Event Based Sampling of Drinking Water Supplies in Newfoundland and Labrador

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1.0 Introduction

Event based sampling is the collection of water quality data during periods of increased water runoff and discharge, with a primary objective of determining potential changes in water quality parameters. Discharge events can be caused by various factors (e.g., rainfall and runoff, ice back-up, excessive snowmelt, and water storage failure) and may affect the water quality dataset when compared to historical, or routine data.

Event based samples have been collected by the Department of Environment, Climate Change and Municipalities since 2016 in five communities that use a surface water supply (Clarenville, Grand Falls-Windsor, Hughes Brook, Meadows and Torbay).

Information on the five surface water supplies analyzed in this study can be found in Table 1.

Table 1: Water System Characteristics

Community	Source Type	Supply Type	Dammed	Reservoir Area	Total Watershed Area (km^2)	Barren (%)	Forest (%)	Shrub (%)	Water (%)	Wetland (%)
Torbay	Pond	SW	Yes	Large	1	2	80	4	8	2
Grand Falls-Windsor	Lake	SW	Yes	Large	61	5	54	12	14	15
Hughes Brook	Reservoir	SW	Yes	Medium	<1	0	93	1	<1	0
Meadows	Pond	SW	Yes	Large	3	0	91	2	6	1
Clarenville	River	SW	Yes	Small	109	3	70	6	8	12
Note: remainder of watershed area is "unclassified" if areas do not sum to 100%.										

Event based samples collected during increased water discharge events were statistically compared to historical drinking water quality data.

The following parameters were analyzed:

- colour (TCU),
- total dissolved solids - TDS (mg/L),
- pH,
- turbidity (NTU),
- dissolved organic carbon - DOC (mg/L), and
- iron (mg/L).

2.0 Methodology

The purpose of this report is to compare event based samples to historical datasets (colour, TDS, pH, turbidity, DOC, and iron) to determine if the two datasets are significantly different.

2.1 Sample Collection

An event-based sample was typically collected when there was a rainfall event of around 20 mm or greater. If there was a significant and rapid snowmelt in the spring, a sample was also collected to represent this melt-runoff event.

2.2 Statistical Tests

Four statistical comparisons were used in this analysis: mean, standard deviation, ANOVA, and Kruskal-Wallis. Microsoft Excel was used for comparing the parameter means and standard deviation in the communities, while *Minitab ® Release 14* was used for the ANOVA and Kruskal-Wallis tests.

2.2.1 ANOVA

ANOVA, or analysis of variance, is a parametric test designed to determine if there is a statistically significant difference between the mean of two groups of data. ANOVA is based on the following three assumptions:

- Data is normally distributed. Note that with violations of normality, continuing with the ANOVA is generally acceptable if there is a large sample size. If the sample size is small, non-parametric tests (e.g. Kruskal-Wallis) are preferred.
- Homogeneity of variance (i.e. variance among the groups should be approximately equal).
- Observations are independent of each other. The results of ANOVA are invalid if the assumption of independence is violated.

The null hypothesis for an ANOVA is that there is no significant difference among the groups being compared. The alternative hypothesis assumes there is at least one significant difference among the groups. The researcher first tests the assumptions of ANOVA and then (using Minitab) calculates the F-ratio and the associated probability value (p-value). In general, if the p-value associated with the F is smaller than 0.05, then the null hypothesis is rejected and the alternative hypothesis is supported. If the null hypothesis is rejected, one concludes that the means of all the groups are not equal. For this assessment, means were not equal when the p-value was less than 0.05 for more than four data points (or less than 0.1 in scenarios with less than three available data points) (Lye, 2005).

2.2.2 Kruskal-Wallis

The Kruskal-Wallis (K-W) test is a non-parametric test that compares the median of two sets of data to determine if they are significantly different. The K-W test is more robust than the parametric ANOVA as it makes use of the median for comparison as opposed to the mean, making it less susceptible to outliers.

For this assessment medians were not equal when the p-value was less than 0.05 for more than four data points (or less than 0.1 in scenarios with less than three available data points) (Lye, 2005).

3.0 Results

3.1 Torbay

Existing source water samples from North Pond were available from 1998-2015 and used for the historical sample data. There have been 16 event based samples collected between 2016 and 2021.

The statistical results (Table 2) indicate the following:

- Colour:
  - ANOVA: event sample data significantly less than historical data.
  - KW: event sample data significantly less than historical data.
- TDS:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- pH:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- Turbidity:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- DOC:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- Iron:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.

Table 2: Torbay - North Pond Statistical Analysis

Colour	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	8.8 (±2.9)	**0.006***
	Historical Data	29	11.6 (±3.1)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	7.7	**0.007***
	Historical Data	29	12.0	
TDS	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	34.1 (±6.2)	0.736
	Historical Data	29	33.5 (±5.6)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	35.5	0.748
	Historical Data	29	33.0	
pH	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	6.6 (±0.3)	**0.000***
	Historical Data	28	6.3 (±0.2)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	6.7	**0.001***
	Historical Data	28	6.3	
Turbidity	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	0.9 (±0.5)	**0.024***
	Historical Data	29	0.6 (±0.4)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	0.7	**0.021***
	Historical Data	29	0.4	
DOC	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	2.9 (±0.5)	0.260
	Historical Data	24	2.7 (±0.8)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	3.0	0.383
	Historical Data	24	2.8	
Iron	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	16	0.04 (±0.04)	0.132
	Historical Data	29	0.03 (±0.02)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	16	0.05	0.432
	Historical Data	29	0.03	

***p-value less than 0.05**

3.2 Grand Falls-Windsor

Existing source water samples from Northern Arm Lake were available from 1987-2017 and used for the historical sample data. There have been five event based samples collected between 2016 and 2021.

The statistical results (Table 3) indicated the following:

- Colour:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- TDS:
  - ANOVA: event sample data significantly less than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly less than historical data.
- pH:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- Turbidity:
  - ANOVA: no significant difference between event sample data and historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: no significant difference between event sample data and historical data.
- DOC:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- Iron:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: event sample data significantly greater than historical data.

Table 3: Grand Falls-Windsor - Northern Arm Lake Statistical Analysis

Colour	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	38.8 (±7.0)	0.652
	Historical Data	78	36.7 (±10.3)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	40.0	0.592
	Historical Data	78	36.0	
TDS	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	8.6 (±1.5)	**0.033***
	Historical Data	71	13.7 (±5.2)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	9.0	**0.005***
	Historical Data	71	13.0	
pH	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	6.7 (±0.3)	**0.032***
	Historical Data	78	6.5 (0.3)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	6.7	**0.048***
	Historical Data	78	6.5	
Turbidity	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	1.0 (±0.4)	0.196
	Historical Data	78	0.7 (±0.5)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	0.8	0.118
	Historical Data	78	0.6	
DOC	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	5.4 (±0.7)	0.699
	Historical Data	78	5.2 (±1.5)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	5.6	0.759
	Historical Data	78	5.4	
Iron	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	5	0.14 (±0.03)	0.054
	Historical Data	73	0.10 (±0.04)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	5	0.14	**0.042***
	Historical Data	73	0.10	

***p-value less than 0.05**

3.3 Hughes Brook

The reservoir in Hughes Brook is fairly small in area and fed by a combination of springs and streams. Existing source water samples from Hughes Brook Reservoir were available from 1988-2015 and used for the historical sample data. There have been 19 event based samples collected between 2016 and 2021.

The statistical results (Table 4) indicate the following:

- Colour:
  - ANOVA: no significant difference between event sample data and historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: no significant difference between event sample data and historical data.
- TDS:
  - ANOVA: no significant difference between event sample data and historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: no significant difference between event sample data and historical data.
- pH:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- Turbidity:
  - ANOVA: event sample data significantly greater than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.
- DOC:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- Iron:
  - ANOVA: no significant difference between event sample data and historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.

Table 4: Hughes Brook Reservoir Statistical Analysis

Colour	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	14.0 (±6.1)	0.148
	Historical Data	8	10.6 (±2.6)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	11.0	0.262
	Historical Data	8	10.5	
TDS	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	190.4 (±21.2)	0.855
	Historical Data	8	188.8 (22.2)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	188.0	0.690
	Historical Data	8	197.5	
pH	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	8.2 (±0.1)	0.405
	Historical Data	8	8.2 (±0.2)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	8.2	0.366
	Historical Data	8	8.2	
Turbidity	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	0.9 (±0.7)	**0.008***
	Historical Data	8	0.2 (±0.1)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	0.7	**0.001***
	Historical Data	8	0.2	
DOC	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	2.7 (±0.9)	0.376
	Historical Data	5	2.3 (±0.8)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	2.9	0.413
	Historical Data	5	2.1	
Iron	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	19	0.01 (±0.03)	**0.380**
	Historical Data	8	0.01 (±0.01)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	19	0.00	0.613
	Historical Data	8	0.00	

***p-value less than 0.05**

3.4 Meadows

Existing source water samples from Meaters Pond are available from 1988-2017 and were used for the historical sample data. There have been 12 event based samples collected for this supply.

The statistical results (Table 5) indicated the following:

- Colour:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- TDS:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- pH:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- Turbidity:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- DOC:
  - ANOVA: event sample data significantly greater than historical data.
  - KW: event sample data significantly greater than historical data.
- Iron:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.

Table 5: Meadows – Meaters Pond Statistical Analysis

Colour	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	15.8 (±6.2)	**0.446**
	Historical Data	15	14.2 (±4.3)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	15.5	0.419
	Historical Data	15	15.0	
TDS	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	42.8 (±3.1)	**0.004***
	Historical Data	15	36.0 (±6.9)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	42.0	**0.001***
	Historical Data	15	37.0	
pH	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	7.3 (±0.3)	**0.003***
	Historical Data	15	6.8 (±0.4)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	7.3	**0.002***
	Historical Data	15	6.8	
Turbidity	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	0.8 (±0.3)	**0.0188***
	Historical Data	15	0.5 (±0.2)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	0.7	**0.047***
	Historical Data	15	0.5	
DOC	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	4.7 (±0.7)	**0.016***
	Historical Data	12	3.9 (±0.8)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	4.7	**0.021***
	Historical Data	12	3.9	
Iron	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	12	0.06 (±0.03)	0.331
	Historical Data	15	0.05 (±0.03)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	12	0.07	0.405
	Historical Data	15	0.06	

***p-value less than 0.05**

3.5 Clarenville

Existing source water samples from Shoal Harbour River are available from 1987-2018 and used for the historical sample data. There have been three event based samples collected.

The statistical results (Table 6) indicated the following:

- Colour:
  - ANOVA: event sample data significantly greater than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.
- TDS:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- pH:
  - ANOVA: no significant difference between event sample data and historical data.
  - KW: no significant difference between event sample data and historical data.
- Turbidity:
  - ANOVA: event sample data significantly greater than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.
- DOC:
  - ANOVA: event sample data significantly greater than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.
- Iron:
  - ANOVA: event sample data significantly greater than historical data. Datasets were not normally distributed therefore the validity of the ANOVA results are uncertain.
  - KW: event sample data significantly greater than historical data.

Due to the lack of event sample data for Clarenville, a 90% confidence interval was used for the statistical assessment. As such, the assessment is considered less accurate when compared to the other analyzed water sources.

Table 6: Clarenville – Shoal Harbour River Reservoir Statistical Analysis

Colour	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	146.7 (±23.1)	**0.000***
	Historical Data	62	54.3 (±20.1)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	144.0	**0.004***
	Historical Data	62	53.5	
TDS	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	31.7 (±5.9)	0.053
	Historical Data	55	24.6 (±6.1)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	34.0	0.060
	Historical Data	55	23.0	
pH	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	6.4 (±0.5)	0.472
	Historical Data	62	6.5 (±0.4)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	6.6	0.802
	Historical Data	62	6.5	
Turbidity	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	1.7 (±0.5)	**0.001***
	Historical Data	61	0.6 (±0.5)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	1.6	**0.009***
	Historical Data	61	0.4	
DOC	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	16.8 (±3.5)	**0.000***
	Historical Data	61	6.7 (±2.0)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	16.1	**0.004***
	Historical Data	61	6.7	
Iron	**ANOVA**	Number of Water Samples	Mean (Standard Deviation)	p-value
	Event Data	3	0.43 (±0.07)	**0.000***
	Historical Data	59	0.21 (±0.10)	
	Kruskal-Wallis	Number of Water Samples	Median	p-value
	Event Data	3	0.42	**0.007***
	Historical Data	59	0.19	

***p-value less than 0.05**

3.6 Mean, Median and Standard Deviation Comparison

3.6.1 Colour

Colour in drinking water can be caused by the presence of organic substances originating in the decay of natural vegetation such as in soil runoff; presence of metals such as iron, manganese and copper; or the presence of highly coloured industrial wastes (the most common being pulp and paper textile wastes). Although colour in water does not necessarily pose any health risks, the Guidelines for Canadian Drinking Water Quality (GCDWQ) set an aesthetic objective (AO) for colour of ≤ 15 TCU, a threshold that can be detected visually by most consumers (Health Canada, 2020).

- Figure 1: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 2: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: event-based sampling significantly lower than historical data (event based median = 7.7 TCU vs. historical median = 12.0 TCU).
- Grand Falls-Windsor: no significant difference between event-based sampling and historical data (event based median = 40.0 TCU vs. historical median = 36.0 TCU).
- Hughes Brook: no significant difference between event-based sampling and historical data (event based median = 11.0 TCU vs. historical median = 10.5 TCU.
- Meadows: no significant difference between event-based sampling and historical data (event based median = 15.5 TCU vs. historical median = 15.0 TCU).
- Clarenville: event-based sampling significantly higher than historical data (event based median = 144.0 TCU vs. historical median = 53.5 TCU).

General conclusion: colour does not always increase during a rainfall-runoff event. Maximum colour observed during event based sampling was in the Clarenville water supply.

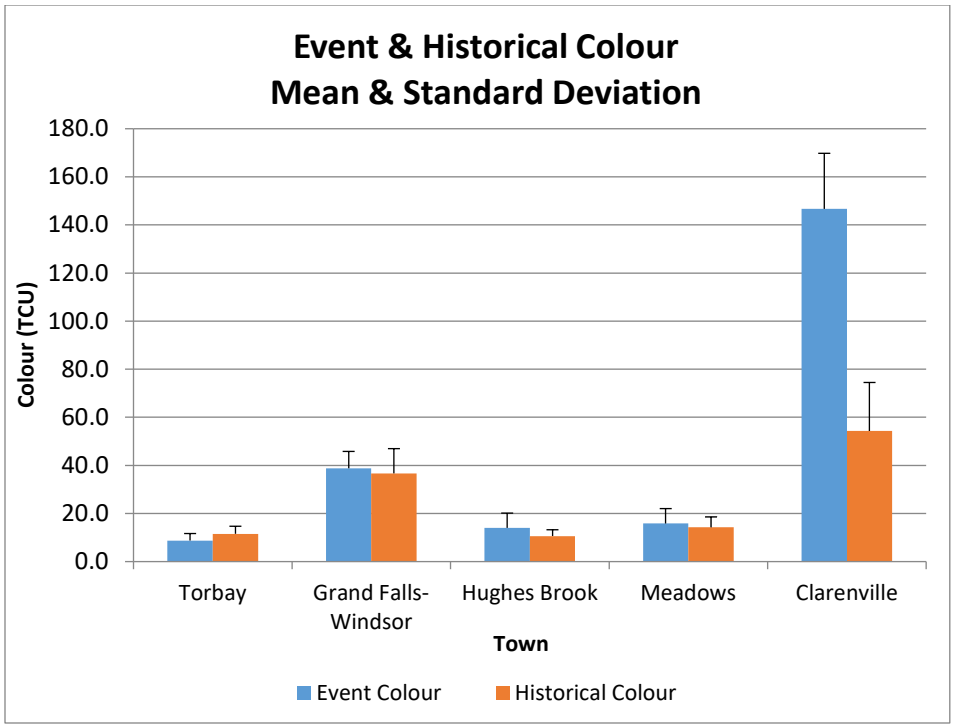

Figure 1: Event & Historical Colour – Mean & Standard Deviation

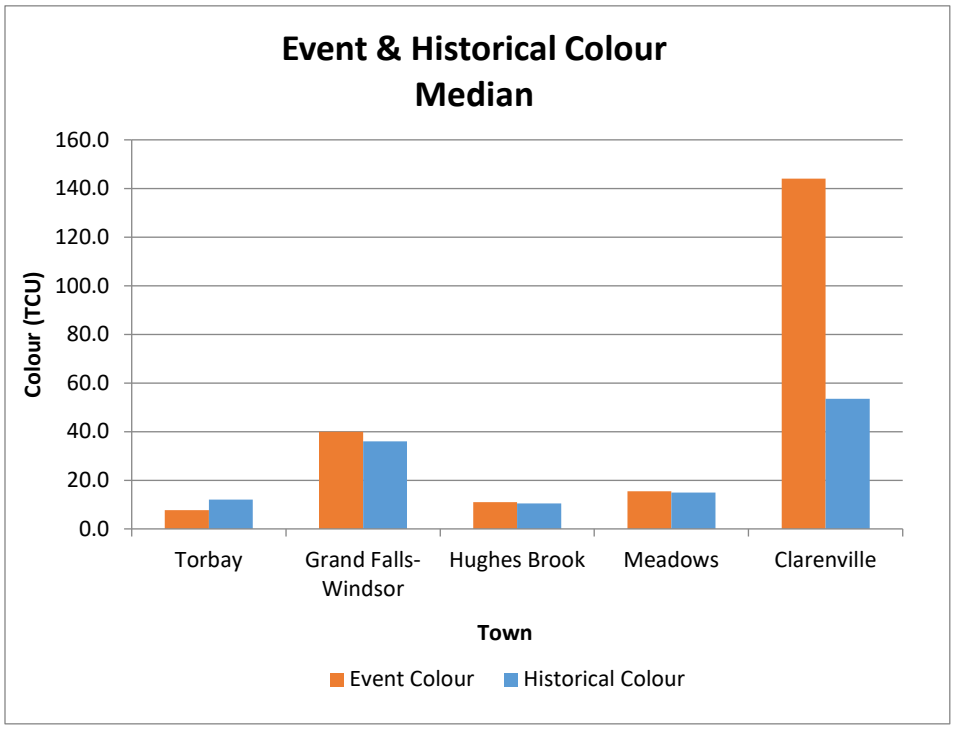

Figure 2: Event & Historical Colour – Median

3.6.2 Total Dissolved Solids

Total dissolved solids (TDS) in drinking water typically originates from natural sources, sewage, urban and agricultural run-off, and chemicals used in the water treatment process. It is composed of inorganic salts and small amounts of organic matter that are dissolved in water (e.g., calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate and nitrate). In general. TDS is the sum of the cations and anions present in drinking water. The main importance of TDS in drinking water is aesthetic. The AO for TDS in drinking water is ≤ 500 mg/L (Health Canada, 2020). At higher levels, excessive hardness, unpalatability, mineral deposition and corrosion may occur.

- Figure 3: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 4: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: no significant difference between event-based sampling and historical data (event median = 35.5 mg/L vs. historical median = 33.0 mg/L)
- Grand Falls-Windsor: event-based sampling significantly lower than historical data (event based median = 9.0 mg/L vs. historical median = 13.0 mg/L).
- Hughes Brook: no significant difference between event-based sampling and historical data (event median = 188.0 mg/L vs. historical median = 197.5 mg/L).
- Meadows: event-based sampling significantly higher than historical data (event based median = 42.0 mg/L vs. historical median = 37.0 mg/L).
- Clarenville: no significant difference between event-based sampling and historical data (event based median = 34.0 mg/L vs. historical median = 23.0 mg/L).

General conclusion: although there is a limited amount of event data, these results indicate that the TDS levels may not always be significantly impacted during increased water runoff and discharge events and may be watershed specific.

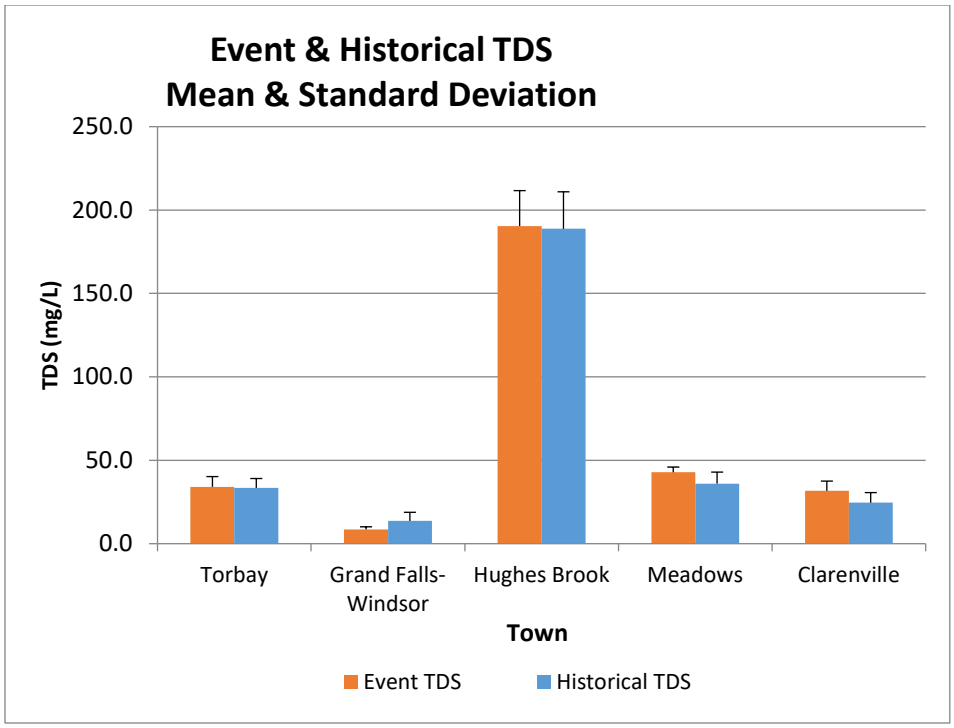

Figure 3: Event & Historical TDS – Mean & Standard Deviation

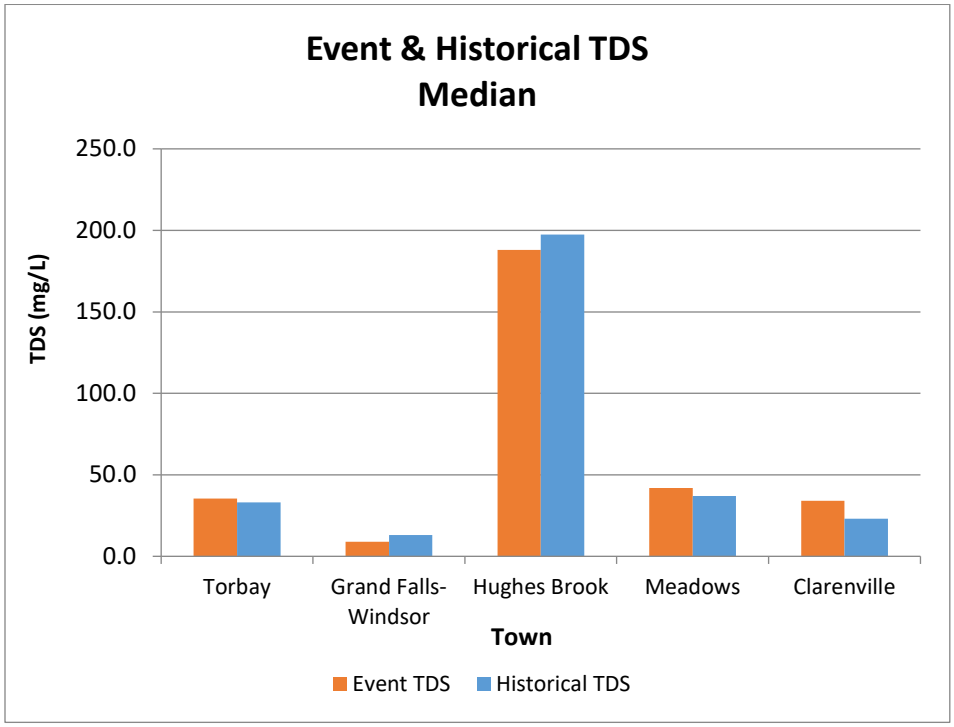

Figure 4: Event & Historical TDS - Median

3.6.3 pH

pH is a measure of the acidity/basicity of water and is one of the most important operational water quality parameters. Every process in water treatment, including coagulation, precipitation, water softening, disinfection and corrosion control, is dependent on pH. The control of pH is important to maximize treatment effectiveness, control corrosion and reduce leaching or metals from distribution system and plumbing components. The GCDWQ acceptable pH range is 7.0-10.5.

- Figure 5: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 6: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: event-based sampling significantly higher than historical data
  (event based median = 6.7 vs. historical median = 6.3)
- Grand Falls-Windsor: event-based sampling significantly higher than historical data
  (event based median = 6.7 vs. historical median = 6.5).
- Hughes Brook: no significant difference between event-based sampling and historical data
  (event based median = 8.2 vs. historical median = 8.2)
- Meadows: event-based sampling significantly higher than historical data
  (event based median = 7.3 vs. historical median = 6.8)
- Clarenville: no significant difference between event-based sampling and historical data
  (event based median = 6.6 vs. historical median = 6.5).

General conclusion: pH levels increased during event based sampling for three out of the five tested sources. pH may respond differently in pond/lake sources than in stream/river sources.

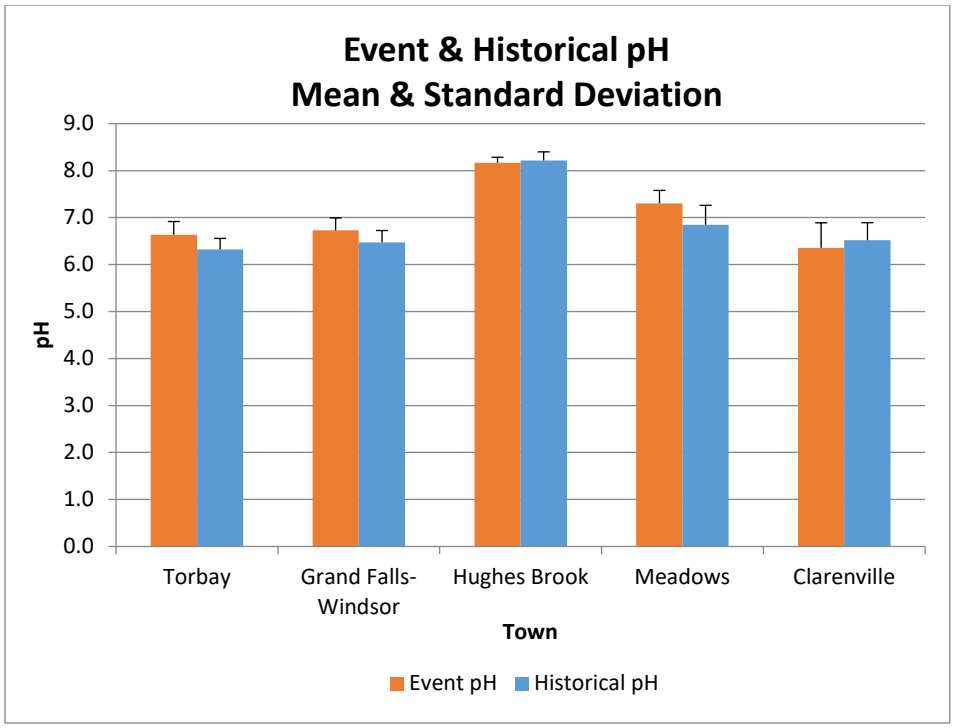

Figure 5: Event & Historical pH – Mean & Standard Deviation

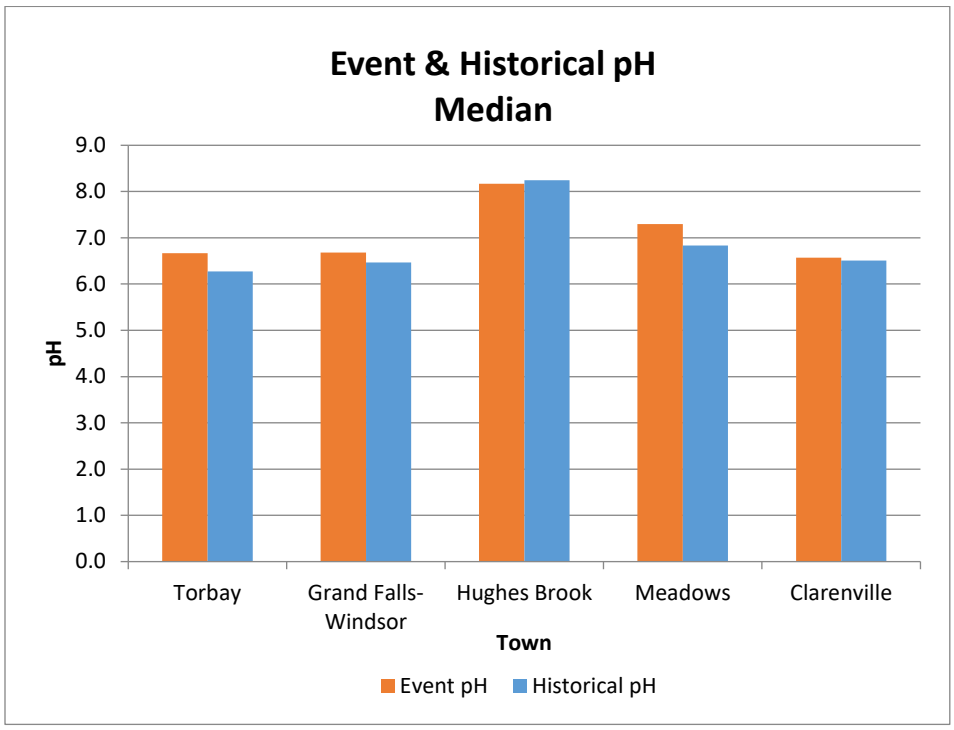

Figure 6: Event & Historical pH - Median

3.6.4 Turbidity

Turbidity is a measure of the relative clarity or cloudiness of water and is measured in nephelometric turbidity units (NTU). It is not a direct measure of suspended particles, but rather a general measure of the scattering and absorbing effect that suspended particles have on light. Turbidity is caused by naturally occurring particles both inorganic (clays, silts, metal precipitates) and organic (decomposed plant and animal microorganisms). These particles can shield microorganisms from disinfection and can entrap heavy metals or biocides. Elevated or fluctuating turbidity levels in filtered water can indicate problems with the water treatment process and a potential increased risk of pathogens in treated water. Filtration systems should be designed and operated to reduce turbidity levels as low as possible to achieve a treated water turbidity ≤ 0.1 NTU for a full scale water treatment plant to ensure pathogen removal goals are met (Health Canada 2020). For the purpose of this study, a guideline value of 1.0 NTU is applicable.

- Figure 7: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 8: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: event-based sampling significantly higher than historical data
  (event based median = 0.72 NTU vs. historical median = 0.40 NTU)
- Grand Falls-Windsor: no significant difference between event-based sampling and historical data
  (event based median = 0.83 NTU vs. historical median = 0.64 NTU)
- Hughes Brook: event-based sampling significantly higher than historical data
  (event based median = 0.70 NTU vs. historical median = 0.20 NTU)
- Meadows: event-based sampling significantly higher than historical data
  (event based median = 0.70 NTU vs. historical median = 0.50 NTU)
- Clarenville: event-based sampling significantly higher than historical data
  (event based median = 1.60 NTU vs historical median = 0.40 NTU).

General conclusion: from this data it can be determined that turbidity is known to increase during a rainfall runoff event as this change occurred for all water sources. The greatest difference between event based sampling turbidity and historical turbidity was observed in Hughes Brook and Clarenville (both have intakes sited in a river).

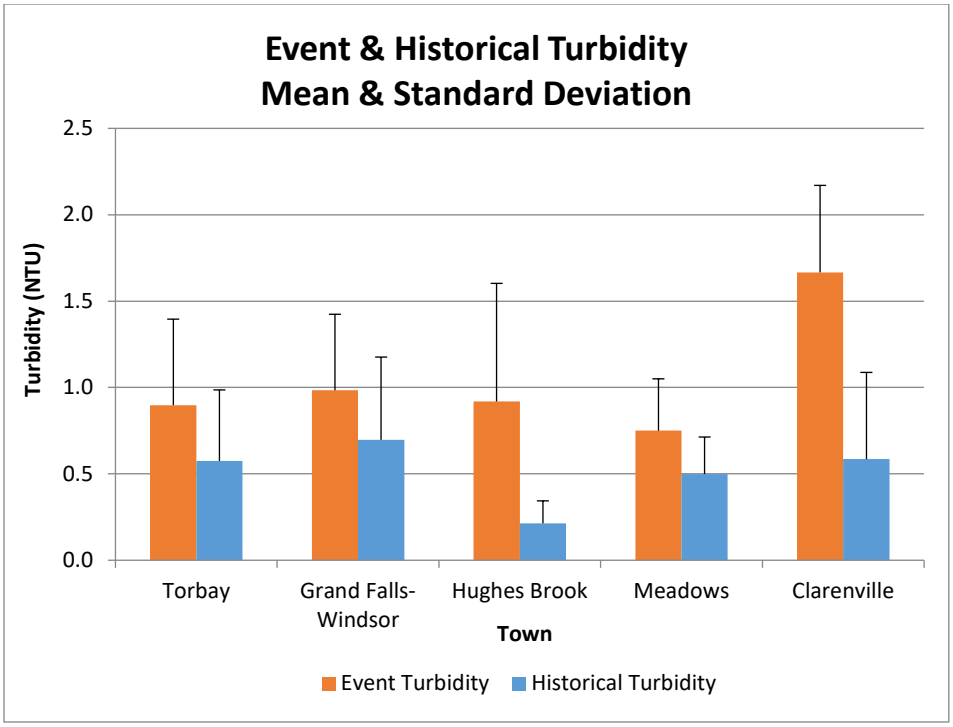

Figure 7: Event & Historical Turbidity – Mean & Standard Deviation

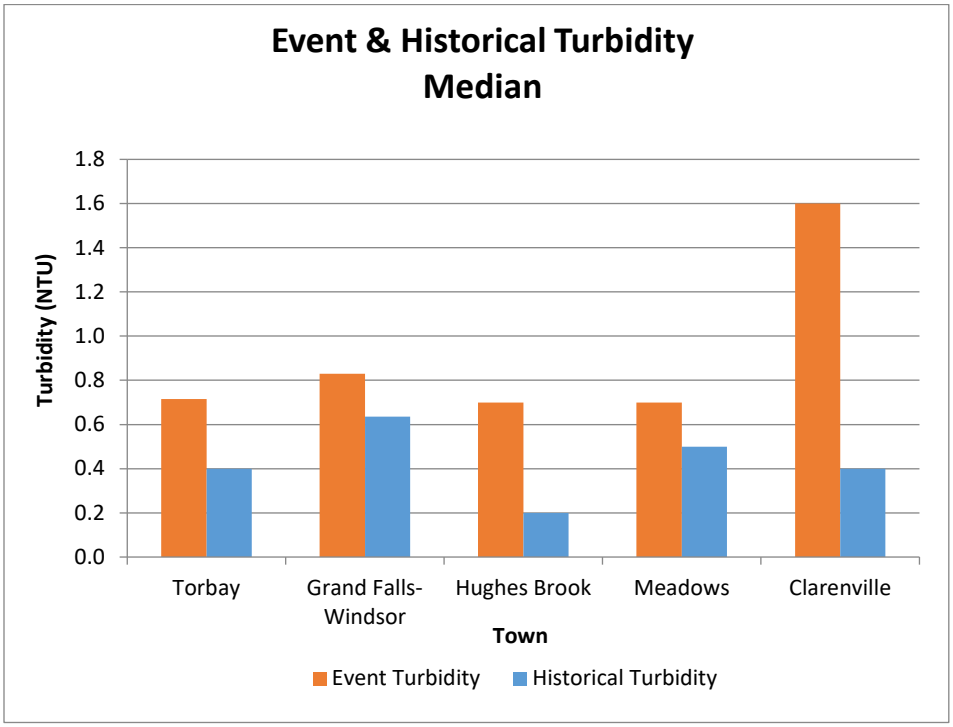

Figure 8: Event & Historical Turbidity - Median

3.6.5 Dissolved Organic Carbon

Natural organic matter (NOM) refers to a group of carbon-based compounds that are found in surface water and some groundwater supplies. Although they do not pose a risk to human health on their own, NOMs are known to react with chlorine and produce disinfection by-products. In most water supplies in Atlantic Canada, the majority of NOM exist as dissolved compounds and is often measured as dissolved organic carbon (DOC). DOC includes soluble carbohydrates, amino acids, and other acids whose sources include photosynthesis, leaching from plant leaves and roots, and soil organic matter. DOC levels are naturally high in Newfoundland and Labrador due to the abundance of bogs and wetlands. There is no guideline for DOC levels in drinking water in the province but it is preferred that this parameter be as low as possible, preferably less than 4 mg/L.

- Figure 9: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 10: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: no significant difference between event-based sampling and historical data (event based median = 2.95 mg/L vs. historical median = 2.80 mg/L)
- Grand Falls-Windsor: no significant difference between event-based sampling and historical data (event based median = 5.60 mg/L vs. historical median = 5.40 mg/L).
- Hughes Brook: no significant difference between event-based sampling and historical data (event based median = 2.90 mg/L vs. historical median = 2.10 mg/L).
- Meadows: event-based sampling significantly higher than historical data (event based median = 4.70 mg/L vs. historical median = 3.85 mg/L)
- Clarenville: event-based sampling significantly higher than historical data (event based median = 16.10 mg/L vs. historical median = 6.70 mg/L).

General conclusion: Meadows and Clarenville were the only sources that displayed a significant change between historical and event based sampling for DOC levels (ANOVA & K-W). From the data available for assessment, it can be assumed that DOC typically increases during a high rainfall event, though not significantly.

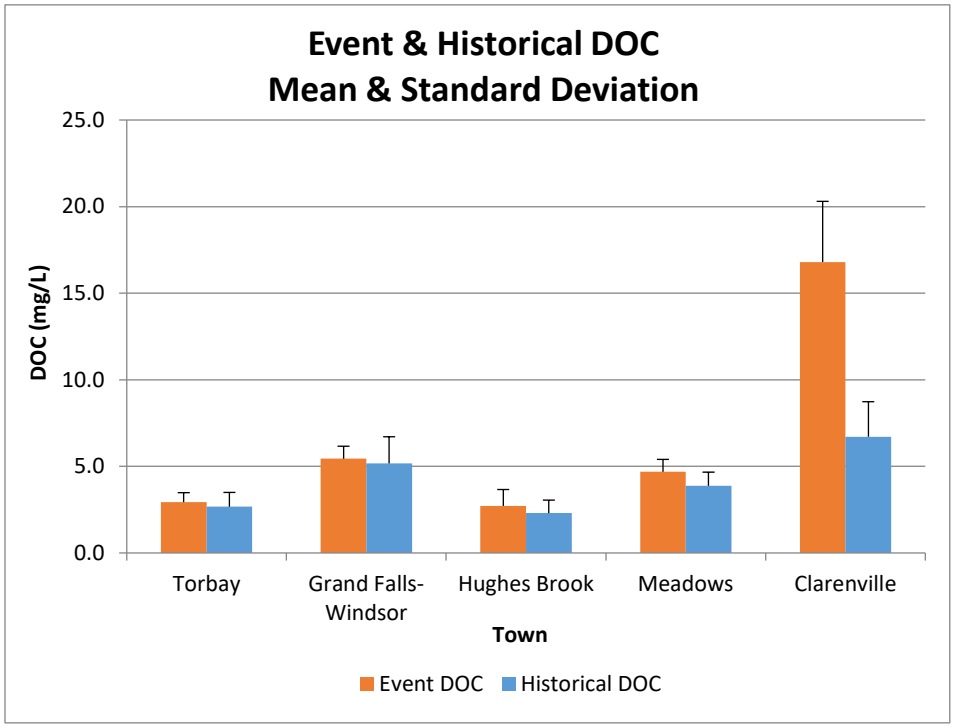

Figure 9: Event & Historical DOC – Mean & Standard Deviation

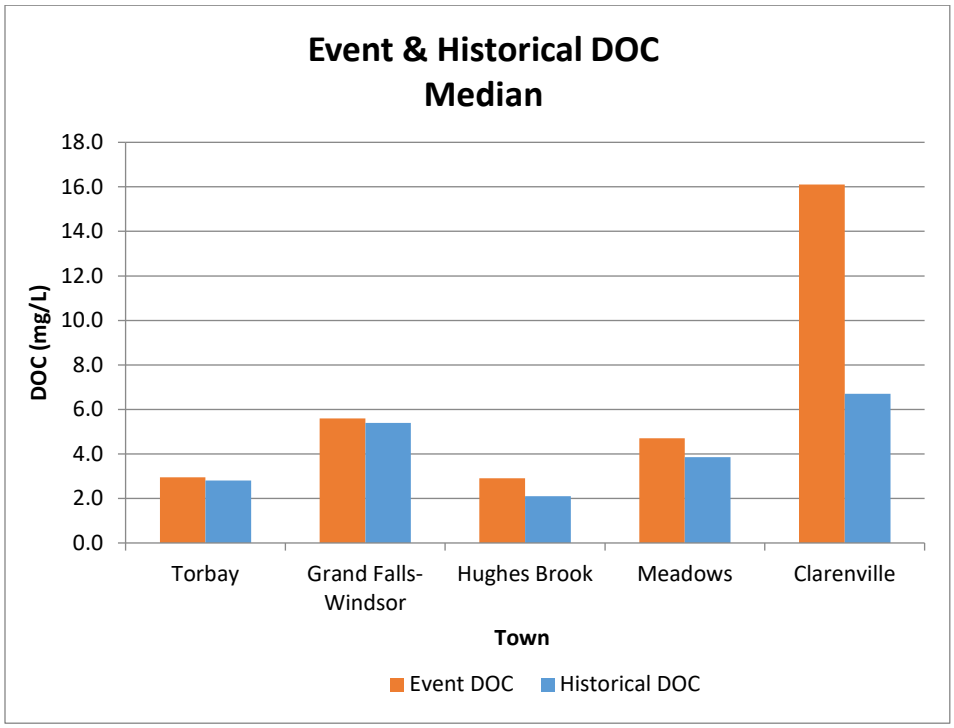

Figure 10: Event & Historical DOC - Median

3.6.6 Iron

Iron is a natural occurring metal caused by erosion and watering of rocks and minerals. It can also become present in drinking water from acidic mine water drainage, landfill leachates, sewage effluents and iron-related industries. Iron is typically present in surface waters as salts containing Fe(III) when the pH is above 7. Toxic effects have resulted from the ingestion of large quantities of iron, but there is no evidence to indicate that concentrations of iron commonly present in food or drinking water constitute any hazard to human health. Therefore, a maximum acceptable concentration (MAC) has not been set. Only a small percentage of the population are capable of tasting iron in drinking water at concentrations below 0.3 mg/L and therefore the aesthetic objective (AO) for iron quantity is ≤ 0.3 mg/L (Health Canada 2020).

- Figure 11: comparison of the mean and standard deviation of event based samples and the historical dataset.
- Figure 12: comparison of the median of the event based samples and the historical dataset.

Community summary:

- Torbay: no significant difference between event-based sampling and historical data (event based median = 0.05 mg/L vs. historical median = 0.03 mg/L).
- Grand Falls-Windsor: event-based sampling significantly higher than historical data (event based median = 0.14 mg/L vs. 0.10 mg/L).
- Hughes Brook: no significant difference between event-based sampling and historical data (event based median = 0.00 mg/L vs. 0.00 mg/L).
- Meadows: no significant difference between event-based sampling and historical data (event based median = 0.07 mg/L vs. historical median = 0.06 mg/L).
- Clarenville: event-based sampling significantly higher than historical data (event based median = 0.42 mg/L vs. historical median = 0.19 mg/L).

General conclusion: From statistical analysis, Grand Falls-Windsor (K-W) and Clarenville (ANOVA & K-W) were the only sources that displayed a significant change between historical and event based sampling for iron content This is clearly displayed (Figure) as all sources display an increase in iron during event based sampling. Therefore it can be confirmed that iron content typically increases during an event.

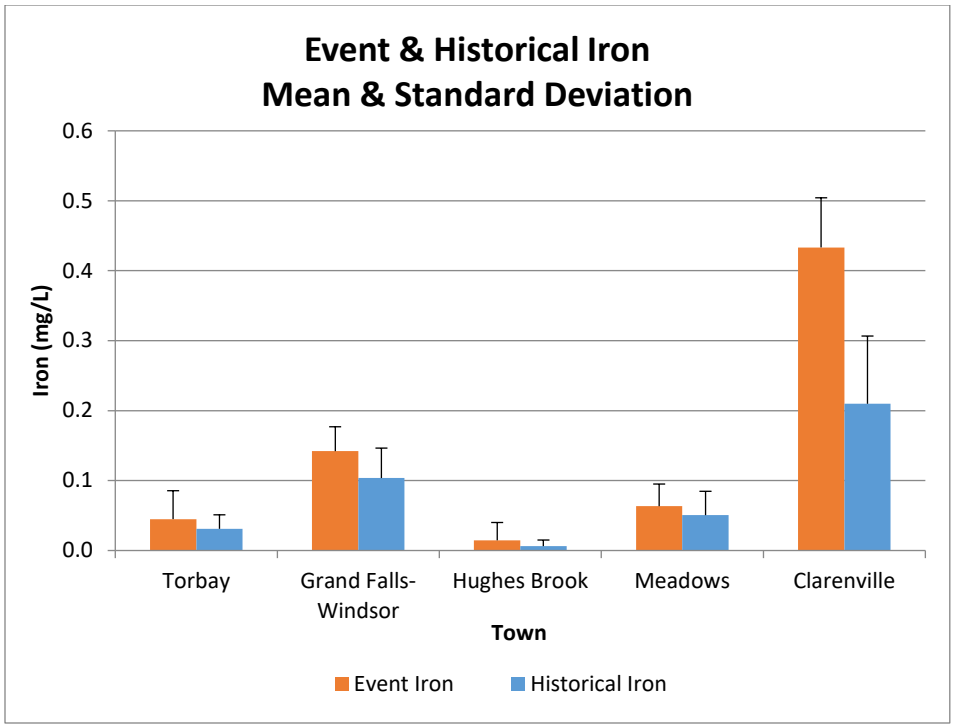

Figure 11: Event & Historical Iron – Mean & Standard Deviation

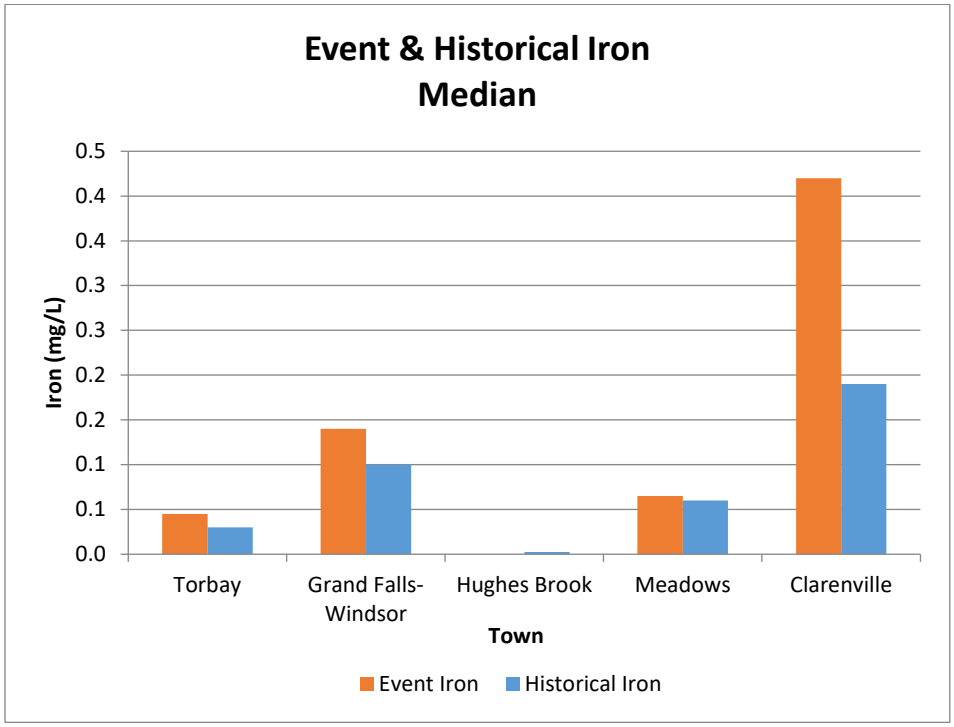

Figure 12: Event & Historical Iron - Median

4.0 Conclusions

The following general conclusions can be made with respect to the impact that rainfall-runoff events have on surface water quality in Newfoundland and Labrador:

- Turbidity increased in all types of surface water sources after an event, and that increase was most significant in stream/river type sources.
- DOC increased in all types of surface water sources after an event, and that increase was most significant in stream/river type sources.
- Iron increased in all types of surface water sources after an event, and that increase was most significant in stream/river type sources.

5.0 Recommendations

Drinking water treatment systems should be designed for the worst-case drinking water quality conditions that can be expected and that may or may not be represented in the available historical source water quality dataset. As such, the variances shown in Table 7 should be added to the historical dataset (mean and max) for determining worst-case drinking water quality conditions from surface drinking water sources.

Table 7: Variances to be added to Historical Data

Parameter	Variance to be added to Historical Mean			Variance to be added to Historical Max		
	Pond	River	Reservoir	Pond	River	Reservoir
Colour	-	+92.360	-	-	+42.000	-
TDS	+6.833	-	-	-	-	-
pH	+0.342	-0.106	-0.106	-	-	-
Turbidity	+0.287	+1.081	+0.705	+0.500	-	+2.000
DOC	+0.449	+10.091	+0.416	-	+5.700	+1.000
Iron	+0.022	+0.224	+0.008	+0.050	-	-
"-" High precipitation event did not negatively affect water quality parameter						

Based on the findings of this report, the following recommendations have been made:

- Continue the collection of event based samples from surface water drinking water sources to improve the statistical comparison between the historical dataset and event-based data.
- Obtain additional event-based samples for river and reservoir water sources to improve variance to be added to historical data.
- Include the table of observed variance for water quality parameter from surface water sources during rainfall-runoff events to reflect worst-case conditions in the Guidelines for the Design, Construction and Operation of Drinking Water Systems.

6.0 References

Dr. Leonard Lye, P. F. 2005. A Short Course in Environmental Statistics. St. John's: Memorial University of Newfoundland and Labrador.

Health Canada. 2020. Guidelines for Canadian Drinking Water Quality. Federal-Provincial-Territorial Committee. Retrieved via: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

Appendix A

Event Based Sample Data

Appendix B

Historical Sample Data

Appendix C

Minitab Results

Torbay - North Pond						
Time	Colour (TCU)	TDS	pH	Turbidity	DOC	Iron
09-Jun-16	8.3	27	6.66	0.99	2.1	0
12-Jul-16	5.6	28	6.32	0.83	2.5	0.059
08-Aug-16	7.1	31	6.89	0.73	2.5	0
21-Nov-16	13	27	6.19	1.1	3.2	0.082
28-Nov-16	15	29	6.52	0.68	3.3	0.11
12-Sep-17	13	25	6.65	0.77	3.8	0.13
11-Dec-17	9.2	27	6.39	0.56	2.9	0.067
5/31/2018	10	36	6.25	0.7	3.2	0.05
6/20/2018	10	38	6.71	0.6	3.3	0
9/13/2018	7	42	7.03	0.6	2.2	0.03
9/19/2018	7	38	6.38	0.5	3.9	0.03
10/17/2018	5	42	6.67	1.6	2.9	0.05
11/30/2018	7	40	6.74	2.4	3.3	0.07
7/2/2019	7	35	7.14	0.6	2.2	0
9/4/2019	6	40	6.8	0.5	3	0
11/22/2019	10	40	6.87	1.2	2.7	0.04
Mean	8.7625	34.0625	6.6381	0.8975	2.9375	0.0449
Standard Dev.	2.9074	6.1695	0.2782	0.4982	0.5439	0.0406
Median	7.700	35.500	6.665	0.715	2.950	0.045
Max	15.000	42.000	7.140	2.400	3.900	0.130

Grand Falls-Windsor - Northern Arm Lake						
Name	Colour (TCU)	TDS	pH	Turbidity	DOC	Iron
07-Jul-16	40	10	6.88	0.66	5.7	0.12
08-Aug-16	27	9	7.1	0.83	5	0.11
12-Oct-16	43	7	6.53	1.4	6.4	0.2
29-May-17	45	7	6.68	0.53	4.5	0.14
5/30/2018	39	10	6.45	1.5	5.6	0.14
Mean	38.8000	8.6000	6.7280	0.9840	5.4400	0.1420
Standard Dev.	7.0143	1.5166	0.2647	0.4399	0.7232	0.0349
Median	40.000	9.000	6.680	0.830	5.600	0.140
Max	45.000	10.000	7.100	1.500	6.400	0.200

Hughes Brook - Reservoir (spring)						
Name	Colour (TCU)	TDS	pH	Turbidity	DOC	Iron
30-Jun-16	11	160	8.16	0.24	1.7	0
09-Sep-16	10	180	8	0.81	2	0.058
11-Oct-16	16	180	8.09	2.1	3.2	0.053
24-Oct-16	21	180	8.06	0.64	3.7	0
17-May-17	17	140	7.92	1.1	2.9	0.066
07-Aug-17	9.2	170	8.09	0.37	2.1	0
13-Sep-17	8.1	180	8.05	1	2.3	0
5/10/2018	32	188	8.33	1.9	2.5	0
5/30/2018	11	184	8.24	0.6	3	0
6/20/2018	11	176	8.13	0.5	3.1	0
7/25/2018	11	204	8.22	0.2	2.9	0
8/10/2018	12	193	8.26	0.2	1.9	0
9/13/2018	9	209	8.23	0.5	1.2	0
10/17/2018	8	213	8.2	0.3	1.9	0
10/30/2018	19	212	8.14	1.8	4.6	0
9/4/2019	9	206	8.17	0.7	1.5	0
11/7/2019	16	221	8.34	0.7	3.2	0
11/13/2019	22	213	8.23	1.4	4.5	0.06
12/11/2019	14	209	8.34	2.4	3.4	0.04
Mean	14.0158	190.4211	8.1684	0.9189	2.7158	0.0146
Standard Dev.	6.1411	21.2376	0.1155	0.6838	0.9483	0.0255
Median	11.000	188.000	8.170	0.700	2.900	0.000
Max	32.000	221.000	8.340	2.400	4.600	0.066

Meadows (Pond)						
Name	Colour (TCU)	TDS	pH	Turbidity	DOC	Iron
5/17/2018	27	46	7.52	0.8	4.2	0.09
5/30/2018	20	38	7.19	0.5	4.5	0.06
6/20/2018	16	38	7.12	0.5	4.7	0.04
7/25/2018	14	46	7.4	0.5	4.9	0.05
8/10/2018	13	47	7.57	0.6	3.8	0.05
9/13/2018	12	41	7.25	0.4	3.4	0
10/17/2018	13	42	6.87	0.9	4.4	0.07
10/30/2018	16	42	6.94	1	5.8	0.07
9/4/2019	15	47	7.88	0.4	4.7	0.03
11/7/2019	22	43	7.31	1.2	4.9	0.11
11/13/2019	20	42	7.32	1.1	5	0.1
12/11/2019	2	42	7.28	1.1	5.9	0.09
Mean	15.8333	42.8333	7.3042	0.7500	4.6833	0.0633
Standard Dev.	6.2061	3.1286	0.2747	0.3000	0.7196	0.0317
Median	15.500	42.000	7.295	0.700	4.700	0.065
Max	27.000	47.000	7.880	1.200	5.900	0.110

Clarenville (River)						
Name	Colour (TCU)	TDS	pH	Turbidity	DOC	Iron
9/13/2018	125	36	6.57	1.6	13.7	0.37
10/22/2018	171	25	5.75	2.2	20.6	0.42
9/4/2019	144	34	6.75	1.2	16.1	0.51
Mean	146.6667	31.6667	6.3567	1.6667	16.8000	0.4333
Standard Dev.	23.1157	5.8595	0.5330	0.5033	3.5029	0.0709
Median	144.000	34.000	6.570	1.600	16.100	0.420
Max	171	36	6.75	2.2	20.6	0.51

LOCATION	EVENT MEAN	EVENT MEDIAN	EVENT MAX	EVENT STDEV	
Event Colour					
Torbay	8.763	7.700	15.000	2.907	Low
Grand Falls-Windso	38.800	40.000	45.000	7.014	
Hughes Brook	14.016	11.000	32.000	6.141	
Meadows	15.833	15.500	27.000	6.206	
Clarenville	146.667	144.000	171.000	23.116	High
Event TDS					
Torbay	34.063	35.500	42.000	6.169	
Grand Falls-Windso	8.600	9.000	10.000	1.517	Low
Hughes Brook	190.421	188.000	221.000	21.238	High
Meadows	42.833	42.000	47.000	3.129	
Clarenville	31.667	34.000	36.000	5.859	
Event pH					
Torbay	6.638	6.665	7.140	0.278	
Grand Falls-Windso	6.728	6.680	7.100	0.265	
Hughes Brook	8.168	8.170	8.340	0.116	High
Meadows	7.304	7.295	7.880	0.275	
Clarenville	6.357	6.570	6.750	0.533	Low
Event Turbidity					
Torbay	0.898	0.715	2.400	0.498	
Grand Falls-Windso	0.984	0.830	1.500	0.440	
Hughes Brook	0.919	0.700	2.400	0.684	
Meadows	0.750	0.700	1.200	0.300	Low
Clarenville	1.667	1.600	2.200	0.503	High
Event DOC					
Torbay	2.938	2.950	3.900	0.544	
Grand Falls-Windso	5.440	5.600	6.400	0.723	
Hughes Brook	2.716	2.900	4.600	0.948	Low
Meadows	4.683	4.700	5.900	0.720	
Clarenville	16.800	16.100	20.600	3.503	High
Event Iron					
Torbay	0.045	0.045	0.130	0.041	
Grand Falls-Windso	0.142	0.140	0.200	0.035	
Hughes Brook	0.015	0.000	0.066	0.025	Low
Meadows	0.063	0.065	0.110	0.032	
Clarenville	0.433	0.420	0.510	0.071	High

Torbay (Pond)						
Time	**Colour (TCU)**	**TDS**	**pH**	**Turbidity**	**DOC**	**Iron**
19-May-88	15	40	6.2	0.3		0.06
13-Jun-90	13	30	6.23	0.22		0.04
15-Nov-90	15	50	6.16	0.17		0.01
16-Jun-93	10	33	6.52	0.85		0.05
8-Nov-93	14	32	6.36	0.26		0.03
7-Jun-94	13	37	6.25	0.33	1.8	0.005
23-Nov-94	14	35	6.32	0.24	2.6	0.02
21-Jun-95	5	40	6.28	0.8	2.9	0.043
12-Oct-95	10	30	6.35	0.8	3.4	0.039
23-May-96	5	30	7.1	0.2	2.7	0.028
26-Sep-96	11	36	6.45	1.3	1.9	0.03
5-Jun-97	17	32		0.32	2.9	0.02
2-Oct-97	12	38	6.23	0.47	3	0.005
14-Apr-98	13	30	6.01	0.27	2.9	0.02
1-Oct-98	14	28	6.43	0.83	3.1	0.03
17-May-99	11	31	6.24	0.36	0.25	0.01
22-Sep-99	11	29	6.32	0.16	1.1	0.005
18-May-00	9	30	6.53	0.22	2.6	0.005
9-Nov-00	15	30	6.27	0.3	2.2	0.01
27-Jun-01	13	28	6.26	0.07	2.4	0.01
31-Oct-01	9	36	6.5	0.4	3.6	0.03
27-May-04	11	40	6.22	0.6	2.4	0.05
3-Nov-04	12	36	5.91	1.1	3.6	0.08
22-Aug-05	8	33	6.38	1.7	3.3	0.04
18-Sep-06	7	34	6.04	1.1	3.3	0.06
27-May-09	13	23	6.44	0.9	2.7	0.05
27-Nov-09	17	23	6.09	1	4.1	0.06
21-Aug-12	8	40	6.77	1	2.9	0.03
19-Aug-15	10	36	6.2	0.4	2.4	0.03
Mean	11.5517	33.4483	6.3236	0.5748	2.6688	0.0310
Standard Dev.	3.1463	5.6289	0.2335	0.4112	0.8270	0.0200
Median	12.000	33.000	6.275	0.400	2.800	0.030
Max	17.000	50.000	7.100	1.700	4.100	0.080

Grand Falls-Windsor (Lake)						
Time	**Colour (TCU)**	**TDS**	**pH**	**Turbidity**	**DOC**	**Iron**
17-Jun-87	20		6.65	0.4	3.85	0.09
21-Oct-87	20		6.3	0.9	6.05	0.19
11-Jun-93	40	10	6.55	0.72	0.5	0.07
25-Oct-93	35	13	6.58	0.76	1	0.13
14-Jun-94	44	12	6.28	0.29	1.8	0.06
15-Nov-94	44	14	6.48	0.31	2.5	0.11
22-Jun-95	30	20	6.5	0.2	4.3	0.119
12-Oct-95	35	30	6.58	0.4	7.3	0.147
18-Jun-96	30	20	6.33	0.4	5	0.058
10-Oct-96	50	16	6.43	1.41	3	0.15
9-Jun-97	40	20	6.1	0.43	4.3	0.02
11-Aug-97	28		6.52	0.34	3.4	
24-Nov-97	50	18	6.33	0.53	6.3	0.08
25-Feb-98	54		6.66	0.27	3.4	
4-Jun-98	40	16	6.36	0.31	4.7	0.07
25-Aug-98	34		6.56	1.22	5.3	
16-Nov-98	48	13	6.46	1.65	5.2	0.12
4-Feb-99	36	12	6.26	0.36	3.1	0.06
26-May-99	34	12	6.46	0.38	3.1	0.02
26-Aug-99	28		6.52	0.67	3.8	
9-Nov-99	44	22	5.99	1.68	5.4	0.03
15-Mar-00	34		5.99	0.34	3.5	
25-May-00	41	14	6.64	0.98	4.3	0.005
9-Aug-00	29	18	6.65	0.46	4.1	0.13
14-Dec-00	53	17	6.45	0.25	5.8	0.005
14-Feb-01	57	23	6.1	0.35	6.3	0.06
25-Jun-01	36	14	6.42	0.15	5.4	0.09
29-Aug-01	23	12	6.32	0.8	3.4	0.1
23-Nov-01	25	14	6.38	1.2	6.3	0.1
16-Jan-02	35	16	6.23	0.4	4.5	0.11
10-May-02	29	11	6.58	0.6	4	0.11
24-Jul-02	20	12	6.22	0.7	3.7	0.14
18-Oct-02	36	17	6.37	0.7	7.1	0.11
4-Feb-03	45	14	6.2	0.7	5.2	0.14
15-May-03	37	10	5.93	1	4.6	0.16
11-Jul-03	26	10	6.29	0.6	4.2	0.07
18-Nov-03	41	12	6.2	1.3	5.9	0.14
23-Jan-04	49	16	6.28	0.5	8.3	0.16
15-Jun-04	32	10	6.09	0.7	4.9	0.08
31-Aug-04	24	11	6.35	0.6	5.9	0.11
9-Nov-04	39	12	6.11	1.2	6.3	0.12
20-Jan-05	57	15	6.36	0.6	6.1	0.1
2-Jun-05	34	8	6.45	0.7	4	0.09
4-Aug-05	19	10	6.76	0.6	4.3	0.08
21-Nov-05	35	12	6.62	0.9	6.5	0.11
13-Feb-06	29	15	6.51	0.2	5.7	0.09
22-Sep-06	38	13	6.46	1	8.3	0.1
1-Jun-07	20	7	6.59	0.4	6.9	0.09
13-Aug-07	33	7	6.7	0.5	6	0.2
5-Dec-07	30	9	6.63	2.1	6	0.15
13-Feb-08	0	37	7.36	0	3	0
2-Jun-08	43	6	6.49	0.3	4.9	0.11
12-Sep-08	30	7	6.39	0.6	4.5	0.15
28-Nov-08	41	9	6.59	1.1	6.5	0.16
11-Feb-09	49	16	6.7	0	6.1	0.14
29-May-09	31	10	6.57	0.7	4.6	0.08
16-Sep-09	40	7	6.7	0.4	6.9	0.12
30-Nov-09	51	11	6.42	0.6	6.3	0.15
22-Jan-10	47	12	6.44	0.5	5.6	0.1
3-Jun-10	37	10	6.53	0.7	6	0.09
16-Sep-10	30	13	6.87	0.7	5.8	0.1
19-Nov-10	43	12	6.62	0.7	7.1	0.09
28-Feb-11	40	17	6.84	0.7	5.4	0.08
24-Jun-11	44	12	6.42	0.9	5.8	0.08
12-Sep-11	34	12	6.1	0.8	6.2	0.11
18-Oct-11	42	16	6.16	0.8	6.1	0.12
14-Dec-11	51	12	6.45	3.3	5.7	0.23
17-Feb-12	55	14	6.53	0.8	6.2	0.15
5-Jun-12	33	11	6.72	0.3	5.4	0.07
13-Sep-12	36	13	6.55	0.7	7.7	0.12
22-Nov-12	48	14	6.27	0.7	8.3	0.12
15-Feb-13	48	18	7.22	1.1	6.5	0.12
22-Aug-13	27	14	6.54	0.7	6.3	0.1
4-Sep-14	30	12	6.77	0.7	6	0.1
5-Aug-15	34	22	7.02	1	5.3	0.08
27-May-16	35	7	6.71	0.57	4.4	0.086
8-Jun-17	45	6	6.52	0.4	4.4	0.1
15-Dec-17	27	13	6.6	0.42	5.4	0.13

LOCATION	HISTORICAL MEAN	HISTORICAL MEDIAN	HISTORICAL MAX	HISTORICAL STDEV	
Historical Colour					
Torbay	11.552	12.000	17.000	3.146	
Grand Falls-Windsor	36.679	36.000	57.000	10.294	
Hughes Brook	10.625	10.500	15.000	2.615	Low
Meadows	14.267	15.000	21.000	4.301	
Clarenville	54.306	53.500	129.000	20.178	High
Historical TDS					
Torbay	33.448	33.000	50.000	5.629	
Grand Falls-Windsor	13.662	13.000	37.000	5.160	Low
Hughes Brook	188.750	197.500	220.000	22.199	High
Meadows	36.000	37.000	53.000	6.918	
Clarenville	24.564	23.000	41.000	6.067	
Historical pH					
Torbay	6.324	6.275	7.100	0.233	Low
Grand Falls-Windsor	6.473	6.470	7.360	0.252	
Hughes Brook	8.218	8.245	8.550	0.182	High
Meadows	6.849	6.830	7.520	0.412	
Clarenville	6.519	6.510	7.870	0.373	
Historical Turbidity					
Torbay	0.575	0.400	1.700	0.411	
Grand Falls-Windsor	0.697	0.635	3.300	0.479	High
Hughes Brook	0.214	0.200	0.400	0.130	Low
Meadows	0.499	0.500	0.900	0.215	
Clarenville	0.586	0.400	2.700	0.502	
Historical DOC					
Torbay	2.669	2.800	4.100	0.827	
Grand Falls-Windsor	5.169	5.400	8.300	1.541	
Hughes Brook	2.300	2.100	3.600	0.752	Low
Meadows	3.875	3.850	5.500	0.793	
Clarenville	6.709	6.700	14.900	2.025	High
Historical Iron					
Torbay	0.031	0.030	0.080	0.020	
Grand Falls-Windsor	0.104	0.100	0.230	0.043	
Hughes Brook	0.006	0.003	0.020	0.009	Low
Meadows	0.051	0.060	0.110	0.034	
Clarenville	0.210	0.190	0.720	0.097	High

Mean	36.6795	13.6620	6.4728	0.6968	5.1692	0.1036
Standard Dev.	10.2937	5.1601	0.2521	0.4793	1.5412	0.0429
Median	36.000	13.000	6.470	0.635	5.400	0.100
Max	57.000	37.000	7.360	3.300	8.300	0.230

Hughes Brook (Spring)						
Time	**Colour**	**TDS**	**pH**	**Turbidity**	**DOC**	**Iron**
28-Apr-88	10	170	7.96	0.2		0.02
31-May-90	11	160	8.26	0.17		0.02
26-Oct-90	15	195	8	0.02		0.005
17-Oct-95	10	200	8.25	0.12	3.6	0.005
23-Aug-05	12	200	8.2	0.4	2.1	0
2-Jul-09	9	161	8.55	0.2	2.2	0
22-Aug-12	6	220	8.28	0.4	1.7	0
11-Sep-15	12	204	8.24	0.2	1.9	0
Mean	10.6250	188.7500	8.2175	0.2138	2.3000	0.0063
Standard Dev.	2.6152	22.1988	0.1820	0.1299	0.7517	0.0088
Median	10.500	197.500	8.245	0.200	2.100	0.003
Max	15.000	220.000	8.550	0.400	3.600	0.020

Meadows (Pond)						
Time	**Colour**	**TDS**	**pH**	**Turbidity**	**DOC**	**Iron**
15-Sep-88	5	35	6.06	0.55		0.11
31-May-90	20	37	6.66	0.38		0.08
26-Oct-90	18	53	6.81	0.49		0.03
29-May-95	10	40	6.99	0.1	2.5	0.091
17-Oct-95	10	40	7.05	0.26	3.4	0.027
8-May-03	16	24	6.11	0.6	3.8	0.07
22-Oct-03	11	38	6.51	0.8	3.5	0.06
23-Aug-06	18	38	6.65	0.7	5.5	0.06
11-Jun-08	11	27	7.27	0.2	3.2	0
9-Dec-08	13	30	7.11	0.4	4	0.07
8-Jun-11	15	37	6.75	0.5	3.9	0
14-Dec-11	21	39	6.83	0.6	3.9	0.05
25-Sep-14	15	40	7.52	0.9	5.1	0.04
27-Jun-17	15	30	7.22	0.48	3.7	0
16-Nov-17	16	32	7.19	0.52	4	0.072
Mean	14.2667	36.0000	6.8487	0.4987	3.8750	0.0507
Standard Dev.	4.3006	6.9179	0.4123	0.2147	0.7933	0.0340
Median	15.000	37.000	6.830	0.500	3.850	0.060
Max	21.000	53.000	7.520	0.900	5.500	0.110

Clarenville (River)						
Time	**Colour**	**TDS**	**pH**	**Turbidity**	**DOC**	**Iron**
28-Sep-87	35	28	6.12	0.5		0.01
15-Jun-89	30		6.6	0.3	3.1	0.18
23-Oct-89	30		6.65	0.55	4.85	0.185
9-Jun-92	55		6.5	0.3	5.7	0.21
29-Oct-92	65		6.15		7	0.3
7-Jun-95	25	30	6.71	0.35	6	0.14
10-Oct-95	100	30	6.84	0.8	9.2	0.133
18-Jun-96	50	30	6.46	0.3	8.2	0.149
1-Oct-96	42	22	6.35	0.62	4.7	0.17
19-May-98	72	24	6.21	0.23	7.4	0.17
15-Oct-98	62	21	6.6	1.86	7	0.21
16-Feb-99	54		6.02	0.3	6.3	
27-May-99	62	20	6.41	0.29	5.8	0.16
20-Jul-99	32		6.9	0.14	3.1	
5-Oct-99	97	27	6.52	2.18	11	0.72
10-Feb-00	57		5.64	0.38	4.9	
7-Jun-01	56	20	6.36	0.15	5	0.18
8-Nov-01	129	20	5.69	1	14.9	0.39
28-Apr-03	61	20	5.89	0.8	6.8	0.21
29-Oct-03	46	19	6.09	0.7	7.3	0.21
30-Aug-05	26	34	6.94	0.3	4.7	0.15
5-Jun-07	24	18	6.8	0.3	4.9	0.15
20-Aug-07	34	21	6.73	0.5	5.8	0.29
6-Nov-07	32	16	6.54	0.1	7.4	0.23
22-Jan-08	39	22	6.42	0.2	5.7	0.28
22-May-08	68	13	6.39	0.4	6.7	0.29
5-Aug-08	34	29	6.89	0.9	3.7	0.14
4-Nov-08	48	14	6.61	0.5	7	0.18
21-Jan-09	50	29	6.45	0.3	4.9	0.19
25-May-09	39	23	6.77	0.4	4.3	0.13
9-Sep-09	46	19	6.84	0.3	5.6	0.15
24-Nov-09	55	16	6.5	0.4	7.9	0.23
10-Feb-10	63	23	6.46	0.3	5.7	0.19
3-Jun-10	52	16	6.32	1.5	7.5	0.16
11-Aug-10	56	22	6.85	0.5	7.6	0.21
3-Nov-10	58	23	7.07	1.6	8.5	0.22
2-Feb-11	62	22	6.07	0.9	6.9	0.2
24-May-11	60	22	6.09	0.5	6.4	0.18
18-Aug-11	108	27	6.35	2.7	11.3	0.51
14-Nov-11	69	21	6.42	0.7	7.3	0.29
1-Feb-12	59	25	6.44	0.8	6.1	0.19
29-May-12	52	32	6.45	0.3	6.6	0.16
20-Nov-12	62	20	6.21	0.7	9	0.24
22-Jan-13	70	31	6.4	0.3	8.3	0.22
28-May-13	50	27	6.62	0.3	5.3	0.16
21-Aug-13	41	29	6.65	0.3	6.8	0.19
25-Nov-13	69	20	6.3	0.7	9.1	0.28
4-Feb-14	73	21	5.73	0.5	7.8	0.25
27-May-14	50	25	6.7	0.4	6.4	0.15
25-Feb-15	53	31	6.37	0.4	6.8	0.18
18-Jun-15	73	39	7.87	0.3	8.7	0.21
25-Aug-15	27	33	6.85	0.3	4.3	0.14
17-Nov-15	64	27	6.54	1.5	8.2	0.22
7-Jun-16	30	29	6.95	0.28	4.4	0.13
12-Sep-16	56	23	7.08	0.34	8.1	0.23
14-Nov-16	46	21	6.52	0.58	6.7	0.2
22-Feb-17	62	30	6.78	0.24	6.3	0.21
13-Jun-17	46	24	6.59	0.3	4.6	0.13
23-Aug-17	46	37	7.15	0.3	6.9	0.2
15-Nov-17	35	25	6.69	1	5.5	0.19
7-Mar-18	39	41	6.74	0.33	5.8	0.17
31-May-18	81	20	6.32	0.5	9.5	0.23
Mean	54.3065	24.5636	6.5189	0.5856	6.7090	0.2098
Standard Dev.	20.1784	6.0668	0.3730	0.5017	2.0250	0.0969
Median	53.500	23.000	6.510	0.400	6.700	0.190
Max	129	41	7.87	2.7	14.9	0.72

Clarenville Event Based Sample Data

1/26/2021 3:22:04 PM

```
Welcome to Minitab, press F1 for help.
```

One-way ANOVA: Color versus Event/Historical

```
Source            DF     SS     MS      F      P
Event/Historical   1  24410  24410  59.36  0.000
Error             63  25906    411
Total             64  50316

S = 20.28   R-Sq = 48.51%   R-Sq(adj) = 47.70%


                           Individual 90% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean  StDev  ---+---------+---------+---------+------
E       3  146.67  23.12                          (------*-----)
H      62   54.31  20.18  (*-)
                           ---+---------+---------+---------+------
                             60        90       120       150

Pooled StDev = 20.28
```

One-way ANOVA: TDS versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   143.5  143.5  3.91  0.053
Error             56  2056.2   36.7
Total             57  2199.7

S = 6.060   R-Sq = 6.52%   R-Sq(adj) = 4.86%


                           Individual 90% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean  StDev   --+---------+---------+---------+-------
E       3  31.667  5.859          (-------------*--------------)
H      55  24.564  6.067   (--*---)
                            --+---------+---------+---------+-------
                           24.0      28.0      32.0      36.0

Pooled StDev = 6.060
```

One-way ANOVA: pH versus Event/Historical

```
Source            DF     SS     MS     F      P
Event/Historical   1  0.075  0.075  0.52  0.472
Error             63  9.055  0.144
Total             64  9.131

S = 0.3791   R-Sq = 0.82%   R-Sq(adj) = 0.00%


                            Individual 90% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+---------
E       3  6.3567  0.5330    (-----------------*-----------------)
H      62  6.5189  0.3730                       (---*---)
```

```
                            +---------+---------+---------+---------
                          6.00      6.20      6.40      6.60

Pooled StDev = 0.3791
```

One-way ANOVA: Turbidity versus Event/Historical

```
Source            DF      SS     MS      F      P
Event/Historical   1   3.342  3.342  13.27  0.001
Error             62  15.612  0.252
Total             63  18.954

S = 0.5018   R-Sq = 17.63%   R-Sq(adj) = 16.30%


                            Individual 90% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+---------
E       3  1.6667  0.5033                (--------*---------)
H      61  0.5856  0.5017    (-*-)
                            +---------+---------+---------+---------
                          0.50      1.00      1.50      2.00

Pooled StDev = 0.5018
```

One-way ANOVA: DOC versus Event/Historical

```
Source            DF      SS      MS      F      P
Event/Historical   1  291.16  291.16  66.72  0.000
Error             62  270.58    4.36
Total             63  561.74

S = 2.089   R-Sq = 51.83%   R-Sq(adj) = 51.06%


                            Individual 90% CIs For Mean Based on
                            Pooled StDev
Level   N    Mean  StDev  --+---------+---------+---------+-------
E       3  16.800  3.503                        (-----*-----)
H      61   6.709  2.025  (*)
                           --+---------+---------+---------+-------
                           7.0      10.5      14.0      17.5

Pooled StDev = 2.089
```

One-way ANOVA: Iron versus Event/Historical

```
Source            DF       SS       MS      F      P
Event/Historical   1  0.14267  0.14267  15.45  0.000
Error             60  0.55424  0.00924
Total             61  0.69691

S = 0.09611   R-Sq = 20.47%   R-Sq(adj) = 19.15%


                              Individual 90% CIs For Mean Based on
                              Pooled StDev
Level   N     Mean    StDev   -+---------+---------+---------+--------
E       3  0.43333  0.07095                 (--------*---------)
H      59  0.20978  0.09686   (-*-)
                              -+---------+---------+---------+--------
                             0.20      0.30      0.40      0.50
```

```
Pooled StDev = 0.09611
```

Kruskal-Wallis Test: Color versus Event/Historical

```
Kruskal-Wallis Test on Color

Event/Historical   N  Median  Ave Rank      Z
E                  3  144.00      63.7   2.88
H                 62   53.50      31.5  -2.88
Overall           65              33.0

H = 8.27  DF = 1  P = 0.004
H = 8.29  DF = 1  P = 0.004  (adjusted for ties)

* NOTE * One or more small samples
```

Kruskal-Wallis Test: TDS versus Event/Historical

```
58 cases were used
7 cases contained missing values


Kruskal-Wallis Test on TDS

Event/Historical   N  Median  Ave Rank      Z
E                  3   34.00      47.3   1.88
H                 55   23.00      28.5  -1.88
Overall           58              29.5

H = 3.53  DF = 1  P = 0.060
H = 3.54  DF = 1  P = 0.060  (adjusted for ties)

* NOTE * One or more small samples
```

Kruskal-Wallis Test: pH versus Event/Historical

```
Kruskal-Wallis Test on pH

Event/Historical   N  Median  Ave Rank      Z
E                  3   6.570      30.3  -0.25
H                 62   6.510      33.1   0.25
Overall           65              33.0

H = 0.06  DF = 1  P = 0.802
H = 0.06  DF = 1  P = 0.802  (adjusted for ties)

* NOTE * One or more small samples
```

Kruskal-Wallis Test: Turbidity versus Event/Historical

```
64 cases were used
1 cases contained missing values


Kruskal-Wallis Test on Turbidity

Event/Historical   N  Median  Ave Rank      Z
E                  3  1.6000      59.5   2.57
H                 61  0.4000      31.2  -2.57
```

```
Overall           64              32.5

H = 6.62  DF = 1  P = 0.010
H = 6.76  DF = 1  P = 0.009  (adjusted for ties)

* NOTE * One or more small samples
```

Kruskal-Wallis Test: DOC versus Event/Historical

```
64 cases were used
1 cases contained missing values


Kruskal-Wallis Test on DOC

Event/Historical   N  Median  Ave Rank      Z
E                  3  16.100      62.7   2.87
H                 61   6.700      31.0  -2.87
Overall           64              32.5

H = 8.26  DF = 1  P = 0.004
H = 8.27  DF = 1  P = 0.004  (adjusted for ties)

* NOTE * One or more small samples
```

Kruskal-Wallis Test: Iron versus Event/Historical

```
62 cases were used
3 cases contained missing values


Kruskal-Wallis Test on Iron

Event/Historical   N  Median  Ave Rank      Z
E                  3  0.4200      58.8   2.69
H                 59  0.1900      30.1  -2.69
Overall           62              31.5

H = 7.24  DF = 1  P = 0.007
H = 7.26  DF = 1  P = 0.007  (adjusted for ties)

* NOTE * One or more small samples
```

E/H	Color	TDS	pH	Turb.	DOC	Iron
H	35	28	6.12	0.50	*	0.010
H	30	*	6.60	0.30	3.10	0.180
H	30	*	6.65	0.55	4.85	0.185
H	55	*	6.50	0.30	5.70	0.210
H	65	*	6.15	*	7.00	0.300
H	25	30	6.71	0.35	6.00	0.140
H	100	30	6.84	0.80	9.20	0.133
H	50	30	6.46	0.30	8.20	0.149
H	42	22	6.35	0.62	4.70	0.170
H	72	24	6.21	0.23	7.40	0.170
H	62	21	6.60	1.86	7.00	0.210
H	54	*	6.02	0.30	6.30	*
H	62	20	6.41	0.29	5.80	0.160
H	32	*	6.90	0.14	3.10	*
H	97	27	6.52	2.18	11.00	0.720
H	57	*	5.64	0.38	4.90	*
H	56	20	6.36	0.15	5.00	0.180
H	129	20	5.69	1.00	14.90	0.390
H	61	20	5.89	0.80	6.80	0.210
H	46	19	6.09	0.70	7.30	0.210

H	26	34	6.94	0.30	4.70	0.150
H	24	18	6.80	0.30	4.90	0.150
H	34	21	6.73	0.50	5.80	0.290
H	32	16	6.54	0.10	7.40	0.230
H	39	22	6.42	0.20	5.70	0.280
H	68	13	6.39	0.40	6.70	0.290
H	34	29	6.89	0.90	3.70	0.140
H	48	14	6.61	0.50	7.00	0.180
H	50	29	6.45	0.30	4.90	0.190
H	39	23	6.77	0.40	4.30	0.130
H	46	19	6.84	0.30	5.60	0.150
H	55	16	6.50	0.40	7.90	0.230
H	63	23	6.46	0.30	5.70	0.190
H	52	16	6.32	1.50	7.50	0.160
H	56	22	6.85	0.50	7.60	0.210
H	58	23	7.07	1.60	8.50	0.220
H	62	22	6.07	0.90	6.90	0.200
H	60	22	6.09	0.50	6.40	0.180
H	108	27	6.35	2.70	11.30	0.510
H	69	21	6.42	0.70	7.30	0.290
H	59	25	6.44	0.80	6.10	0.190
H	52	32	6.45	0.30	6.60	0.160
H	62	20	6.21	0.70	9.00	0.240
H	70	31	6.40	0.30	8.30	0.220
H	50	27	6.62	0.30	5.30	0.160
H	41	29	6.65	0.30	6.80	0.190
H	69	20	6.30	0.70	9.10	0.280
H	73	21	5.73	0.50	7.80	0.250
H	50	25	6.70	0.40	6.40	0.150
H	53	31	6.37	0.40	6.80	0.180
H	73	39	7.87	0.30	8.70	0.210
H	27	33	6.85	0.30	4.30	0.140
H	64	27	6.54	1.50	8.20	0.220
H	30	29	6.95	0.28	4.40	0.130
H	56	23	7.08	0.34	8.10	0.230
H	46	21	6.52	0.58	6.70	0.200
H	62	30	6.78	0.24	6.30	0.210
H	46	24	6.59	0.30	4.60	0.130
H	46	37	7.15	0.30	6.90	0.200
H	35	25	6.69	1.00	5.50	0.190
H	39	41	6.74	0.33	5.80	0.170
H	81	20	6.32	0.50	9.50	0.230
E	125	36	6.57	1.60	13.70	0.370
E	171	25	5.75	2.20	20.60	0.420
E	144	34	6.75	1.20	16.10	0.510

Grand Falls-Windsor Event Based Sample Data

1/26/2021 2:54:21 PM

```
Welcome to Minitab, press F1 for help.
```

One-way ANOVA: Color versus Event/Historical

```
Source            DF    SS   MS     F      P
Event/Historical   1    21   21  0.20  0.652
Error             81  8356  103
Total             82  8377

S = 10.16   R-Sq = 0.25%   R-Sq(adj) = 0.00%


                          Individual 95% CIs For Mean Based on Pooled
                          StDev
Level   N   Mean  StDev     +---------+---------+---------+---------
E       5  38.80   7.01     (-----------------*-----------------)
H      78  36.68  10.29              (---*----)
                            +---------+---------+---------+---------
                          30.0      35.0      40.0      45.0

Pooled StDev = 10.16
```

One-way ANOVA: TDS versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   119.7  119.7  4.73  0.033
Error             74  1873.1   25.3
Total             75  1992.8

S = 5.031   R-Sq = 6.01%   R-Sq(adj) = 4.74%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  ------+---------+---------+---------+---
E       5   8.600  1.517  (--------------*--------------)
H      71  13.662  5.160                             (---*---)
                          ------+---------+---------+---------+---
                              6.0       9.0      12.0      15.0

Pooled StDev = 5.031
```

One-way ANOVA: pH versus Event/Historical

```
Source            DF      SS      MS     F      P
Event/Historical   1  0.3060  0.3060  4.79  0.032
Error             81  5.1755  0.0639
Total             82  5.4814

S = 0.2528   R-Sq = 5.58%   R-Sq(adj) = 4.42%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  --+---------+---------+---------+-------
E       5  6.7280  0.2647        (--------------*--------------)
H      78  6.4728  0.2521  (---*--)
```

```
                          --+---------+---------+---------+-------
                          6.45      6.60      6.75      6.90

Pooled StDev = 0.2528
```

One-way ANOVA: Turbidity versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   0.388  0.388  1.70  0.196
Error             81  18.461  0.228
Total             82  18.848

S = 0.4774   R-Sq = 2.06%   R-Sq(adj) = 0.85%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  --------+---------+---------+---------+-
E       5  0.9840  0.4399  (----------------*----------------)
H      78  0.6968  0.4793    (---*---)
                           --------+---------+---------+---------+-
                                 0.75      1.00      1.25      1.50

Pooled StDev = 0.4774
```

One-way ANOVA: DOC versus Event/Historical

```
Source            DF      SS    MS     F      P
Event/Historical   1    0.34  0.34  0.15  0.699
Error             81  184.99  2.28
Total             82  185.34

S = 1.511   R-Sq = 0.19%   R-Sq(adj) = 0.00%


                         Individual 95% CIs For Mean Based on
                         Pooled StDev
Level   N   Mean  StDev   -+---------+---------+---------+--------
E       5  5.440  0.723   (------------------*------------------)
H      78  5.169  1.541             (----*----)
                          -+---------+---------+---------+--------
                         4.20      4.90      5.60      6.30

Pooled StDev = 1.511
```

One-way ANOVA: Iron versus Event/Historical

```
Source            DF       SS       MS     F      P
Event/Historical   1  0.00691  0.00691  3.83  0.054
Error             76  0.13713  0.00180
Total             77  0.14405

S = 0.04248   R-Sq = 4.80%   R-Sq(adj) = 3.55%


                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level   N     Mean    StDev  ---+---------+---------+---------+------
E       5  0.14200  0.03493       (--------------*--------------)
H      73  0.10356  0.04286  (---*---)
                             ---+---------+---------+---------+------
                              0.100     0.125     0.150     0.175
```

```
Pooled StDev = 0.04248
```

Kruskal-Wallis Test: Color versus Event/Historical

```
Kruskal-Wallis Test on Color

Event/Historical   N  Median  Ave Rank      Z
E                  5   40.00      47.6   0.54
H                 78   36.00      41.6  -0.54
Overall           83              42.0

H = 0.29  DF = 1  P = 0.592
H = 0.29  DF = 1  P = 0.592  (adjusted for ties)
```

Kruskal-Wallis Test: TDS versus Event/Historical

```
76 cases were used
7 cases contained missing values


Kruskal-Wallis Test on TDS

Event/Historical   N  Median  Ave Rank      Z
E                  5   9.000      12.0  -2.78
H                 71  13.000      40.4   2.78
Overall           76              38.5

H = 7.71  DF = 1  P = 0.006
H = 7.79  DF = 1  P = 0.005  (adjusted for ties)
```

Kruskal-Wallis Test: pH versus Event/Historical

```
Kruskal-Wallis Test on pH

Event/Historical   N  Median  Ave Rank      Z
E                  5   6.680      62.7   1.98
H                 78   6.470      40.7  -1.98
Overall           83              42.0

H = 3.92  DF = 1  P = 0.048
H = 3.93  DF = 1  P = 0.048  (adjusted for ties)
```

Kruskal-Wallis Test: Turbidity versus Event/Historical

```
Kruskal-Wallis Test on Turbidity

Event/Historical   N  Median  Ave Rank      Z
E                  5  0.8300      58.3   1.56
H                 78  0.6350      41.0  -1.56
Overall           83              42.0

H = 2.43  DF = 1  P = 0.119
H = 2.45  DF = 1  P = 0.118  (adjusted for ties)
```

Kruskal-Wallis Test: DOC versus Event/Historical

```
Kruskal-Wallis Test on DOC
```

Event/Historical	N	Median	Ave Rank	Z
E	5	5.600	45.2	0.31
H	78	5.400	41.8	-0.31
Overall	83		42.0	

H = 0.09 DF = 1 P = 0.759
H = 0.09 DF = 1 P = 0.759 (adjusted for ties)

Kruskal-Wallis Test: Iron versus Event/Historical

78 cases were used
5 cases contained missing values

Kruskal-Wallis Test on Iron

Event/Historical	N	Median	Ave Rank	Z
E	5	0.1400	59.4	2.03
H	73	0.1000	38.1	-2.03
Overall	78		39.5	

H = 4.12 DF = 1 P = 0.042
H = 4.15 DF = 1 P = 0.042 (adjusted for ties)

E/H	Color	TDS	pH	Turb.	DOC	Iron
H	20	*	6.65	0.40	3.85	0.090
H	20	*	6.30	0.90	6.05	0.190
H	40	10	6.55	0.72	0.50	0.070
H	35	13	6.58	0.76	1.00	0.130
H	44	12	6.28	0.29	1.80	0.060
H	44	14	6.48	0.31	2.50	0.110
H	30	20	6.50	0.20	4.30	0.119
H	35	30	6.58	0.40	7.30	0.147
H	30	20	6.33	0.40	5.00	0.058
H	50	16	6.43	1.41	3.00	0.150
H	40	20	6.10	0.43	4.30	0.020
H	28	*	6.52	0.34	3.40	*
H	50	18	6.33	0.53	6.30	0.080
H	54	*	6.66	0.27	3.40	*
H	40	16	6.36	0.31	4.70	0.070
H	34	*	6.56	1.22	5.30	*
H	48	13	6.46	1.65	5.20	0.120
H	36	12	6.26	0.36	3.10	0.060
H	34	12	6.46	0.38	3.10	0.020
H	28	*	6.52	0.67	3.80	*
H	44	22	5.99	1.68	5.40	0.030
H	34	*	5.99	0.34	3.50	*
H	41	14	6.64	0.98	4.30	0.005
H	29	18	6.65	0.46	4.10	0.130
H	53	17	6.45	0.25	5.80	0.005
H	57	23	6.10	0.35	6.30	0.060
H	36	14	6.42	0.15	5.40	0.090
H	23	12	6.32	0.80	3.40	0.100
H	25	14	6.38	1.20	6.30	0.100
H	35	16	6.23	0.40	4.50	0.110
H	29	11	6.58	0.60	4.00	0.110
H	20	12	6.22	0.70	3.70	0.140
H	36	17	6.37	0.70	7.10	0.110
H	45	14	6.20	0.70	5.20	0.140
H	37	10	5.93	1.00	4.60	0.160
H	26	10	6.29	0.60	4.20	0.070
H	41	12	6.20	1.30	5.90	0.140
H	49	16	6.28	0.50	8.30	0.160
H	32	10	6.09	0.70	4.90	0.080
H	24	11	6.35	0.60	5.90	0.110

H	39	12	6.11	1.20	6.30	0.120
H	57	15	6.36	0.60	6.10	0.100
H	34	8	6.45	0.70	4.00	0.090
H	19	10	6.76	0.60	4.30	0.080
H	35	12	6.62	0.90	6.50	0.110
H	29	15	6.51	0.20	5.70	0.090
H	38	13	6.46	1.00	8.30	0.100
H	20	7	6.59	0.40	6.90	0.090
H	33	7	6.70	0.50	6.00	0.200
H	30	9	6.63	2.10	6.00	0.150
H	0	37	7.36	0.00	3.00	0.000
H	43	6	6.49	0.30	4.90	0.110
H	30	7	6.39	0.60	4.50	0.150
H	41	9	6.59	1.10	6.50	0.160
H	49	16	6.70	0.00	6.10	0.140
H	31	10	6.57	0.70	4.60	0.080
H	40	7	6.70	0.40	6.90	0.120
H	51	11	6.42	0.60	6.30	0.150
H	47	12	6.44	0.50	5.60	0.100
H	37	10	6.53	0.70	6.00	0.090
H	30	13	6.87	0.70	5.80	0.100
H	43	12	6.62	0.70	7.10	0.090
H	40	17	6.84	0.70	5.40	0.080
H	44	12	6.42	0.90	5.80	0.080
H	34	12	6.10	0.80	6.20	0.110
H	42	16	6.16	0.80	6.10	0.120
H	51	12	6.45	3.30	5.70	0.230
H	55	14	6.53	0.80	6.20	0.150
H	33	11	6.72	0.30	5.40	0.070
H	36	13	6.55	0.70	7.70	0.120
H	48	14	6.27	0.70	8.30	0.120
H	48	18	7.22	1.10	6.50	0.120
H	27	14	6.54	0.70	6.30	0.100
H	30	12	6.77	0.70	6.00	0.100
H	34	22	7.02	1.00	5.30	0.080
H	35	7	6.71	0.57	4.40	0.086
H	45	6	6.52	0.40	4.40	0.100
H	27	13	6.60	0.42	5.40	0.130
E	40	10	6.88	0.66	5.70	0.120
E	27	9	7.10	0.83	5.00	0.110
E	43	7	6.53	1.40	6.40	0.200
E	45	7	6.68	0.53	4.50	0.140
E	39	10	6.45	1.50	5.60	0.140

Hughes Brook Event Based Sample Data

1/26/2021 2:59:30 PM

```
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```

One-way ANOVA: Color versus Event/Historical

```
Source            DF     SS    MS     F      P
Event/Historical   1   64.7  64.7  2.23  0.148
Error             25  726.7  29.1
Total             26  791.4

S = 5.392   R-Sq = 8.18%   R-Sq(adj) = 4.51%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  ---+---------+---------+---------+------
E      19  14.016  6.141                    (---------*---------)
H       8  10.625  2.615  (---------------*--------------)
                          ---+---------+---------+---------+------
                           7.5      10.0      12.5      15.0

Pooled StDev = 5.392
```

One-way ANOVA: TDS versus Event/Historical

```
Source            DF     SS   MS     F      P
Event/Historical   1     16   16  0.03  0.855
Error             25  11568  463
Total             26  11584

S = 21.51   R-Sq = 0.14%   R-Sq(adj) = 0.00%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  ----+---------+---------+---------+-----
E      19  190.42  21.24           (------------*------------)
H       8  188.75  22.20  (-------------------*-------------------)
                          ----+---------+---------+---------+-----
                          176.0     184.0     192.0     200.0

Pooled StDev = 21.51
```

One-way ANOVA: pH versus Event/Historical

```
Source            DF      SS      MS     F      P
Event/Historical   1  0.0136  0.0136  0.72  0.405
Error             25  0.4720  0.0189
Total             26  0.4856

S = 0.1374   R-Sq = 2.79%   R-Sq(adj) = 0.00%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  ---------+---------+---------+---------+
E      19  8.1684  0.1155  (---------*----------)
H       8  8.2175  0.1820    (----------------*---------------)
```

```
                          ---------+---------+---------+---------+
                                 8.160     8.220     8.280     8.340

Pooled StDev = 0.1374
```

One-way ANOVA: Turbidity versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   2.800  2.800  8.20  0.008
Error             25   8.534  0.341
Total             26  11.333

S = 0.5842   R-Sq = 24.70%   R-Sq(adj) = 21.69%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  -----+---------+---------+---------+----
E      19  0.9189  0.6838                      (------*------)
H       8  0.2138  0.1299  (---------*----------)
                           -----+---------+---------+---------+----
                              0.00      0.40      0.80      1.20

Pooled StDev = 0.5842
```

One-way ANOVA: DOC versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   0.684  0.684  0.82  0.376
Error             22  18.445  0.838
Total             23  19.130

S = 0.9157   R-Sq = 3.58%   R-Sq(adj) = 0.00%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev   -+---------+---------+---------+--------
E      19  2.7158  0.9483                    (-------*--------)
H       5  2.3000  0.7517   (----------------*----------------)
                           -+---------+---------+---------+--------
                           1.50      2.00      2.50      3.00

Pooled StDev = 0.9157
```

One-way ANOVA: Iron versus Event/Historical

```
Source            DF        SS        MS     F      P
Event/Historical   1  0.000391  0.000391  0.80  0.380
Error             25  0.012228  0.000489
Total             26  0.012619

S = 0.02212   R-Sq = 3.09%   R-Sq(adj) = 0.00%


                            Individual 95% CIs For Mean Based on Pooled
                            StDev
Level   N     Mean    StDev     +---------+---------+---------+---------
E      19  0.01458  0.02548                  (----------*---------)
H       8  0.00625  0.00876     (---------------*---------------)
                              +---------+---------+---------+---------
                            -0.010     0.000     0.010     0.020
```

```
Pooled StDev = 0.02212
```

Kruskal-Wallis Test: Color versus Event/Historical

```
Kruskal-Wallis Test on Color

Event/Historical   N  Median  Ave Rank      Z
E                 19   11.00      15.1   1.12
H                  8   10.50      11.4  -1.12
Overall           27               14.0

H = 1.24  DF = 1  P = 0.265
H = 1.26  DF = 1  P = 0.262  (adjusted for ties)
```

Kruskal-Wallis Test: TDS versus Event/Historical

```
Kruskal-Wallis Test on TDS

Event/Historical   N  Median  Ave Rank      Z
E                 19   188.0      14.4   0.40
H                  8   197.5      13.1  -0.40
Overall           27               14.0

H = 0.16  DF = 1  P = 0.690
H = 0.16  DF = 1  P = 0.690  (adjusted for ties)
```

Kruskal-Wallis Test: pH versus Event/Historical

```
Kruskal-Wallis Test on pH

Event/Historical   N  Median  Ave Rank      Z
E                 19   8.170      13.1  -0.90
H                  8   8.245      16.1   0.90
Overall           27               14.0

H = 0.81  DF = 1  P = 0.367
H = 0.82  DF = 1  P = 0.366  (adjusted for ties)
```

Kruskal-Wallis Test: Turbidity versus Event/Historical

```
Kruskal-Wallis Test on Turbidity

Event/Historical   N  Median  Ave Rank      Z
E                 19  0.7000      17.3   3.35
H                  8  0.2000       6.1  -3.35
Overall           27               14.0

H = 11.19  DF = 1  P = 0.001
H = 11.27  DF = 1  P = 0.001  (adjusted for ties)
```

Kruskal-Wallis Test: DOC versus Event/Historical

```
24 cases were used
3 cases contained missing values


Kruskal-Wallis Test on DOC
```

Event/Historical	N	Median	Ave Rank	Z
E	19	2.900	13.1	0.82
H	5	2.100	10.2	-0.82
Overall	24		12.5	

H = 0.67 DF = 1 P = 0.414
H = 0.67 DF = 1 P = 0.413 (adjusted for ties)

Kruskal-Wallis Test: Iron versus Event/Historical

Kruskal-Wallis Test on Iron

Event/Historical	N	Median	Ave Rank	Z
E	19	0.000000000	13.6	-0.42
H	8	0.002500000	15.0	0.42
Overall	27		14.0	

H = 0.18 DF = 1 P = 0.671
H = 0.26 DF = 1 P = 0.613 (adjusted for ties)

E/H	Color	TDS	pH	Turb.	DOC	Iron
H	10.0	170	7.96	0.20	*	0.020
H	11.0	160	8.26	0.17	*	0.020
H	15.0	195	8.00	0.02	*	0.005
H	10.0	200	8.25	0.12	3.6	0.005
H	12.0	200	8.20	0.40	2.1	0.000
H	9.0	161	8.55	0.20	2.2	0.000
H	6.0	220	8.28	0.40	1.7	0.000
H	12.0	204	8.24	0.20	1.9	0.000
E	11.0	160	8.16	0.24	1.7	0.000
E	10.0	180	8.00	0.81	2.0	0.058
E	16.0	180	8.09	2.10	3.2	0.053
E	21.0	180	8.06	0.64	3.7	0.000
E	17.0	140	7.92	1.10	2.9	0.066
E	9.2	170	8.09	0.37	2.1	0.000
E	8.1	180	8.05	1.00	2.3	0.000
E	32.0	188	8.33	1.90	2.5	0.000
E	11.0	184	8.24	0.60	3.0	0.000
E	11.0	176	8.13	0.50	3.1	0.000
E	11.0	204	8.22	0.20	2.9	0.000
E	12.0	193	8.26	0.20	1.9	0.000
E	9.0	209	8.23	0.50	1.2	0.000
E	8.0	213	8.20	0.30	1.9	0.000
E	19.0	212	8.14	1.80	4.6	0.000
E	9.0	206	8.17	0.70	1.5	0.000
E	16.0	221	8.34	0.70	3.2	0.000
E	22.0	213	8.23	1.40	4.5	0.060
E	14.0	209	8.34	2.40	3.4	0.040

Meadows Event Bases Sample Data

1/26/2021 3:03:41 PM

```
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```

One-way ANOVA: Color versus Event/Historical

```
Source            DF     SS    MS     F      P
Event/Historical   1   16.4  16.4  0.60  0.446
Error             25  682.6  27.3
Total             26  699.0

S = 5.225   R-Sq = 2.34%   R-Sq(adj) = 0.00%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  ---+---------+---------+---------+------
E      12  15.833  6.206         (--------------*---------------)
H      15  14.267  4.301  (-------------*-------------)
                          ---+---------+---------+---------+------
                          12.0      14.0      16.0      18.0

Pooled StDev = 5.225
```

One-way ANOVA: TDS versus Event/Historical

```
Source            DF      SS     MS      F      P
Event/Historical   1   311.3  311.3  10.01  0.004
Error             25   777.7   31.1
Total             26  1089.0

S = 5.577   R-Sq = 28.59%   R-Sq(adj) = 25.73%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  ------+---------+---------+---------+---
E      12  42.833  3.129                     (--------*---------)
H      15  36.000  6.918  (--------*-------)
                          ------+---------+---------+---------+---
                             35.0      38.5      42.0      45.5

Pooled StDev = 5.577
```

One-way ANOVA: pH versus Event/Historical

```
Source            DF     SS     MS      F      P
Event/Historical   1  1.383  1.383  10.77  0.003
Error             25  3.210  0.128
Total             26  4.593

S = 0.3583   R-Sq = 30.11%   R-Sq(adj) = 27.32%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  ----+---------+---------+---------+-----
E      12  7.3042  0.2747                    (-------*--------)
H      15  6.8487  0.4123  (-------*-------)
```

```
                          ----+---------+---------+---------+-----
                            6.75      7.00      7.25      7.50

Pooled StDev = 0.3583
```

One-way ANOVA: Turbidity versus Event/Historical

```
Source            DF      SS      MS     F      P
Event/Historical   1  0.4211  0.4211  6.44  0.018
Error             25  1.6354  0.0654
Total             26  2.0565

S = 0.2558   R-Sq = 20.48%   R-Sq(adj) = 17.30%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean   StDev  ------+---------+---------+---------+---
E      12  0.7500  0.3000                (---------*---------)
H      15  0.4987  0.2147  (--------*--------)
                          ------+---------+---------+---------+---
                              0.45      0.60      0.75      0.90

Pooled StDev = 0.2558
```

One-way ANOVA: DOC versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   3.920  3.920  6.83  0.016
Error             22  12.619  0.574
Total             23  16.540

S = 0.7574   R-Sq = 23.70%   R-Sq(adj) = 20.24%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean   StDev  --+---------+---------+---------+-------
E      12  4.6833  0.7196                  (--------*--------)
H      12  3.8750  0.7933  (--------*---------)
                          --+---------+---------+---------+-------
                          3.50      4.00      4.50      5.00

Pooled StDev = 0.7574
```

One-way ANOVA: Iron versus Event/Historical

```
Source            DF       SS       MS     F      P
Event/Historical   1  0.00107  0.00107  0.98  0.331
Error             25  0.02725  0.00109
Total             26  0.02832

S = 0.03302   R-Sq = 3.78%   R-Sq(adj) = 0.00%


                            Individual 95% CIs For Mean Based on
                            Pooled StDev
Level   N     Mean    StDev  --------+---------+---------+---------+-
E      12  0.06333  0.03172          (------------*------------)
H      15  0.05067  0.03400  (-----------*----------)
                            --------+---------+---------+---------+-
                                  0.045     0.060     0.075     0.090
```

```
Pooled StDev = 0.03302
```

Kruskal-Wallis Test: Color versus Event/Historical

```
Kruskal-Wallis Test on Color

Event/Historical   N  Median  Ave Rank      Z
E                 12   15.50      15.4   0.81
H                 15   15.00      12.9  -0.81
Overall           27              14.0

H = 0.65  DF = 1  P = 0.421
H = 0.65  DF = 1  P = 0.419  (adjusted for ties)
```

Kruskal-Wallis Test: TDS versus Event/Historical

```
Kruskal-Wallis Test on TDS

Event/Historical   N  Median  Ave Rank      Z
E                 12   42.00      19.7   3.32
H                 15   37.00       9.5  -3.32
Overall           27              14.0

H = 11.01  DF = 1  P = 0.001
H = 11.10  DF = 1  P = 0.001  (adjusted for ties)
```

Kruskal-Wallis Test: pH versus Event/Historical

```
Kruskal-Wallis Test on pH

Event/Historical   N  Median  Ave Rank      Z
E                 12   7.295      19.2   3.03
H                 15   6.830       9.9  -3.03
Overall           27              14.0

H = 9.15  DF = 1  P = 0.002
H = 9.16  DF = 1  P = 0.002  (adjusted for ties)
```

Kruskal-Wallis Test: Turbidity versus Event/Historical

```
Kruskal-Wallis Test on Turbidity

Event/Historical   N  Median  Ave Rank      Z
E                 12  0.7000      17.4   1.98
H                 15  0.5000      11.3  -1.98
Overall           27              14.0

H = 3.91  DF = 1  P = 0.048
H = 3.93  DF = 1  P = 0.047  (adjusted for ties)
```

Kruskal-Wallis Test: DOC versus Event/Historical

```
24 cases were used
3 cases contained missing values


Kruskal-Wallis Test on DOC
```

```
Event/Historical   N  Median  Ave Rank      Z
E                 12   4.700      15.8   2.31
H                 12   3.850       9.2  -2.31
Overall           24              12.5

H = 5.33  DF = 1  P = 0.021
H = 5.35  DF = 1  P = 0.021  (adjusted for ties)
```

Kruskal-Wallis Test: Iron versus Event/Historical

```
Kruskal-Wallis Test on Iron

Event/Historical   N   Median  Ave Rank      Z
E                 12  0.06500      15.4   0.83
H                 15  0.06000      12.9  -0.83
Overall           27               14.0

H = 0.69  DF = 1  P = 0.407
H = 0.69  DF = 1  P = 0.405  (adjusted for ties)
```

E/H	Color	TDS	pH	Turb.	DOC	Iron
H	5	35	6.06	0.55	*	0.110
H	20	37	6.66	0.38	*	0.080
H	18	53	6.81	0.49	*	0.030
H	10	40	6.99	0.10	2.5	0.091
H	10	40	7.05	0.26	3.4	0.027
H	16	24	6.11	0.60	3.8	0.070
H	11	38	6.51	0.80	3.5	0.060
H	18	38	6.65	0.70	5.5	0.060
H	11	27	7.27	0.20	3.2	0.000
H	13	30	7.11	0.40	4.0	0.070
H	15	37	6.75	0.50	3.9	0.000
H	21	39	6.83	0.60	3.9	0.050
H	15	40	7.52	0.90	5.1	0.040
H	15	30	7.22	0.48	3.7	0.000
H	16	32	7.19	0.52	4.0	0.072
E	27	46	7.52	0.80	4.2	0.090
E	20	38	7.19	0.50	4.5	0.060
E	16	38	7.12	0.50	4.7	0.040
E	14	46	7.40	0.50	4.9	0.050
E	13	47	7.57	0.60	3.8	0.050
E	12	41	7.25	0.40	3.4	0.000
E	13	42	6.87	0.90	4.4	0.070
E	16	42	6.94	1.00	5.8	0.070
E	15	47	7.88	0.40	4.7	0.030
E	22	43	7.31	1.20	4.9	0.110
E	20	42	7.32	1.10	5.0	0.100
E	2	42	7.28	1.10	5.9	0.090

Torbay Event Based Sample Data

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```
Welcome to Minitab, press F1 for help.
```

One-way ANOVA: Color versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   80.22  80.22  8.54  0.006
Error             43  403.97   9.39
Total             44  484.19

S = 3.065   R-Sq = 16.57%   R-Sq(adj) = 14.63%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev  --+---------+---------+---------+-------
E      16   8.763  2.907  (---------*----------)
H      29  11.552  3.146                       (-------*-------)
                          --+---------+---------+---------+-------
                          7.5       9.0      10.5      12.0

Pooled StDev = 3.065
```

One-way ANOVA: TDS versus Event/Historical

```
Source            DF      SS    MS     F      P
Event/Historical   1     3.9   3.9  0.11  0.736
Error             43  1458.1  33.9
Total             44  1462.0

S = 5.823   R-Sq = 0.27%   R-Sq(adj) = 0.00%


                          Individual 95% CIs For Mean Based on
                          Pooled StDev
Level   N    Mean  StDev   --+---------+---------+---------+-------
E      16  34.063  6.169   (------------------*-------------------)
H      29  33.448  5.629   (--------------*--------------)
                           --+---------+---------+---------+-------
                          31.5      33.0      34.5      36.0

Pooled StDev = 5.823
```

One-way ANOVA: pH versus Event/Historical

```
Source            DF      SS      MS      F      P
Event/Historical   1  1.0074  1.0074  16.07  0.000
Error             42  2.6325  0.0627
Total             43  3.6399

S = 0.2504   R-Sq = 27.68%   R-Sq(adj) = 25.96%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  -----+---------+---------+---------+----
E      16  6.6381  0.2782                     (--------*-------)
H      28  6.3236  0.2335  (------*-----)
```

```
                           -----+---------+---------+---------+----
                              6.30      6.45      6.60      6.75

Pooled StDev = 0.2504
```

One-way ANOVA: Turbidity versus Event/Historical

```
Source            DF     SS     MS     F      P
Event/Historical   1  1.074  1.074  5.46  0.024
Error             43  8.458  0.197
Total             44  9.531

S = 0.4435   R-Sq = 11.26%   R-Sq(adj) = 9.20%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev    +---------+---------+---------+---------
E      16  0.8975  0.4982                (-----------*-----------)
H      29  0.5748  0.4112    (--------*-------)
                             +---------+---------+---------+---------
                           0.40      0.60      0.80      1.00

Pooled StDev = 0.4435
```

One-way ANOVA: DOC versus Event/Historical

```
Source            DF      SS     MS     F      P
Event/Historical   1   0.693  0.693  1.31  0.260
Error             38  20.167  0.531
Total             39  20.860

S = 0.7285   R-Sq = 3.32%   R-Sq(adj) = 0.78%


                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level   N    Mean   StDev  -----+---------+---------+---------+----
E      16  2.9375  0.5439          (--------------*-------------)
H      24  2.6688  0.8270  (-----------*-----------)
                           -----+---------+---------+---------+----
                              2.50      2.75      3.00      3.25

Pooled StDev = 0.7285
```

One-way ANOVA: Iron versus Event/Historical

```
Source            DF        SS        MS     F      P
Event/Historical   1  0.001975  0.001975  2.36  0.132
Error             43  0.035997  0.000837
Total             44  0.037972

S = 0.02893   R-Sq = 5.20%   R-Sq(adj) = 3.00%


                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level   N     Mean    StDev    +---------+---------+---------+---------
E      16  0.04488  0.04064              (--------------*-------------)
H      29  0.03103  0.02002    (----------*----------)
                               +---------+---------+---------+---------
                             0.020     0.030     0.040     0.050
```

Pooled StDev = 0.02893

Kruskal-Wallis Test: Color versus Event/Historical

Kruskal-Wallis Test on Color

Event/Historical	N	Median	Ave Rank	Z
E	16	7.700	15.9	-2.70
H	29	12.000	26.9	2.70
Overall	45		23.0	

H = 7.31 DF = 1 P = 0.007
H = 7.38 DF = 1 P = 0.007 (adjusted for ties)

Kruskal-Wallis Test: TDS versus Event/Historical

Kruskal-Wallis Test on TDS

Event/Historical	N	Median	Ave Rank	Z
E	16	35.50	23.8	0.32
H	29	33.00	22.5	-0.32
Overall	45		23.0	

H = 0.10 DF = 1 P = 0.749
H = 0.10 DF = 1 P = 0.748 (adjusted for ties)

Kruskal-Wallis Test: pH versus Event/Historical

44 cases were used
1 cases contained missing values

Kruskal-Wallis Test on pH

Event/Historical	N	Median	Ave Rank	Z
E	16	6.665	31.2	3.38
H	28	6.275	17.6	-3.38
Overall	44		22.5	

H = 11.42 DF = 1 P = 0.001
H = 11.43 DF = 1 P = 0.001 (adjusted for ties)

Kruskal-Wallis Test: Turbidity versus Event/Historical

Kruskal-Wallis Test on Turbidity

Event/Historical	N	Median	Ave Rank	Z
E	16	0.7150	29.1	2.30
H	29	0.4000	19.7	-2.30
Overall	45		23.0	

H = 5.29 DF = 1 P = 0.021
H = 5.30 DF = 1 P = 0.021 (adjusted for ties)

Kruskal-Wallis Test: DOC versus Event/Historical

40 cases were used
5 cases contained missing values

```
Kruskal-Wallis Test on DOC

Event/Historical   N  Median  Ave Rank      Z
E                 16   2.950      22.5   0.87
H                 24   2.800      19.2  -0.87
Overall           40              20.5

H = 0.76  DF = 1  P = 0.384
H = 0.76  DF = 1  P = 0.383  (adjusted for ties)
```

Kruskal-Wallis Test: Iron versus Event/Historical

```
Kruskal-Wallis Test on Iron

Event/Historical   N   Median  Ave Rank      Z
E                 16  0.04500      25.1   0.78
H                 29  0.03000      21.9  -0.78
Overall           45               23.0

H = 0.61  DF = 1  P = 0.434
H = 0.62  DF = 1  P = 0.432  (adjusted for ties)
```

E/H	Color	TDS	pH	Turb.	DOC	Iron
H	15.0	40	6.20	0.30	*	0.060
H	13.0	30	6.23	0.22	*	0.040
H	15.0	50	6.16	0.17	*	0.010
H	10.0	33	6.52	0.85	*	0.050
H	14.0	32	6.36	0.26	*	0.030
H	13.0	37	6.25	0.33	1.80	0.005
H	14.0	35	6.32	0.24	2.60	0.020
H	5.0	40	6.28	0.80	2.90	0.043
H	10.0	30	6.35	0.80	3.40	0.039
H	5.0	30	7.10	0.20	2.70	0.028
H	11.0	36	6.45	1.30	1.90	0.030
H	17.0	32	*	0.32	2.90	0.020
H	12.0	38	6.23	0.47	3.00	0.005
H	13.0	30	6.01	0.27	2.90	0.020
H	14.0	28	6.43	0.83	3.10	0.030
H	11.0	31	6.24	0.36	0.25	0.010
H	11.0	29	6.32	0.16	1.10	0.005
H	9.0	30	6.53	0.22	2.60	0.005
H	15.0	30	6.27	0.30	2.20	0.010
H	13.0	28	6.26	0.07	2.40	0.010
H	9.0	36	6.50	0.40	3.60	0.030
H	11.0	40	6.22	0.60	2.40	0.050
H	12.0	36	5.91	1.10	3.60	0.080
H	8.0	33	6.38	1.70	3.30	0.040
H	7.0	34	6.04	1.10	3.30	0.060
H	13.0	23	6.44	0.90	2.70	0.050
H	17.0	23	6.09	1.00	4.10	0.060
H	8.0	40	6.77	1.00	2.90	0.030
H	10.0	36	6.20	0.40	2.40	0.030
E	8.3	27	6.66	0.99	2.10	0.000
E	5.6	28	6.32	0.83	2.50	0.059
E	7.1	31	6.89	0.73	2.50	0.000
E	13.0	27	6.19	1.10	3.20	0.082
E	15.0	29	6.52	0.68	3.30	0.110

E	13.0	25	6.65	0.77	3.80	0.130
E	9.2	27	6.39	0.56	2.90	0.067
E	10.0	36	6.25	0.70	3.20	0.050
E	10.0	38	6.71	0.60	3.30	0.000
E	7.0	42	7.03	0.60	2.20	0.030
E	7.0	38	6.38	0.50	3.90	0.030
E	5.0	42	6.67	1.60	2.90	0.050
E	7.0	40	6.74	2.40	3.30	0.070
E	7.0	35	7.14	0.60	2.20	0.000
E	6.0	40	6.80	0.50	3.00	0.000
E	10.0	40	6.87	1.20	2.70	0.040