistical difference between Dagenham Brook and the Salmons Brook for counts of faecal coliforms ($P = 0.01$).

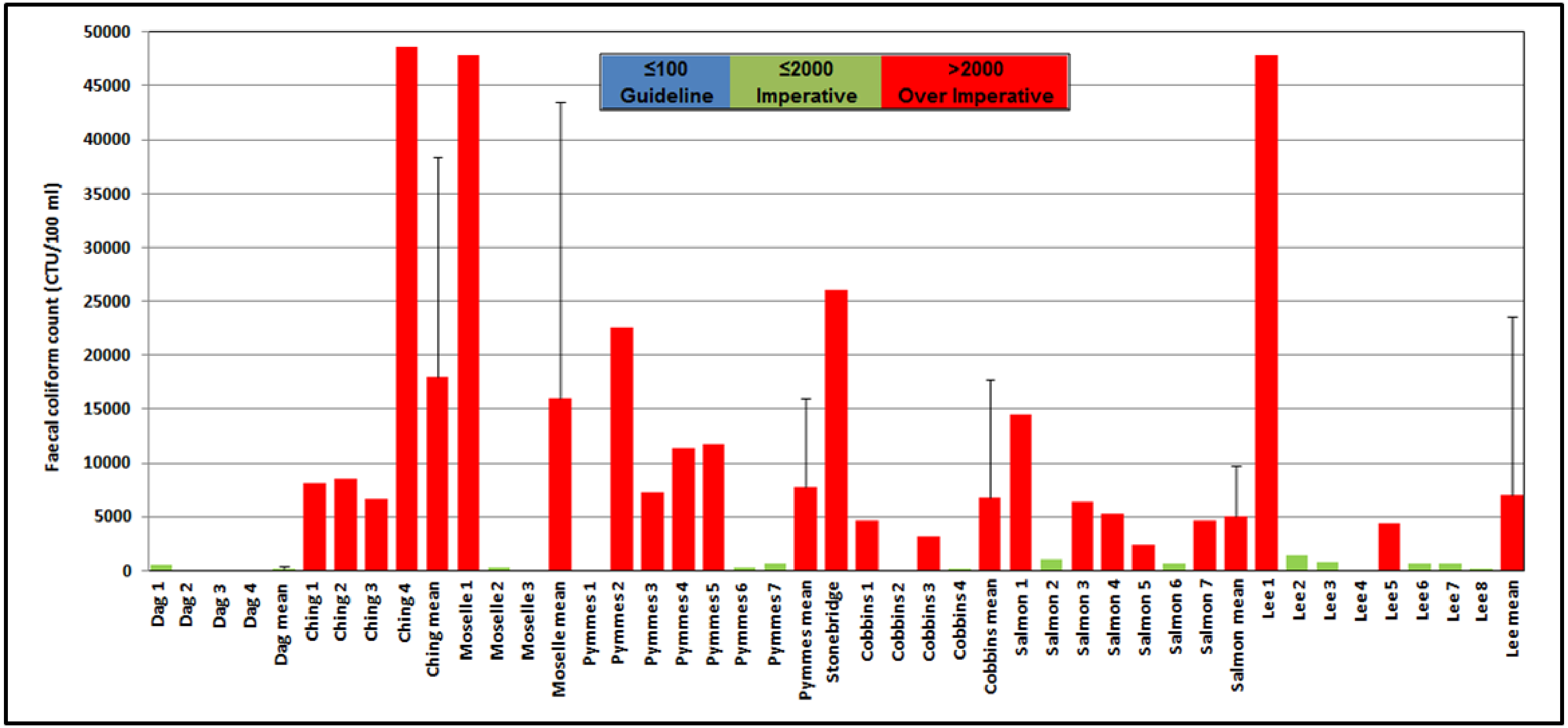

Figure 11.8 – Counts of faecal coliform colonies (CTU/100 ml) which were determined for each sample site within the investigation. The mean value of faecal coliforms for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the European Community Bathing Water Directive 76/160/EEC, and its proposed revision.

11.9. Total coliforms

Total coliforms were present in all water samples taken during the investigation. All samples were over the 'imperative' threshold (>10000 CTU) specified by the European Community Bathing Water Directive 76/160/EEC (Figure 11.9). Sites on the River Lee were between 21900 and 241100 CTU, site 5 (Waterworks River by Otter Close) possessed the least count of total coliforms for the whole dataset of 21900 CTU. The second sample site on the Dagenham Brook at Marsh Lane possessed the greatest total coliform count in the investigation of 720000 CTU. The waterway with the greatest mean count of total coliforms was the Dagenham Brook 463450 ± 320544 CTU, while the water with the least was the Moselle Brook 104333 ± 91471 CTU.

A Kruskal-Wallis one-way test was used to further compare total counts of coliforms between the seven different watercourses. Stonebridge brook was removed from the analysis as it is the only waterway with one sample or observation, and therefore it does not have sufficient replicate samples that can be used for the test. The analysis found there was no statistically significant difference in counts of total coliforms between the different watercourses in the investigation (P >0.05).

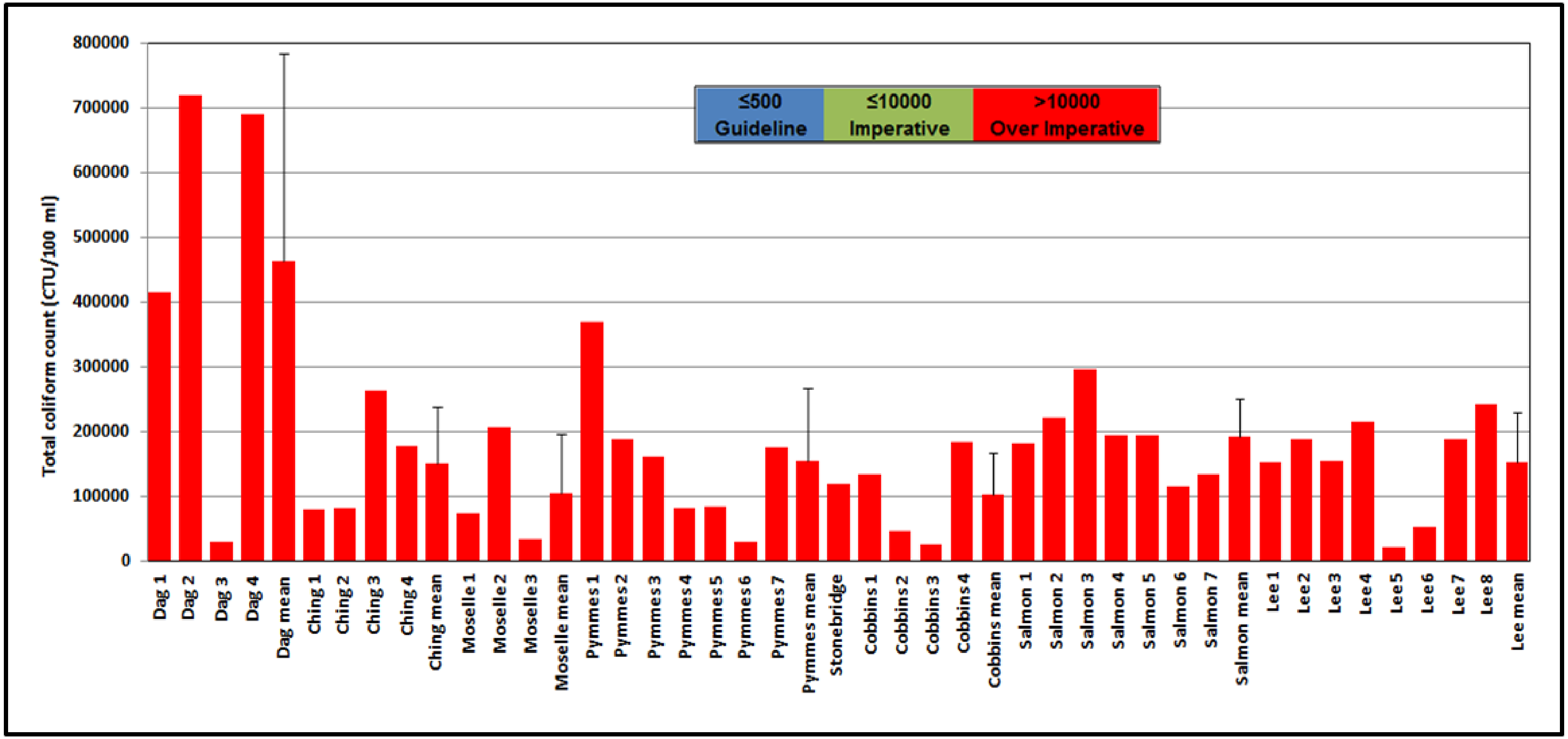

Figure 11.9 – Counts of total coliform colonies (CTU/100 ml) which were determined for each sample site within the investigation. The mean value of total coliforms for each watercourse is calculated from the concentration values of all samples sites along its length. Whiskers on the mean concentration bars indicate the standard deviation. The classification scale is taken from the European Community Bathing Water Directive 76/160/EEC, and its proposed revision.

11.10. Watercourses ranked by water quality index scores

A simple water quality index was used to assess the 'health' of each waterway and therefore give a comparison, the score weighting for each parameter is given in Table 11.1. It is possible to assess the 'health' of a waterway by assigning the mean value for each assessed parameter a point based on the weighting criteria outlined in Table 11.1. In the case of Stonebridge Brook the single value measured for each parameter is used instead of a mean value. The points from all assessed parameters are then summed together for an individual waterway to create the total number of points scored for that waterway. This score is then divided by the total number of available points that can be allocated. Within this investigation the total number of points that can be scored is 39. This can then be expressed as a percentage of the total number of points and ranked accordingly.

Table 11.2 compares the seven watercourses within this investigation ranked in order of the number of total points that they have been scored. The Ching was assessed to be the 'healthiest' waterway with 23 points or a score of 59 %. The average score between the watercourses within this investigation was 20 points or 51 %. The Moselle Brook, Pymmes Brook and River Lee were assessed to have average water quality or half of the optimum 'health' score, as they all individually scored 20 points or 51 %. Only the Dagenham Brook and Cobbins Brook had above average water quality at 21 and 22 points, or 54 and 56 % respectively. Salmons Brook was assessed to have below average water quality with 19 points or 49 %, while the waterway with the worst 'health' was Stonebridge Brook with 18 points or 46 %.

Table 11.1 – A table illustrating the classification points scale that was assigned to each water quality parameter within the water quality index that was used in this investigation. The least favourable or poorest values for each parameter receive the lowest points scored, with the point available being 1. While the most favourable or best values receive the highest points scored, with the highest point depending on the number of classifications values for each parameter.

Parameter		Water Quality Values & Index Points					
Biochemical Oxygen Demand (mg/L)	Classfication	2.5 Very Good	4 Good	6 Fairly Good	8 Fair	15 Poor	
	Index points	5	4	3	2	1	
Chemical Oxygen Demand (mg/L)	Classfication	5.88 High	7.35 Good	9.55 Moderate	13.23 Poor		
	Index points	4	3	2	1		
Dissolved Oxygen (% saturation)	Classfication	≤20 Bad	20-49 Poor	50-59 Fair	60-69 Fairly Good	70-79 Good	≥80 Very Good
	Index points	6	5	4	3	2	1
Reactive phosphorus (orthophosphate) (mg/L)	Classfication	0.02 Very Low	0.06 Low	0.1 Moderate	0.2 High	1 Very High	>1 Excessively High
	Index points	6	5	4	3	2	1
Nitrate (mg/L)	Classfication	5 Very Low	10 Low	20 Moderate	30 High	40 Very High	>40 Excessively High
	Index points	6	5	4	3	2	1
pH	Classfication	<6 Too Low	≥6 - ≤9 Good				>9 Too High
	Index points	1	2				1
Total coliforms (CFU)	Classfication	≤500 Guideline	≤10000 Imperative	>10000 Over Imperative			
	Index points	3	2	1			
Faecal coliforms (CFU)	Classfication	≤100 Guideline	≤2000 Imperative	>2000 Over Imperative			
	Index points	3	2	1			
Turbidity freshwaters (FTU)	Classfication	<3 Clear	3 < 29 Intermediate	29 - 88 Medium turbidy	>88 Very Turbid		
	Index points	4	3	2	1		
Total Dissolved Solids (mg/L)		Not Accessed					
Temperature of water °C		Not Accessed					

Table 11.2 – The watercourses within this investigation and their water quality index scores assessed by totaling the points from the mean values for each of the nine parameters within each watercourse. The optimum number of points that a watercourse can score is 39, the scores are also translated into percentages. The index indicates that the Ching is the best watercourse in terms of water quality, while Stonebridge Brook possesses the worst water quality index score.

Parameter	Watercourses									
	Dagenham Brook	The Ching	Moselle Brook	Pymmes Brook	Stonebridge Brook	Cobbins Brook	Salmons Brook	River Lee		Optimum score
Nitrate	6	6	5	6	5	6	5	5		6
Reactive phosphate	1	1	1	1	1	1	1	1		6
Dissolved Oxygen	2	3	2	2	2	4	2	4		6
Biochemical Oxygen Demand	5	5	5	3	2	3	3	4		5
Chemical Oxygen Demand	1	1	1	1	1	1	1	1		4
Turbidity	1	3	2	3	3	3	3	1		4
pH	2	2	2	2	2	2	2	2		2
Faecal coliforms	2	1	1	1	1	1	1	1		3
Total coliforms	1	1	1	1	1	1	1	1		3
Points scored	21	23	20	20	18	22	19	20		39
Out of 100 %	54	59	51	51	46	56	49	51		100

11.11. Sample sites ranked by water quality index scores

Using the same scoring criteria outlined in Table 11.1 within Section 11.10 above, it was possible to assess individual sampling sites on their 'health' or water quality. Within Table 11.3 is the list of sample sites within this investigation together with their assigned water quality score from the index.

The site with the highest water quality score was Cobbinsend Road (site 2) on Cobbins Brook with 28 points or 72 %. The average score for sites in this investigation was 22 points or 54 %, with the majority of sites (82 %) possessing a water quality score of greater than 20 points or 50 %. Of all thirty-eight sites only three were found to possess scores of 51 %, or half of the optimum scores for water quality. These included Stonebridge Loch (site 1) on the Moselle Brook, West Walk (site 3) on the Pymmes Brook, and south of the confluence with Deephams STW (site 2) on the Salmons Brook. Four sites within the investigation were found to be lower than 20 points or less than 51 % for water quality. The site with the worst water quality score was Deephams STW outfall (site 1) on the Salmons Brook with 17 points or 44 %. Sites that also possessed below average water quality scores included Montague Road (site 3) on the Salmons Brook, the confluence of the Pymmes Brook with the River Lee (site 7) and the single site on Stonebridge Brook.

Table 11.3 – A list of the sites sampled within this investigation and their associated water quality index point scores, calculated out of a possible 39 points. The points are also represented by a percentage score. The average score for all sites in the investigation was 22 points.

Waterway	ID	Name of site	Index Points Scored	Out of 100 %
Dagenham Brook	Dag 1	North Access Road	21	54
Dagenham Brook	Dag 2	Marsh Lane	25	64
Dagenham Brook	Dag 3	Orient Way	24	62
Dagenham Brook	Dag 4	Outfall site	22	56
Ching	Ching 1	Rangers Road	24	62
Ching	Ching 2	Hatch Grove (Chingdale Road)	24	62
Ching	Ching 3	Sainsbury's Carpark	24	62
Ching	Ching 4	Harbett Road	23	59
Moselle	Moselle 1	Stonebridge Loch	20	51
Moselle	Moselle 2	Tottenham Loch	21	54
Moselle	Moselle 3	Tottenham Cemetary	21	54
Pymmes	Pymmes 1	Baring Road/Fordham Road	25	64
Pymmes	Pymmes 2	Victoria Park	23	59
Pymmes	Pymmes 3	West Walk	20	51
Pymmes	Pymmes 4	Arnos Grove Park near bridge	21	54
Pymmes	Pymmes 5	Tile Kiln Lane	21	54
Pymmes	Pymmes 6	Pymme Park Pond	22	56
Pymmes	Pymmes 7	Pymme meets Lee	19	49
Stonebridge	Stonebridge	Stonebridge Brook meets Lee	18	46
Cobbins Brook	Cobbins 1	Hayleys Farm	21	54
Cobbins Brook	Cobbins 2	Upshire, Cobbinsend Road	28	72
Cobbins Brook	Cobbins 3	Waltham Abbey	24	62
Cobbins Brook	Cobbins 4	Meridian Way	22	56
Salmons Brook	Salmon 1	Deephams STW outfall	17	44
Salmons Brook	Salmon 2	South of Confluence STW	20	51
Salmons Brook	Salmon 3	Montague Road	18	46
Salmons Brook	Salmon 4	Churchfields	22	56
Salmons Brook	Salmon 5	Blakeswane Gardens	22	56
Salmons Brook	Salmon 6	Slade Rise Drain	22	56
Salmons Brook	Salmon 7	Salmons N. Slade Rise	21	54
River Lee	Lee 1	Hertford Union flow, Hackney Wick	22	56
River Lee	Lee 2	Old River Lea (Old Ford Lock)	22	56
River Lee	Lee 3	Bow Backs River (A12/High St)	22	56
River Lee	Lee 4	City Mill River (City Mill Lock)	22	56
River Lee	Lee 5	Waterworks River (Otter Close)	21	54
River Lee	Lee 6	Prescott Channel	21	54
River Lee	Lee 7	Channelsea - Gasworks	21	54
River Lee	Lee 8	Channel Sea	21	54

12. Conclusions and further investigation

12.1. Water quality of watercourses and individual sites

It can be concluded that the River Lee and the majority of the six tributaries within this investigation have severe problems with water quality.

It was a surprise that the Ching was found to be the waterway with the best 'health' regarding water quality measurements in this investigation, with all of its sites possessing above average water quality scores. This investigation indicated that Stonebridge Brook has the worst water quality of all the watercourses that were analysed. This suggests that it is imperative for further efforts to be made to improve the water quality within the Stonebridge Brook. This may include further investigations into the quality of water along its course. With investigations, modifications and improvements for streams and rivers being most effective when they are started from the headwater proceeding downstream. Additional efforts should also be made to improve water quality within the London River Lee, Moselle Brook, Salmons Brook and Pymmes Brook. Further intensive investigations could be used to determine the source of water quality problems within these watercourses.

The results of this investigation have determined that water quality is lowest within sites 1 to 3 on the Salmons Brook. Further investigations should be focused primarily on these areas to mitigate and improve water quality. In addition to this the confluence of the Pymmes Brook with the River Lee appears to have severe water quality issues. Greater focus should be proportioned to this area of the Pymmes Brook to assess possible water quality issues and their long-term severity.

12.2. Levels of parameters within the investigation

All of the watercourses within this investigation were found to possess considerably high levels of chemical oxygen demand with alarmingly high counts of total coliforms, in addition to some localised problems with faecal coliforms.

The excessive level of microbial activity within most of sample sites is a possible sign that a considerable amount of dissolved oxygen in the water column is being used in aerobic processes to breakdown organic matter and maybe organic pollutants. Although biochemical oxygen demand levels would indicate that microbial use of dissolved oxygen is only occurring within a small fraction of sampled sites. The possible presence of a number of inorganic pollutants within the investigated watercourses cannot be ruled out, as they could be utilising dissolved oxygen in the water column in reduction-oxidation (redox) processes.

In light of this analysis, further efforts are required to investigate sources of both faecal and total coliform pollution within the investigated watercourses, and also to assess whether there are temporal patterns governed by either flood events or periods of heavy precipitation. Although the standards used in this investigation are for European Community bathing waters, it should be noted at that the levels of coliform counts found were mostly excessive. Although coliforms do not cause disease themselves, they can be used to assess the possible risk to human and pet health if individuals were to come into contact with water from these watercourses. Possible sources of faecal coliforms include seepage of faecal waste from domestic pets, untreated or poorly treated sewage effluent, in addition to seepage of agricultural silage or livestock waste. This therefore could indicate possible problems with pet waste disposal, sewage treatment processes, pipe misconnections from domestic and commercial foul sewers or poor waste management practices within local farms. Furthermore, high levels of total coliforms may indicate inadequate poor processing of sewage effluent and in particular sanitary sewage in addition to misconnections from domestic and commercial properties.

Excessive concentrations of reactive phosphate (>1.0 mg/L) were found within the majority of water samples. Further investigations should be made to understand what and where the sources of the reactive phosphate are within the London River Lee catchment. If sources of reactive phosphate are identified within the watercourses, further investigations should aim to determine whether these are temporally or seasonally variable. Also if there is a connection between precipitation and the level of water within the watercourse. It may be possible that there is storage of reactive phosphorus within the sediment in the bottom of the channels of the watercourses that were investigated.

Concentrations of nitrate within water samples were found to be lower than expected. This is definitely a positive outcome, but further monitoring of nitrate concentrations should continue within these watercourses, with a greater emphasis on finding the source of nitrate within some of the sample sites in this investigation.

Sites 1 and 2 on the Moselle Brook, site 7 on the Pymmes Brook and sites 1 and 2 on Salmons Brook were conspicuously high in both nitrate and reactive phosphate concentrations. This is a possible indicator of problems with nutrient seepage into the waterway, and therefore further investigations at these sites should be conducted.

Turbidity was found to be excessively high within the Dagenham Brook, Moselle Brook and the River Lee. Higher levels of turbidity within site 1 on the Dagenham Brook and site 3 on the River Lee may be associated with the roads that are located within those areas. It is possible that increased precipitation could cause high ephemeral levels of turbidity, indicating the entry of surface grit or eroded sediment draining from road surfaces. Although the turbid nature of the water may not be a problem in itself, it could be a possible indication of automobile and road-associated contaminants leeching into the investigated waterway. This is an aspect that could be further investigated.

12.3. Further research, other impacts and additional parameters

There have been many possible indications of poor water quality found within this investigation. One of the stipulations of this investigation was that it was made during ‘reference’ flow conditions, or that the investigation was conducted without the presence of notable precipitation, spates or high flow levels. Therefore, it is not known at this stage what the impact of such events may cause on the water quality of the watercourses within this investigation.

The long-term temporal, seasonal and flow-induced variances in water quality (if any?) are currently not fully understood within the London River Lee and its tributaries. Further long-term analysis of water quality parameters like those used in this investigation, in addition to other possible parameters (e.g. heavy metals and poly aromatic hydrocarbons or PAH) should be considered as well as biological and ecological assessments to fully understand the ‘health’ of the London River Lee and its associated tributary watercourses. These could possibly include the presence or absence of aquatic macrophytes as well as aquatic invertebrate sampling and taxonomy.

13. References

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Appendix

List of sites within the investigation

Waterway	ID	Name of site
Dagenham Brook	Dag 1	North Access Road
Dagenham Brook	Dag 2	Marsh Lane
Dagenham Brook	Dag 3	Orient Way
Dagenham Brook	Dag 4	Outfall site
Ching	Ching 1	Rangers Road
Ching	Ching 2	Hatch Grove (Chingdale Road)
Ching	Ching 3	Sainsbury's Carpark
Ching	Ching 4	Harbett Road
Moselle	Moselle 1	Stonebridge Loch
Moselle	Moselle 2	Tottenham Loch
Moselle	Moselle 3	Tottenham Cemetary
Pymmes	Pymmes 1	Baring Road/Fordham Road
Pymmes	Pymmes 2	Victoria Park
Pymmes	Pymmes 3	West Walk
Pymmes	Pymmes 4	Arnos Grove Park near bridge
Pymmes	Pymmes 5	Tile Kiln Lane
Pymmes	Pymmes 6	Pymme Park Pond
Pymmes	Pymmes 7	Pymme meets Lee
Stonebridge	Stonebridge	Stonebridge Brook meets Lee
Cobbins Brook	Cobbins 1	Hayleys Farm
Cobbins Brook	Cobbins 2	Upshire, Cobbinsend Road
Cobbins Brook	Cobbins 3	Waltham Abbey
Cobbins Brook	Cobbins 4	Meridian Way
Salmons Brook	Salmon 1	Deephams STW outfall
Salmons Brook	Salmon 2	South of Confluence STW
Salmons Brook	Salmon 3	Montague Road
Salmons Brook	Salmon 4	Churchfields
Salmons Brook	Salmon 5	Blakeswane Gardens
Salmons Brook	Salmon 6	Slade Rise Drain
Salmons Brook	Salmon 7	Salmons N. Slade Rise
River Lee	Lee 1	Hertford Union flow, Hackney Wick
River Lee	Lee 2	Old River Lea (Old Ford Lock)
River Lee	Lee 3	Bow Backs River (A12/High St)
River Lee	Lee 4	City Mill River (City Mill Lock)
River Lee	Lee 5	Waterworks River (Otter Close)
River Lee	Lee 6	Prescott Channel
River Lee	Lee 7	Channelsea - Gasworks
River Lee	Lee 8	Channel Sea

Hach parameter methods

- Chemical Oxygen Demand (COD) was determined using a high range (0-1500 mg/L) dichromate (digestion) method with a Hach DR 2010 spectrophotometer. A pdf document with details of the procedure can be found at http://www.hach.com/asset-get.download-en.jsa?id=7639983817.

- Concentration of nitrate (NO_3^--N) was determined using a high range (0-30 mg/L) cadmium reduction method with a Hach DR 2010 spectrophotometer. A pdf document with details of the procedure can be found at http://www.hach.com/asset-get.download-en.jsa?id=7639983736.

- Concentration of reactive phosphate (or orthophosphate, PO_4^{3-}) was determined using the amino acid method (0-30 mg/L) with a Hach DR 2010 spectrophotometer. A pdf document with details of the procedure can be found at http://www.hach.com/asset-get.download.jsa?id=7639983830.

- Turbidity (FAU) was determined using the 'absorbtometric' with a Hach DR 2010 spectrophotometer. A pdf document with details of the procedure can be found at http://www.hach.com/asset-get.download.jsa?id=7639983664

Millipore coliform count methods

- Faecal and total coliform colony counts were conducted using Millipore 'paddle' samplers. Documentation from the manufacturer including methods can be found at http://www.millipore.com/userguides/tech1/p15325.

Statistical analyses and post-hoc tests

The statistical analyses used within this investigation were conducted in Minitab (v. 12). The following is the result script from Minitab for the analyses within this investigation.

Kruskal-Wallis Test

Kruskal-Wallis Test on Nitrate

Waterway	N	Median	Ave Rank	Z
Ching	4	3.250	20.3	0.24
Cobbins	4	1.250	9.8	-1.81
Dagenham	4	2.000	12.1	-1.35
Moselle	3	13.000	28.7	1.61
Pymmes	7	2.500	15.8	-0.87
River Le	8	8.200	26.8	2.29
Salmons	7	2.400	17.7	-0.35
Overall	37		19.0	

H = 11.80 DF = 6 P = 0.067
H = 11.81 DF = 6 P = 0.066 (adjusted for ties)

* NOTE * One or more small samples

Kruskal-Wallis Test

Kruskal-Wallis Test on Phosphat

Waterway	N	Median	Ave Rank	Z
Ching	4	3.085	14.8	-0.83
Cobbins	4	2.500	10.5	-1.66
Dagenham	4	5.680	22.5	0.68
Moselle	3	14.030	30.0	1.84
Pymmes	7	2.310	10.7	-2.25
River Le	8	9.040	27.9	2.62
Salmons	7	3.180	17.7	-0.35
Overall	37		19.0	

H = 16.18 DF = 6 P = 0.013

Current worksheet: Phosphate.MTW

Mann-Whitney Confidence Interval and Test

Dag P N = 4 Median = 5.680
Ching P N = 4 Median = 3.085
Point estimate for ETA1-ETA2 is 2.430
97.0 Percent CI for ETA1-ETA2 is (-0.690,9.772)
W = 24.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1124

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Moselle N = 3 Median = 14.03
Dag P N = 4 Median = 5.68
Point estimate for ETA1-ETA2 is 4.63
94.8 Percent CI for ETA1-ETA2 is (-7.33,10.96)
W = 16.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2159

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pymmes P N = 7 Median = 2.310
Dag P N = 4 Median = 5.680
Point estimate for ETA1-ETA2 is -2.620
95.3 Percent CI for ETA1-ETA2 is (-10.151,0.992)
W = 33.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1082

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cobbins N = 4 Median = 2.500
Dag P N = 4 Median = 5.680
Point estimate for ETA1-ETA2 is -2.945
97.0 Percent CI for ETA1-ETA2 is (-11.562,1.492)
W = 12.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1124

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salmon P N = 7 Median = 3.18
Dag P N = 4 Median = 5.68
Point estimate for ETA1-ETA2 is -1.50
95.3 Percent CI for ETA1-ETA2 is (-9.28,10.65)
W = 38.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5083

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Lee P N = 8 Median = 9.040
Dag P N = 4 Median = 5.680
Point estimate for ETA1-ETA2 is 2.895
96.6 Percent CI for ETA1-ETA2 is (-3.961,8.118)
W = 59.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2696

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Moselle   N =   3   Median =   14.030
Ching P   N =   4   Median =   3.085
Point estimate for ETA1-ETA2 is   10.415
94.8 Percent CI for ETA1-ETA2 is (1.318,11.392)
W = 18.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0518

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pymmes P   N =   7   Median =   2.310
Ching P   N =   4   Median =   3.085
Point estimate for ETA1-ETA2 is   -0.660
95.3 Percent CI for ETA1-ETA2 is (-2.130,9.641)
W = 34.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1564

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cobbins   N =   4   Median =   2.500
Ching P   N =   4   Median =   3.085
Point estimate for ETA1-ETA2 is   -0.585
97.0 Percent CI for ETA1-ETA2 is (-2.910,1.920)
W = 14.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3123

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salmon P   N =   7   Median =   3.180
Ching P   N =   4   Median =   3.085
Point estimate for ETA1-ETA2 is   0.245
95.3 Percent CI for ETA1-ETA2 is (-1.702,12.518)
W = 43.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.9247

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Lee P   N =   8   Median =   9.040
Ching P   N =   4   Median =   3.085
Point estimate for ETA1-ETA2 is   5.805
96.6 Percent CI for ETA1-ETA2 is (2.150,11.939)
W = 68.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0085

Mann-Whitney Confidence Interval and Test

Pymmes P   N =   7   Median =   2.31
Moselle   N =   3   Median =   14.03

Point estimate for ETA1-ETA2 is -10.79
96.0 Percent CI for ETA1-ETA2 is (-13.47,-0.58)
W = 29.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0402

Mann-Whitney Confidence Interval and Test

Cobbins N = 4 Median = 2.50
Moselle N = 3 Median = 14.03
Point estimate for ETA1-ETA2 is -10.46
94.8 Percent CI for ETA1-ETA2 is (-13.18,-0.52)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0518

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salmon P N = 7 Median = 3.18
Moselle N = 3 Median = 14.03
Point estimate for ETA1-ETA2 is -3.81
96.0 Percent CI for ETA1-ETA2 is (-12.71,10.09)
W = 34.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3619

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Lee P N = 8 Median = 9.04
Moselle N = 3 Median = 14.03
Point estimate for ETA1-ETA2 is -2.96
96.8 Percent CI for ETA1-ETA2 is (-8.96,6.11)
W = 45.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6098

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cobbins N = 4 Median = 2.500
Pymmes P N = 7 Median = 2.310
Point estimate for ETA1-ETA2 is 0.245
95.3 Percent CI for ETA1-ETA2 is (-8.840,2.302)
W = 27.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6366

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salmon P N = 7 Median = 3.18
Pymmes P N = 7 Median = 2.31
Point estimate for ETA1-ETA2 is 0.99
95.9 Percent CI for ETA1-ETA2 is (-0.99,12.91)

W = 60.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3711

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Lee P N = 8 Median = 9.040
Pymmes P N = 7 Median = 2.310
Point estimate for ETA1-ETA2 is 6.240
95.7 Percent CI for ETA1-ETA2 is (2.749,9.051)
W = 85.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0177

Mann-Whitney Confidence Interval and Test

Salmon P N = 7 Median = 3.180
Cobbins N = 4 Median = 2.500
Point estimate for ETA1-ETA2 is 0.820
95.3 Percent CI for ETA1-ETA2 is (-1.431,12.808)
W = 47.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3951

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Lee P N = 8 Median = 9.040
Cobbins N = 4 Median = 2.500
Point estimate for ETA1-ETA2 is 6.485
96.6 Percent CI for ETA1-ETA2 is (2.661,11.140)
W = 68.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0085

Mann-Whitney Confidence Interval and Test

Lee P N = 8 Median = 9.040
Salmon P N = 7 Median = 3.180
Point estimate for ETA1-ETA2 is 4.500
95.7 Percent CI for ETA1-ETA2 is (-4.372,8.261)
W = 78.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1182

Saving file as: C:\Users\Grieg\Documents\Consultancy\Thames21\Thames21 RLee.MPJ
* NOTE * Existing file replaced.

Current worksheet: Parameters.MTW

Kruskal-Wallis Test

Kruskal-Wallis Test on % DO AS

Waterway	N	Median	Ave Rank	Z
Ching	4	50.73	23.3	0.83
Cobbins	4	64.30	30.0	2.15
Dagenham	4	44.71	17.0	-0.39

Moselle	3	36.88	8.3	-1.78
Pymmes	7	43.28	15.7	-0.89
River Le	8	53.73	27.9	2.62
Salmons	7	38.82	9.1	-2.68
Overall	37		19.0	

H = 19.63 DF = 6 P = 0.003
H = 19.63 DF = 6 P = 0.003 (adjusted for ties)

Current worksheet: Dissolved oxygen.MTW

Mann-Whitney Confidence Interval and Test

DagDO N = 4 Median = 44.71
LeeDO N = 8 Median = 53.73
Point estimate for ETA1-ETA2 is -8.43
96.6 Percent CI for ETA1-ETA2 is (-15.56,-0.37)
W = 13.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0338

Mann-Whitney Confidence Interval and Test

ChingDO N = 4 Median = 50.734
LeeDO N = 8 Median = 53.731
Point estimate for ETA1-ETA2 is -3.261
96.6 Percent CI for ETA1-ETA2 is (-5.480,3.969)
W = 17.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1488

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

MoselleD N = 3 Median = 36.88
LeeDO N = 8 Median = 53.73
Point estimate for ETA1-ETA2 is -16.85
96.8 Percent CI for ETA1-ETA2 is (-34.32,-5.86)
W = 6.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0189

Mann-Whitney Confidence Interval and Test

PymmesDO N = 7 Median = 43.28
LeeDO N = 8 Median = 53.73
Point estimate for ETA1-ETA2 is -9.65
95.7 Percent CI for ETA1-ETA2 is (-19.27,1.79)
W = 41.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0933
The test is significant at 0.0930 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

CobbinsD N = 4 Median = 64.30
LeeDO N = 8 Median = 53.73

Point estimate for ETA1-ETA2 is 13.72
96.6 Percent CI for ETA1-ETA2 is (-10.84,22.64)
W = 32.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3502
The test is significant at 0.3494 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.11
LeeDO N = 8 Median = 53.73
Point estimate for ETA1-ETA2 is -14.03
95.5 Percent CI for ETA1-ETA2 is (-20.55,-9.34)
W = 21.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0024

Mann-Whitney Confidence Interval and Test

ChingDO N = 4 Median = 50.734
DagDO N = 4 Median = 44.709
Point estimate for ETA1-ETA2 is 5.464
97.0 Percent CI for ETA1-ETA2 is (-2.606,12.603)
W = 22.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3123

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

MoselleD N = 3 Median = 36.88
DagDO N = 4 Median = 44.71
Point estimate for ETA1-ETA2 is -8.24
94.8 Percent CI for ETA1-ETA2 is (-29.72,5.56)
W = 8.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2159

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

PymmesDO N = 7 Median = 43.28
DagDO N = 4 Median = 44.71
Point estimate for ETA1-ETA2 is -2.67
95.3 Percent CI for ETA1-ETA2 is (-11.66,14.56)
W = 40.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.7768

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

CobbinsD N = 4 Median = 64.30
DagDO N = 4 Median = 44.71
Point estimate for ETA1-ETA2 is 19.13

97.0 Percent CI for ETA1-ETA2 is (-8.07,34.50)
W = 24.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1124

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.11
DagDO N = 4 Median = 44.71
Point estimate for ETA1-ETA2 is -6.81
95.7 Percent CI for ETA1-ETA2 is (-15.96,2.06)
W = 25.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1098

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

MoselleD N = 3 Median = 36.88
ChingDO N = 4 Median = 50.73
Point estimate for ETA1-ETA2 is -13.86
94.8 Percent CI for ETA1-ETA2 is (-29.52,-4.65)
W = 6.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0518

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

PymmesDO N = 7 Median = 43.28
ChingDO N = 4 Median = 50.73
Point estimate for ETA1-ETA2 is -7.45
95.3 Percent CI for ETA1-ETA2 is (-16.24,9.30)
W = 36.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2986

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

CobbinsD N = 4 Median = 64.30
ChingDO N = 4 Median = 50.73
Point estimate for ETA1-ETA2 is 14.13
97.0 Percent CI for ETA1-ETA2 is (-7.87,24.28)
W = 22.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3123

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.106
ChingDO N = 4 Median = 50.734
Point estimate for ETA1-ETA2 is -11.067

95.7 Percent CI for ETA1-ETA2 is (-23.160,-6.896)
W = 21.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0142

Mann-Whitney Confidence Interval and Test

PymmesDO N = 7 Median = 43.28
MoselleD N = 3 Median = 36.88
Point estimate for ETA1-ETA2 is 9.84
96.0 Percent CI for ETA1-ETA2 is (-9.26,31.87)
W = 42.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4941

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

CobbinsD N = 4 Median = 64.30
MoselleD N = 3 Median = 36.88
Point estimate for ETA1-ETA2 is 28.72
94.8 Percent CI for ETA1-ETA2 is (-0.82,51.42)
W = 21.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1116

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.11
MoselleD N = 3 Median = 36.88
Point estimate for ETA1-ETA2 is 2.23
97.2 Percent CI for ETA1-ETA2 is (-16.80,21.94)
W = 31.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.8973

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

CobbinsD N = 4 Median = 64.30
PymmesDO N = 7 Median = 43.28
Point estimate for ETA1-ETA2 is 19.30
95.3 Percent CI for ETA1-ETA2 is (-3.21,37.76)
W = 34.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0726

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.11
PymmesDO N = 7 Median = 43.28
Point estimate for ETA1-ETA2 is -5.89
96.2 Percent CI for ETA1-ETA2 is (-18.12,6.39)
W = 36.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4320

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

SalmonDO N = 6 Median = 39.11
CobbinsD N = 4 Median = 64.30
Point estimate for ETA1-ETA2 is -28.64
95.7 Percent CI for ETA1-ETA2 is (-37.65,-2.67)
W = 22.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0252

Current worksheet: Parameters.MTW

Kruskal-Wallis Test

Kruskal-Wallis Test on BOD

Waterway	N	Median	Ave Rank	Z
Ching	4	0.8750	6.2	-2.49
Cobbins	4	5.7550	30.0	2.15
Dagenham	4	0.4950	5.3	-2.69
Moselle	3	1.3900	7.3	-1.95
Pymmes	7	5.8600	28.0	2.44
River Le	8	3.8300	19.7	0.22
Salmons	7	3.4100	23.0	1.09
Overall	37		19.0	

H = 25.45 DF = 6 P = 0.000

Current worksheet: BOD.MTW

Mann-Whitney Confidence Interval and Test

Dag BOD N = 4 Median = 0.495
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is -2.970
96.6 Percent CI for ETA1-ETA2 is (-3.959,-1.130)
W = 11.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0138

Mann-Whitney Confidence Interval and Test

Ching BO N = 4 Median = 0.875
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is -2.775
96.6 Percent CI for ETA1-ETA2 is (-3.620,-1.480)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0085

Mann-Whitney Confidence Interval and Test

Mos BOD N = 3 Median = 1.390
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is -2.360

96.8 Percent CI for ETA1-ETA2 is (-3.760,-0.240)
W = 7.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0321

Mann-Whitney Confidence Interval and Test

Pym BOD N = 7 Median = 5.860
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is 1.935
95.7 Percent CI for ETA1-ETA2 is (-0.009,2.630)
W = 73.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0562

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cobbs BO N = 4 Median = 5.755
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is 1.955
96.6 Percent CI for ETA1-ETA2 is (0.259,3.370)
W = 41.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0138

Mann-Whitney Confidence Interval and Test

Salm BOD N = 7 Median = 3.410
Lee BOD N = 8 Median = 3.830
Point estimate for ETA1-ETA2 is 0.665
95.7 Percent CI for ETA1-ETA2 is (-0.870,2.531)
W = 60.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6854

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag BOD N = 4 Median = 0.495
Salm BOD N = 7 Median = 3.410
Point estimate for ETA1-ETA2 is -3.075
95.3 Percent CI for ETA1-ETA2 is (-6.010,-0.769)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107

Mann-Whitney Confidence Interval and Test

Ching BO N = 4 Median = 0.875
Salm BOD N = 7 Median = 3.410
Point estimate for ETA1-ETA2 is -2.775
95.3 Percent CI for ETA1-ETA2 is (-5.579,-1.740)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107

Mann-Whitney Confidence Interval and Test

Mos BOD N = 3 Median = 1.390
Salm BOD N = 7 Median = 3.410
Point estimate for ETA1-ETA2 is -2.840
96.0 Percent CI for ETA1-ETA2 is (-5.810,-0.730)
W = 6.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0227

Mann-Whitney Confidence Interval and Test

Pym BOD N = 7 Median = 5.860
Salm BOD N = 7 Median = 3.410
Point estimate for ETA1-ETA2 is 0.600
95.9 Percent CI for ETA1-ETA2 is (-0.580,2.830)
W = 62.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2502

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cobbs BO N = 4 Median = 5.755
Salm BOD N = 7 Median = 3.410
Point estimate for ETA1-ETA2 is 0.985
95.3 Percent CI for ETA1-ETA2 is (-1.099,2.881)
W = 29.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3951

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag BOD N = 4 Median = 0.495
Cobbs BO N = 4 Median = 5.755
Point estimate for ETA1-ETA2 is -4.895
97.0 Percent CI for ETA1-ETA2 is (-5.961,-1.510)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Mann-Whitney Confidence Interval and Test

Ching BO N = 4 Median = 0.875
Cobbs BO N = 4 Median = 5.755
Point estimate for ETA1-ETA2 is -4.675
97.0 Percent CI for ETA1-ETA2 is (-5.580,-2.600)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Mann-Whitney Confidence Interval and Test

Mos BOD N = 3 Median = 1.390
Cobbs BO N = 4 Median = 5.755
Point estimate for ETA1-ETA2 is -3.950
94.8 Percent CI for ETA1-ETA2 is (-5.720,-1.720)
W = 6.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0518

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym BOD N = 7 Median = 5.860
Cobbs BO N = 4 Median = 5.755
Point estimate for ETA1-ETA2 is -0.045
95.3 Percent CI for ETA1-ETA2 is (-2.279,1.710)
W = 40.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.7768

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag BOD N = 4 Median = 0.495
Pym BOD N = 7 Median = 5.860
Point estimate for ETA1-ETA2 is -4.950
95.3 Percent CI for ETA1-ETA2 is (-5.901,-2.900)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107

Mann-Whitney Confidence Interval and Test

Ching BO N = 4 Median = 0.875
Pym BOD N = 7 Median = 5.860
Point estimate for ETA1-ETA2 is -4.680
95.3 Percent CI for ETA1-ETA2 is (-5.520,-2.570)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107

Mann-Whitney Confidence Interval and Test

Mos BOD N = 3 Median = 1.390
Pym BOD N = 7 Median = 5.860
Point estimate for ETA1-ETA2 is -3.810
96.0 Percent CI for ETA1-ETA2 is (-5.681,-1.331)
W = 6.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0227

Mann-Whitney Confidence Interval and Test

Dag BOD N = 4 Median = 0.495
Mos BOD N = 3 Median = 1.390
Point estimate for ETA1-ETA2 is -0.385
94.8 Percent CI for ETA1-ETA2 is (-2.339,2.311)
W = 14.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5959

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching BO   N =   4   Median =   0.875
Mos BOD   N =   3   Median =   1.390
Point estimate for ETA1-ETA2 is   -0.515
94.8 Percent CI for ETA1-ETA2 is (-1.960,1.219)
W = 15.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.8597

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag BOD   N =   4   Median =   0.495
Ching BO   N =   4   Median =   0.875
Point estimate for ETA1-ETA2 is   -0.360
97.0 Percent CI for ETA1-ETA2 is (-1.460,2.169)
W = 16.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6650

Cannot reject at alpha = 0.05

Current worksheet: Parameters.MTW

Kruskal-Wallis Test

Kruskal-Wallis Test on pH

Waterway	N	Median	Ave Rank	Z
Ching	4	8.085	26.5	1.47
Cobbins	4	8.075	27.3	1.61
Dagenham	4	7.765	12.5	-1.27
Moselle	3	7.430	5.7	-2.23
Pymmes	7	7.880	18.7	-0.08
River Le	8	7.815	15.4	-1.07
Salmons	7	8.090	23.9	1.32
Overall	37		19.0	

H = 12.55 DF = 6 P = 0.051
H = 12.56 DF = 6 P = 0.051 (adjusted for ties)

* NOTE * One or more small samples

Kruskal-Wallis Test

Kruskal-Wallis Test on Fcoli

Waterway	N	Median	Ave Rank	Z
Ching	4	8.30E+03	30.8	2.30
Cobbins	4	1.65E+03	14.3	-0.93
Dagenham	4	0.00E+00	6.0	-2.54
Moselle	3	3.00E+02	16.5	-0.42
Pymmes	7	7.30E+03	22.0	0.81
River Le	8	7.50E+02	16.9	-0.61
Salmons	7	4.70E+03	22.9	1.05
Overall	37		19.0	

H = 13.13 DF = 6 P = 0.041
H = 13.24 DF = 6 P = 0.039 (adjusted for ties)

Current worksheet: faecal coliforms.MTW

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is -700.0
96.6 Percent CI for ETA1-ETA2 is (-47399.9,0.0)
W = 13.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0415
The test is significant at 0.0377 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Ching FC N = 4 Median = 8300.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is 7350.0
96.6 Percent CI for ETA1-ETA2 is (700.0,47900.1)
W = 39.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0338
The test is significant at 0.0334 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Mos FC N = 3 Median = 300.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is -300.0
96.8 Percent CI for ETA1-ETA2 is (-47599.9,47600.0)
W = 15.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6831
The test is significant at 0.6817 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym FC N = 7 Median = 7300.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is 1800.0
95.7 Percent CI for ETA1-ETA2 is (-1400.1,11200.1)
W = 61.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5628
The test is significant at 0.5611 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob FC N = 4 Median = 1650.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is -100.0
96.6 Percent CI for ETA1-ETA2 is (-43199.9,4000.1)
W = 25.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.9323

The test is significant at 0.9320 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm FC N = 7 Median = 4700.0
Lee FC N = 8 Median = 750.0
Point estimate for ETA1-ETA2 is 1850.0
95.7 Percent CI for ETA1-ETA2 is (-699.8,5699.9)
W = 70.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1182
The test is significant at 0.1169 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Salm FC N = 7 Median = 4700.0
Point estimate for ETA1-ETA2 is -4700.0
95.3 Percent CI for ETA1-ETA2 is (-14000.1,-700.0)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107
The test is significant at 0.0100 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Ching FC N = 4 Median = 8300.0
Salm FC N = 7 Median = 4700.0
Point estimate for ETA1-ETA2 is 5600.0
95.3 Percent CI for ETA1-ETA2 is (200.1,43900.1)
W = 35.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0472

Mann-Whitney Confidence Interval and Test

Mos FC N = 3 Median = 300.0
Salm FC N = 7 Median = 4700.0
Point estimate for ETA1-ETA2 is -1100.0
96.0 Percent CI for ETA1-ETA2 is (-14200.2,46700.0)
W = 13.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4941

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym FC N = 7 Median = 7300.0
Salm FC N = 7 Median = 4700.0
Point estimate for ETA1-ETA2 is 900.0
95.9 Percent CI for ETA1-ETA2 is (-5000.1,10600.0)
W = 53.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.9491
The test is significant at 0.9490 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob FC N = 4 Median = 1650.0
Salm FC N = 7 Median = 4700.0
Point estimate for ETA1-ETA2 is -1950.0
95.3 Percent CI for ETA1-ETA2 is (-9800.0,2300.0)
W = 16.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1859
The test is significant at 0.1849 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Cob FC N = 4 Median = 1650.0
Point estimate for ETA1-ETA2 is -1400.0
97.0 Percent CI for ETA1-ETA2 is (-4699.9,499.9)
W = 13.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2482
The test is significant at 0.2186 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching FC N = 4 Median = 8300.0
Cob FC N = 4 Median = 1650.0
Point estimate for ETA1-ETA2 is 7250.0
97.0 Percent CI for ETA1-ETA2 is (1900.0,48599.8)
W = 26.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Mann-Whitney Confidence Interval and Test

Mos FC N = 3 Median = 300.0
Cob FC N = 4 Median = 1650.0
Point estimate for ETA1-ETA2 is 50.0
94.8 Percent CI for ETA1-ETA2 is (-4700.0,47800.0)
W = 12.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
The test is significant at 1.0000 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym FC N = 7 Median = 7300.0
Cob FC N = 4 Median = 1650.0
Point estimate for ETA1-ETA2 is 5450.0
95.3 Percent CI for ETA1-ETA2 is (-3099.9,17900.0)
W = 48.5

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2568
The test is significant at 0.2558 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Pym FC N = 7 Median = 7300.0
Point estimate for ETA1-ETA2 is -7300.0
95.3 Percent CI for ETA1-ETA2 is (-22100.1,0.0)
W = 13.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0588
The test is significant at 0.0531 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching FC N = 4 Median = 8300.0
Pym FC N = 7 Median = 7300.0
Point estimate for ETA1-ETA2 is 6450.0
95.3 Percent CI for ETA1-ETA2 is (-5100.1,41300.1)
W = 28.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5083

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Mos FC N = 3 Median = 300.0
Pym FC N = 7 Median = 7300.0
Point estimate for ETA1-ETA2 is -300.0
96.0 Percent CI for ETA1-ETA2 is (-22300.1,47499.8)
W = 15.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.8197
The test is significant at 0.8186 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Mos FC N = 3 Median = 300.0
Point estimate for ETA1-ETA2 is -300.0
94.8 Percent CI for ETA1-ETA2 is (-47800.0,499.8)
W = 13.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4795
The test is significant at 0.4353 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching FC N = 4 Median = 8300.0

Mos FC N = 3 Median = 300.0
Point estimate for ETA1-ETA2 is 7200.0
94.8 Percent CI for ETA1-ETA2 is (-41200.1,48600.1)
W = 19.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3768

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag FC N = 4 Median = 0.0
Ching FC N = 4 Median = 8300.0
Point estimate for ETA1-ETA2 is -8100.0
97.0 Percent CI for ETA1-ETA2 is (-48600.2,-6100.0)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304
The test is significant at 0.0265 (adjusted for ties)

Current worksheet: Parameters.MTW

Kruskal-Wallis Test

Kruskal-Wallis Test on Totcoli

Waterway	N	Median	Ave Rank	Z
Ching	4	129600	17.7	-0.24
Cobbins	4	90000	11.0	-1.57
Dagenham	4	552250	27.9	1.74
Moselle	3	72800	13.7	-0.89
Pymmes	7	159900	17.4	-0.45
River Le	8	170900	18.6	-0.11
Salmons	7	193500	23.6	1.24
Overall	37		19.0	

H = 7.07 DF = 6 P = 0.314
H = 7.08 DF = 6 P = 0.314 (adjusted for ties)

* NOTE * One or more small samples

Kruskal-Wallis Test

Kruskal-Wallis Test on Turbidit

Waterway	N	Median	Ave Rank	Z
Ching	4	10.500	15.1	-0.76
Cobbins	4	3.500	6.6	-2.42
Dagenham	4	66.000	31.4	2.42
Moselle	3	10.000	20.8	0.31
Pymmes	7	13.000	18.2	-0.21
River Le	8	46.500	28.6	2.82
Salmons	7	5.000	10.3	-2.37
Overall	37		19.0	

H = 21.87 DF = 6 P = 0.001
H = 21.95 DF = 6 P = 0.001 (adjusted for ties)

* NOTE * One or more small samples

Saving file as: C:\Users\Grieg\Documents\Consultancy\Thames21\Thames21 RLee.MPJ
* NOTE * Existing file replaced.

Current worksheet: Worksheet 6

Mann-Whitney Confidence Interval and Test

Dag Turb   N =   4   Median =   66.0
Lee Turb   N =   8   Median =   46.5
Point estimate for ETA1-ETA2 is   14.0
96.6 Percent CI for ETA1-ETA2 is (-100.0,240.0)
W = 30.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4969
The test is significant at 0.4946 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching Tu   N =   4   Median =   10.5
Lee Turb   N =   8   Median =   46.5
Point estimate for ETA1-ETA2 is   -36.5
96.6 Percent CI for ETA1-ETA2 is (-244.0,-4.0)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0085
The test is significant at 0.0082 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Mos Turb   N =   3   Median =   10.0
Lee Turb   N =   8   Median =   46.5
Point estimate for ETA1-ETA2 is   -9.0
96.8 Percent CI for ETA1-ETA2 is (-248.0,175.1)
W = 13.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3583
The test is significant at 0.3561 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym Turb   N =   7   Median =   13.0
Lee Turb   N =   8   Median =   46.5
Point estimate for ETA1-ETA2 is   -33.0
95.7 Percent CI for ETA1-ETA2 is (-118.0,-3.0)
W = 36.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0240
The test is significant at 0.0237 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Cob turb   N =   4   Median =   3.5
Lee Turb   N =   8   Median =   46.5
Point estimate for ETA1-ETA2 is   -43.0
96.6 Percent CI for ETA1-ETA2 is (-252.0,-12.0)
W = 10.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0085
The test is significant at 0.0082 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Salm Tur N = 7 Median = 5.0
Lee Turb N = 8 Median = 46.5
Point estimate for ETA1-ETA2 is -17.5
95.7 Percent CI for ETA1-ETA2 is (-126.0,-12.0)
W = 32.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0065
The test is significant at 0.0063 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Dag Turb N = 4 Median = 66.0
Salm Tur N = 7 Median = 5.0
Point estimate for ETA1-ETA2 is 49.0
95.3 Percent CI for ETA1-ETA2 is (25.0,253.0)
W = 36.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0298
The test is significant at 0.0283 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Ching Tu N = 4 Median = 10.50
Salm Tur N = 7 Median = 5.00
Point estimate for ETA1-ETA2 is 5.00
95.3 Percent CI for ETA1-ETA2 is (-43.01,10.99)
W = 31.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1859
The test is significant at 0.1808 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Mos Turb N = 3 Median = 10.0
Salm Tur N = 7 Median = 5.0
Point estimate for ETA1-ETA2 is 7.0
96.0 Percent CI for ETA1-ETA2 is (-47.1,191.0)
W = 23.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1385
The test is significant at 0.1325 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym Turb N = 7 Median = 13.00
Salm Tur N = 7 Median = 5.00
Point estimate for ETA1-ETA2 is 8.00
95.9 Percent CI for ETA1-ETA2 is (-4.99,18.00)
W = 64.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1417

The test is significant at 0.1369 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob turb N = 4 Median = 3.50
Salm Tur N = 7 Median = 5.00
Point estimate for ETA1-ETA2 is 0.00
95.3 Percent CI for ETA1-ETA2 is (-50.99,4.00)
W = 22.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.8501
The test is significant at 0.8459 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag Turb N = 4 Median = 66.0
Cob turb N = 4 Median = 3.5
Point estimate for ETA1-ETA2 is 62.5
97.0 Percent CI for ETA1-ETA2 is (25.0,257.0)
W = 26.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Mann-Whitney Confidence Interval and Test

Ching Tu N = 4 Median = 10.500
Cob turb N = 4 Median = 3.500
Point estimate for ETA1-ETA2 is 7.000
97.0 Percent CI for ETA1-ETA2 is (-0.001,12.998)
W = 25.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0433
The test is significant at 0.0421 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Mos Turb N = 3 Median = 10.0
Cob turb N = 4 Median = 3.5
Point estimate for ETA1-ETA2 is 7.5
94.8 Percent CI for ETA1-ETA2 is (2.0,191.0)
W = 18.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0518

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym Turb N = 7 Median = 13.00
Cob turb N = 4 Median = 3.50
Point estimate for ETA1-ETA2 is 10.50
95.3 Percent CI for ETA1-ETA2 is (-0.00,21.00)
W = 52.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0588
The test is significant at 0.0576 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag Turb N = 4 Median = 66.0
Pym Turb N = 7 Median = 13.0
Point estimate for ETA1-ETA2 is 52.5
95.3 Percent CI for ETA1-ETA2 is (18.0,245.0)
W = 38.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107
The test is significant at 0.0106 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Ching Tu N = 4 Median = 10.50
Pym Turb N = 7 Median = 13.00
Point estimate for ETA1-ETA2 is -3.50
95.3 Percent CI for ETA1-ETA2 is (-14.00,5.00)
W = 18.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3447
The test is significant at 0.3425 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Mos Turb N = 3 Median = 10.0
Pym Turb N = 7 Median = 13.0
Point estimate for ETA1-ETA2 is -1.0
96.0 Percent CI for ETA1-ETA2 is (-16.0,183.0)
W = 16.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
The test is significant at 1.0000 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag Turb N = 4 Median = 66.0
Mos Turb N = 3 Median = 10.0
Point estimate for ETA1-ETA2 is 41.0
94.8 Percent CI for ETA1-ETA2 is (-161.0,250.0)
W = 19.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3768

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching Tu N = 4 Median = 10.5
Mos Turb N = 3 Median = 10.0
Point estimate for ETA1-ETA2 is -1.5
94.8 Percent CI for ETA1-ETA2 is (-186.0,6.0)
W = 15.0

Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.8597

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Dag Turb N = 4 Median = 66.0
Ching Tu N = 4 Median = 10.5
Point estimate for ETA1-ETA2 is 56.0
97.0 Percent CI for ETA1-ETA2 is (17.0,252.0)
W = 26.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Current worksheet: Parameters.MTW

Kruskal-Wallis Test

Kruskal-Wallis Test on COD

Waterway	N	Median	Ave Rank	Z
Ching	4	23.50	9.9	-1.79
Cobbins	4	36.50	20.8	0.34
Dagenham	4	138.00	32.4	2.62
Moselle	3	30.00	23.2	0.70
Pymmes	7	24.00	11.7	-1.98
River Le	8	30.00	17.9	-0.31
Salmons	7	46.00	22.3	0.89
Overall	37		19.0	

H = 13.39 DF = 6 P = 0.037
H = 13.42 DF = 6 P = 0.037 (adjusted for ties)

* NOTE * One or more small samples

Current worksheet: Worksheet 7

Mann-Whitney Confidence Interval and Test

Dag COD N = 4 Median = 138.0
Lee COD N = 8 Median = 30.0
Point estimate for ETA1-ETA2 is 103.5
96.6 Percent CI for ETA1-ETA2 is (-0.0,210.0)
W = 38.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0415
The test is significant at 0.0408 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Ching CO N = 4 Median = 23.50
Lee COD N = 8 Median = 30.00
Point estimate for ETA1-ETA2 is -8.00
96.6 Percent CI for ETA1-ETA2 is (-33.01,8.00)
W = 20.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3502

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Mos COD N = 3 Median = 30.00
Lee COD N = 8 Median = 30.00
Point estimate for ETA1-ETA2 is 7.00
96.8 Percent CI for ETA1-ETA2 is (-28.01,71.03)
W = 22.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.4750
The test is significant at 0.4740 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym COD N = 7 Median = 24.00
Lee COD N = 8 Median = 30.00
Point estimate for ETA1-ETA2 is -4.50
95.7 Percent CI for ETA1-ETA2 is (-25.00,6.01)
W = 47.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.3545
The test is significant at 0.3532 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.50
Lee COD N = 8 Median = 30.00
Point estimate for ETA1-ETA2 is 3.00
96.6 Percent CI for ETA1-ETA2 is (-19.99,25.01)
W = 28.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.7989

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm COD N = 7 Median = 46.00
Lee COD N = 8 Median = 30.00
Point estimate for ETA1-ETA2 is 5.00
95.7 Percent CI for ETA1-ETA2 is (-10.00,26.00)
W = 60.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6434
The test is significant at 0.6425 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Ching CO N = 4 Median = 23.5
Dag COD N = 4 Median = 138.0
Point estimate for ETA1-ETA2 is -115.5
97.0 Percent CI for ETA1-ETA2 is (-219.0,-6.0)
W = 10.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0304

Mann-Whitney Confidence Interval and Test

Mos COD N = 3 Median = 30.0
Dag COD N = 4 Median = 138.0
Point estimate for ETA1-ETA2 is -79.5
94.8 Percent CI for ETA1-ETA2 is (-209.0,55.9)
W = 8.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.2159

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym COD N = 7 Median = 24.0
Dag COD N = 4 Median = 138.0
Point estimate for ETA1-ETA2 is -112.0
95.3 Percent CI for ETA1-ETA2 is (-212.0,-10.0)
W = 28.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0107
The test is significant at 0.0106 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.5
Dag COD N = 4 Median = 138.0
Point estimate for ETA1-ETA2 is -102.0
97.0 Percent CI for ETA1-ETA2 is (-215.0,17.0)
W = 13.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1939

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm COD N = 7 Median = 46.0
Dag COD N = 4 Median = 138.0
Point estimate for ETA1-ETA2 is -100.5
95.3 Percent CI for ETA1-ETA2 is (-189.9,12.0)
W = 32.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0726
The test is significant at 0.0720 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Mos COD N = 3 Median = 30.00
Ching CO N = 4 Median = 23.50
Point estimate for ETA1-ETA2 is 9.00
94.8 Percent CI for ETA1-ETA2 is (-1.02,73.02)
W = 17.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1116

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym COD N = 7 Median = 24.000
Ching CO N = 4 Median = 23.500
Point estimate for ETA1-ETA2 is 2.000
95.3 Percent CI for ETA1-ETA2 is (-3.997,8.002)
W = 44.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.7055
The test is significant at 0.7042 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.50
Ching CO N = 4 Median = 23.50
Point estimate for ETA1-ETA2 is 13.00
97.0 Percent CI for ETA1-ETA2 is (-7.00,34.00)
W = 23.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1939

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm COD N = 7 Median = 46.00
Ching CO N = 4 Median = 23.50
Point estimate for ETA1-ETA2 is 20.00
95.3 Percent CI for ETA1-ETA2 is (-1.00,30.00)
W = 52.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0726

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Pym COD N = 7 Median = 24.00
Mos COD N = 3 Median = 30.00
Point estimate for ETA1-ETA2 is -6.00
96.0 Percent CI for ETA1-ETA2 is (-68.99,3.02)
W = 31.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1385
The test is significant at 0.1361 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.50
Mos COD N = 3 Median = 30.00
Point estimate for ETA1-ETA2 is -0.50
94.8 Percent CI for ETA1-ETA2 is (-69.01,23.98)
W = 16.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm COD N = 7 Median = 46.00
Mos COD N = 3 Median = 30.00
Point estimate for ETA1-ETA2 is -3.00
96.0 Percent CI for ETA1-ETA2 is (-66.01,25.01)
W = 38.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 1.0000
The test is significant at 1.0000 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.50
Pym COD N = 7 Median = 24.00
Point estimate for ETA1-ETA2 is 12.50
95.3 Percent CI for ETA1-ETA2 is (-3.00,27.00)
W = 32.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.1564
The test is significant at 0.1526 (adjusted for ties)

Cannot reject at alpha = 0.05

Mann-Whitney Confidence Interval and Test

Salm COD N = 7 Median = 46.00
Pym COD N = 7 Median = 24.00
Point estimate for ETA1-ETA2 is 17.00
95.9 Percent CI for ETA1-ETA2 is (0.00,27.00)
W = 68.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0476
The test is significant at 0.0464 (adjusted for ties)

Mann-Whitney Confidence Interval and Test

Cob COD N = 4 Median = 36.50
Salm COD N = 7 Median = 46.00
Point estimate for ETA1-ETA2 is -2.50
95.3 Percent CI for ETA1-ETA2 is (-24.99,15.01)
W = 21.0
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.6366

Cannot reject at alpha = 0.05