APPENDICES

40 Year Water Quality Report (1984-2024)

Environmental Commission
Township of Stillwater, New Jersey

Appendix No.	Description
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Appendix A

Prior Stream Names and Stations
Excerpted from the 2004 Surface Water Report*

*S.Grodsky, 2004. Stream Surface Water Sampling – Chemical Data and Biological Analysis through Macroinvertebrates. Prepared for the Stillwater Township Environmental Commission. 2004.

Stillwater Township

Stream Surface Water Sampling – Chemical Data and Biological Analysis through Macroinvertebrates

Prepared For
The Stillwater Township
Environmental Commission

By
Steve Grodsky

Sampling Stations and Dates

Sampling stations were selected in four watersheds within Stillwater Township at the following locations to evaluate trends in water quality:

Station Number	Sampling Station	Trout Identification	Location
1	Blair Creek	Trout Maintenance	Off of Old Schoolhouse Rd – along dirt road below confluence of North and South branch of Blair Creek
2	Trout Brook	Trout Production	Owassa Rd. at the junction with Fairview lake Rd.
3	Trout Brook	Trout Production	Middleville Rd. and Pond Brook Rd.
4	Spring Brook (Quick Pond)	Trout Maintenance	Mount Benevolence Rd. near Crandon Lodge
5	Spring Brook (Crandon)	Trout Maintenance	Hampton Rd. Bridge
6	Spring Brook	Trout Maintenance	Swartswood Rd. Bridge
7	Paulinskill River	Trout Maintenance	Stillwater Rd. – Main St. Bridge
8	Keen's Mill	Trout Maintenance	Off of Rt. 521 - next to Keen's Mill

Dates of sampling range from the beginning of the project in the spring of 1984 to present, the most recent sampling being the fall of 2003. All water samples were collected in accordance with the New Jersey Department of Environmental Protection (NJDEP) "Field Procedures Manual for Water Data Acquisition" (NJDEP Division of Water Resources) and were remanded to a licensed environmental laboratory (QC Laboratories - Southampton, PA) for analysis.

*No sampling took place during the years of 1991, 1992, 1994, and 1995. As a result, the graphical representation of the data will exclude these time periods.

Appendix B
NJDEP SWQS Excerpts, Screening Levels and References

40 Year Water Quality Report (1984-2024)
Environmental Commission - Township of Stillwater, NJ

Summary of Surface Water Qulaity Criteria (SWQC) and Screenineg Levels (SLs) used for 2024 SWMP Report

Parameter	Units	General	Acute	Chronic	HH	TP	TM	NT	Notes	Source
Alkalinity	mg/L	20 - 200							(1) (1A)	USEPA; NMSU
Aluminum	mg/L		0.75	0.087					(2)	CDC_ASTDR
E. coli	Counts/100 ml	100 GM; 320 STV			100				(3)	NJAC 7:9B
Fecal Coliforms	Counts/100 ml	100 GM; 320 STV							(3A)	NJAC 7:9B
Lead (ug/L)	mg/L		0.038(d)(s)	0.0054(d)(s)	0.005(h)(T)					NJAC 7:9B
Nitrogen, Ammonia	mg/L		2.4	0.54					(4)	NJAC 7:9B
Nitrate (as N)	mg/L				10(h)					NJAC 7:9B
Nitrite (as N)	mg/L				1				(5)	NJAC 7:10
Nitrogen,Total Kjeldhal (TKN)	mg/L	6							(6)	USEPA
Ortho Phosphate as P	mg/L	0.1							(7)	
Phosphorus (Total)	mg/L	0.1								NJAC 7:9B
pH	su	6.5-8.5								NJAC 7:9B
Specific Conductance	umhos/cm	500							(8)	USEPA
Total Dissolved Solids (TDS)	mg/L								(9)	NJAC 7:9B; NJAC 7:10
Total Suspended Solids (TSS)	mg/L					25	25	40		NJAC 7:9B

Notes:

(d) Criterion is expressed as a function of the Water Effect Ratio (WER). For criterion in the table, WER equates to the default value of 1.0

(h) Human health noncarcinogen

(s) Dissolved criterion

(T) Total recoverable criterion

(1) https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table (acessed 03/22/2024)

(1A) https://aces.nmsu.edu/pubs Cooperative Extension Servise Guide W-104 (acessed 09/01/2024)

(2) CDC_ASTDR Toxilogical Profiles; www.atsdr.cdc.gov/ToxProfiles/tp22-c8.pdf

(3) See NJAC7:9B. Primary Contact Recreation;

Max E. coli geometric mean of 100/100 ml per 90-day period and STV of 320/100 ml with no greater than 10 percent excursion frequency over 90-days.

(3A) SWQC-based screening level for E.coli used for Fecal coliform SWMP data (see report for basis and background).

(4) Calculated per NJAC 7:9B using field measured pH (8.45) and temp (14.5 c) from October 16, 2024 sampling event.

(5) Screening Level (SL) based on NJDEP Safe Drinking Water MCL per NJAC 7:10.

(6) USEPA "Total Nitrogen" https://nepis.epa.gov (acessed 09/01/2024)

(7) Phosphorus SWQC adopted as SL.

(8) https://archive.epa.gov/water/archive/web/html/vms59.html (acessed 09/01/2024)

(9) Screening Level (SL) based on NJDEP Safe Drinking Water Secondary Standards per NJAC 7:10;Background evaluation and WET test data unavailable for SWQC.

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

Substance	Criteria		Classifications
1. Bacterial quality (Counts/100 ml)	i.	Shellfish Harvesting: Bacterial Indicators shall not exceed, in all shellfish waters, the standard for approved shellfish waters as established by the National Shellfish Sanitation Program as set forth in its current manual of operations.	Shellfish Waters
	ii.	Primary Contact Recreation:	
		(1) Enterococci levels shall not exceed a geometric mean of 30/100 ml over a 90-day period and a Statistical Threshold Value of 110/100 ml, which shall not be greater than 10 percent excursion frequency over a 90-day period.	SE1 and SC
		(2) *E. coli* levels shall not exceed a geometric mean of 100/100 ml over a 90-day period and a Statistical Threshold Value of 320/100 ml, which shall not be greater than 10 percent excursion frequency over a 90-day period.	All FW2
	iii.	Secondary Contact Recreation:	
		(1) Fecal coliform levels shall not exceed a geometric mean of 770/100 ml.	SE2
		(2) Fecal coliform levels shall not exceed a geometric mean of 1500/100ml.	SE3
2. Dissolved oxygen (mg/L)	i.	Not less than 7.0 at any time;	FW2-TP
	ii.	24 hour average not less than 6.0. Not less than 5.0 at any time (see paragraph viii below);	FW2-TM

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
		iii.	24 hour average not less than 5.0, but not less than 4.0 at any time (see paragraph viii below);	FW2-NT (except as in iv below), SE1
		iv.	Not less than 4.0 at any time;	Tidal portions of FW2-NT tributaries to the Delaware River, between Rancocas Creek and Big Timber Creek inclusive.
		v.	Not less than 5.0 at any time;	SC
		vi.	Not less than 4.0 at any time;	SE2
		vii.	Not less than 3.0 at any time; and	SE3
		viii.	Supersaturated dissolved oxygen values shall be expressed as their corresponding 100 percent saturation values for purposes of calculating 24 hour averages.	FW2-TM, FW2-NT, SE1
3.	Floating, colloidal, color and settleable solids; petroleum hydrocarbons and other oils and grease	i.	None noticeable in the water or deposited along the shore or on the aquatic substrata in quantities detrimental to the natural biota. None which would render the waters unsuitable for the designated uses.	All Classifications

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
4.	Nutrients	i.	Except as due to natural conditions, nutrients shall not be allowed in concentrations that render the waters unsuitable for the existing or designated uses due to objectionable algal densities, nuisance aquatic vegetation, diurnal fluctuations in dissolved oxygen or pH indicative of excessive photosynthetic activity, detrimental changes to the composition of aquatic ecosystems, or other indicators of use impairment caused by nutrients.	All Classifications
		ii.	Phosphorus (mg/L)*	
			(1) Non Tidal Streams: Concentrations of total P shall not exceed 0.1 in any stream, unless site-specific criteria or watershed-specific translators are established pursuant to N.J.A.C. 7:9B-1.5(g)2 or if the Department determines that concentrations do not render the waters unsuitable in accordance with (d)4i. above.	FW2
			(2) Lakes: Concentrations of total P shall not exceed 0.05 in any lake, pond or reservoir, or in a tributary at the point where it enters such bodies of water, unless site-specific criteria or watershed-specific translators are developed pursuant to N.J.A.C. 7:9B-1.5(g)2 or if the Department determines that concentrations do not render the waters unsuitable in accordance with (d)4i. above.	FW2

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
5.	pH (Standard Units)	i.	6.5-8.5	FW2 waters listed at 1.15(d), (f), (g) and (i), All SE
		ii.	4.5 – 7.5	FW2 waters listed at 1.15(c), (e) and (h)
		iii.	Natural pH conditions shall prevail.	SC
6.	Radioactivity	i.	Prevailing regulations including all amendments and future supplements thereto adopted by the U.S. Environmental Protection Agency pursuant to Sections 1412, 1445, and 1450 of the Public Health Services Act, as amended by the Safe Drinking Water Act (PL 93-523)	All Classifications
7.	Solids, Suspended (mg/L) (Non-filterable residue)	i.	25.0	FW2-TP, FW2-TM
		ii.	40.0	FW2-NT
		iii.	None of which would render the water unsuitable for the designated uses.	All SE, SC
8.	Solids, Total Dissolved (mg/L) (Filterable Residue)	i.	No increase in background which may adversely affect the survival, growth or propagation of the aquatic biota. Compliance with water quality-based WET limitations or $LC_{50} \geq 50$ percent, whichever is more stringent, shall be deemed to meet this requirement.	FW2

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
		ii.	No increase in background which would interfere with the designated or existing uses, or 500 mg/L, whichever is more stringent.	FW2
		iii.	None which would render the water unsuitable for the designated uses.	All SE
9.	Sulfate (mg/L)	i.	250	FW2
10.	Taste and odor producing substances	i.	None offensive to humans or which would produce offensive taste or odors in water supplies and biota used for human consumption. None which would render the water unsuitable for the designated uses.	All Classifications
11.	Temperature	i.	Temperatures shall not exceed a daily maximum of 22 degrees Celsius or rolling seven-day average of the daily maximum of 19 degrees Celsius, unless due to natural conditions	FW2-TP
		ii.	Temperatures shall not exceed a daily maximum of 25 degrees Celsius or rolling seven-day average of the daily maximum of 23 degrees Celsius, unless due to natural conditions	FW2-TM
		iii.	Temperatures shall not exceed a daily maximum of 31 degrees Celsius or rolling seven-day average of the daily maximum of 28 degrees Celsius, unless due to natural conditions	FW2-NT
		iv.	No thermal alterations which would cause temperatures to exceed 29.4 degrees Celsius (85 degree Fahrenheit) Summer seasonal average	SE

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
		v.	No thermal alterations which would cause temperatures to exceed 26.7 degrees Celsius (80 degree Fahrenheit) Summer seasonal average	SC
12.	Toxic Substances (general)	i.	None, either alone or in combination with other substances, in such concentrations as to affect humans or be detrimental to the natural aquatic biota, produce undesirable aquatic life, or which would render the waters unsuitable for the designated uses.	All Classifications
		ii.	None which would cause standards for drinking water to be exceeded after appropriate treatment.	FW2
		iii.	Toxic substances shall not be present in concentrations that cause acute or chronic toxicity to aquatic biota, or bioaccumulate within an organism to concentrations that exert a toxic effect on that organism or render it unfit for consumption.	All Classifications
		iv.	The concentrations of nonpersistent toxic substances in the State's waters shall not exceed one-twentieth (0.05) of the acute definitive LC_{50} or EC_{50} value, as determined by appropriate bioassays conducted in accordance with N.J.A.C. 7:18.	All Classifications
		v.	The concentration of persistent toxic substances in the State's waters shall not exceed one-hundredeth (0.01) of the acute definitive LC_{50} or EC_{50} value, as determined by appropriate bioassays conducted in accordance with N.J.A.C. 7:18.	All Classifications

7:9B-1.14(d) General Surface Water Quality Criteria for FW2, SE and SC Waters:
(Expressed as Maximum concentrations unless otherwise noted)

	Substance		Criteria	Classifications
13.	Turbidity (Nephelometric Turbidity Unit-NTU)	i.	Maximum 30-day average of 15 NTU, a maximum of 50 NTU at any time.	FW2, SE3
		ii.	Maximum 30-day average of 10 NTU, a maximum of 30 NTU at any time.	SE1, SE2
		iii.	Levels shall not exceed 10.0 NTU.	SC

* See N.J.A.C. 7:9B-1.14(g) for site-specific criteria.

(e) Surface Water Quality Criteria for Ammonia are derived in accordance with the formulas set forth below. Acute criteria are expressed as three-hour average using MA1CD10 flow and chronic criteria are expressed as 30-day average using MA30CD10 flow. No exceedance of criteria shall be permitted at or above the design flows specified.

		CAS Number		Criteria	Classification
1.	Ammonia, un-ionized (mg NH_3-N/L)	7664-41-7	i.	at pH < 8.30 $0.238*10^{0.026(Temp-20) + 0.41 (pH-7.80)}$ (acute) $0.061*10^{0.026(Temp-20) + 0.41 (pH-7.80)}$ (chronic)	PL
			ii.	0.115 (acute); 0.030 (chronic)	All SE
			iii.	0.094 (acute); 0.024 (chronic)	SC

2. Ammonia, Total (mg TAN/L) - Acute criteria are expressed as one-hour average using MA1CD10 flow, chronic criteria are expressed as 30-day rolling average using MA30CD10 flow and the highest four-day average within the 30-day averaging period should not be more than 2.5 times of chronic criteria. No exceedance of criteria shall be permitted at or above the design flows specified.

		CAS Number		Criteria applicable in FW2 waters	Classifications
3.	Ammonia, total (mg TAN/L)	7664-41-7	i.	$\text{MIN}\left(\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right), \left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times10^{0.036\times(20-T)}\right)\right)\right)$ (acute)	FW2-TP, FW2-TM
			ii.	$0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times MIN\left(51.93,23.12\times10^{0.036\times(20-T)}\right)$ (acute)	FW2-NT
			iii.	$0.8876\times\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\times\left(2.126\times10^{0.028\times(20-MAX(T,7))}\right)$ (chronic)	All FW2

(f) Surface Water Quality Criteria for Toxic Substances are as follows:

1. Acute aquatic life protection criteria are determined with no exceedance at or above the MA1CD10 flow and expressed as one-hour average except,
   i. for copper the criteria are expressed as 24-hour average, and
   ii. for cadmium, chromium, lead, mercury, nickel, silver, and zinc the criteria are expressed as 6-hour average.
2. Chronic aquatic life protection criteria are determined with no exceedance at or above the MA7CD10 flow and expressed as four-day average.
3. Freshwater aquatic criteria for cadmium, chromium III, copper, nickel, silver, and zinc are expressed as a function of water hardness. Criteria can be calculated at any hardness using these equations as listed below. Criteria thus calculated are multiplied by appropriate conversion factor (CF) to convert total recoverable metal into dissolved metal and by the default Water Effect Ratio (WER) of 1.0.

General formula $WER\ [e^{(V[\ln (hardness)] + \ln A - V[\ln Z])}]\ CF$

where:
V = pooled slope
A = FAV at given hardness
Z = selected value of hardness

Cadmium:

Acute dissolved criterion $WER\ [e^{(1.0166\ (\ln\ [hardness])-3.924)}]\ 0.651$

Chronic dissolved criterion $WER\ [e^{(0.7409\ (\ln\ [hardness])-4.719)}]\ 0.651$

Chromium III:

Acute dissolved criterion $WER\ [e^{(0.819\ (\ln\ [hardness])+3.7256)}]\ 0.277$

Chronic dissolved criterion $WER\ [e^{(0.819\ (\ln\ [hardness])+0.6848)}]\ 0.277$

Copper:

Acute dissolved criterion $WER\ [e^{(0.9422\ (\ln\ [hardness])-1.7)}]\ 0.908$

Chronic dissolved criterion $WER\ [e^{(0.8545\ (\ln\ [hardness])-1.702)}]\ 0.908$

Nickel:

Acute dissolved criterion $WER\ [e^{(0.846\ (\ln\ [hardness])+2.255)}]\ 0.846$

Chronic dissolved criterion $WER\ [e^{(0.846\ (\ln\ [hardness])+0.0584)}]\ 0.846$

Silver:

Acute dissolved criterion	*WER* $[e^{(1.72\ (\ln\ [hardness])-6.59)}]\ 0.85$

Zinc:

Acute or dissolved criterion	*WER* $[e^{(0.8473\ (\ln\ [hardness])+0.884)}]\ 0.950$
Chronic dissolved criterion	*WER* $[e^{(0.8473\ (\ln\ [hardness])+0.884)}]\ 0.950$

4. Freshwater criteria for pentachlorophenol are expressed as a function of pH. Criteria are derived in accordance with the formula set forth below:

   Acute criterion $= e^{(1.005[pH]-4.869)}$

   Chronic criterion $= e^{(1.005[pH]-5.134)}$
5. Human health noncarcinogenic effect-based criteria are expressed as a 30-day average with no frequency of exceedance at or above the MA7CD10 flow.
6. Human health carcinogenic effect-based criteria are based on a risk level of one-in-one-million and are expressed as a 70-year average with no frequency of exceedance at or above the design flow as specified at N.J.A.C. 7:9B-1.5(c)2iii.

7. SURFACE WATER QUALITY CRITERIA FOR TOXIC SUBSTANCES:

(µg/L)

Toxic Substance	CAS Number	Fresh Water (FW2) Criteria			Saline Water (SE & SC) Criteria		
		Aquatic		Human Health	Aquatic		Human Health
		Acute	Chronic		Acute	Chronic	
Acenaphthene	83-32-9			670(h)			990(h)
Acrolein	107-02-8			6.1(h)			9.3(h)
Acrylonitrile	107-13-1			0.051(hc)			0.25(hc)
Aldrin	309-00-2	3.0		0.000049(hc)	1.3		0.000050(hc)
Ammonia, un-ionized	7664-41-7	See N.J.A.C. 7:9B-1.14(e)			See N.J.A.C. 7:9B-1.14(e)		
Anthracene	120-12-7			8,300(h)			40,000(h)
Antimony	7440-36-0			5.6(h)(T)			640(h)(T)
Arsenic	7440-38-2	340(d)(s)	150(d)(s)	0.017(hc)(T)	69(d)(s)	36(d)(s)	0.061(hc)(T)
Asbestos	1332-21-4			$7x10^6$fibers/L >10µm(h)			
Barium	7440-39-3			2,000(h)(T)			
Benz(a)anthracene	56-55-3			0.038(hc)			0.18(hc)
Benzene	71-43-2			0.15(hc)			3.3(hc)
Benzidine	92-87-5			0.000086(hc)			0.00020(hc)
3,4-Benzofluoranthene (Benzo(b)fluoranthene)	205-99-2			0.038(hc)			0.18(hc)
Benzo(k)fluoranthene	207-08-9			0.38(hc)			1.8(hc)
Benzo(a)pyrene (BaP)	50-32-8			0.0038(hc)			0.018(hc)
Beryllium	7440-41-7			6.0(h)(T)			42(h)(T)
alpha-BHC (alpha-HCH)	319-84-6			0.0026(hc)			0.0049(hc)
beta-BHC (beta-HCH)	319-85-7			0.0091(hc)			0.017(hc)
gamma-BHC (gamma-HCH/Lindane)	58-89-9	0.95		0.98(h)	0.16		1.8(h)
Bis(2-chloroethyl) ether	111-44-4			0.030(hc)			0.53(hc)
Bis(2-chloroisopropyl) ether	108-60-1			1,400(h)			65,000(h)
Bis(2-ethylhexyl) phthalate	117-81-7			1.2(hc)			2.2(hc)
Bromodichloromethane (Dichlorobromomethane)	75-27-4			0.55(hc)			17(hc)
Bromoform	75-25-2			4.3(hc)			140(hc)
Butyl benzyl phthalate	85-68-7			150(h)			190(h)
Cadmium	7440-43-9	(a)	(a)	3.4(h)(T)	40(d)(s)	8.8(d)(s)	16(h)(T)
Carbon tetrachloride	56-23-5			0.33(hc)			2.3(hc)
Chlordane	57-74-9	2.4	0.0043	0.00010(hc)	0.09	0.0040	0.00011(hc)

Toxic Substance	CAS Number	Fresh Water (FW2) Criteria			Saline Water (SE & SC) Criteria		
		Aquatic		Human Health	Aquatic		Human Health
		Acute	Chronic		Acute	Chronic	
Chloride	16887-00-6	860,000	230,000	250,000(ol)			
Chlorine Produced Oxidants (CPO)	7782-50-5	19	11		13	7.5	
Chlorobenzene	108-90-7			210(h)			2,500(h)
Chloroform	67-66-3			68(h)			2,100(h)
2-Chloronaphthalene	91-58-7			1,000(h)			1,600(h)
2-Chlorophenol	95-57-8			81(h)			150(h)
Chlorpyrifos	2921-88-2	0.083	0.041		0.011	0.0056	
Chromium	7440-47-3			92(h)(T)			750(h)(T)
Chromium^{+3}	16065-83-1	(a)	(a)				
Chromium^{+6}	18540-29-9	15(d)(s)	10(d)(s)		1,100(d)(s)	50(d)(s)	
Chrysene	218-01-9			3.8(hc)			18(hc)
Copper*	7440-50-8	(a)	(a)	1,300(h)(T)	4.8(d)(s)	3.1(d)(s)	
Cyanide (Total)	57-12-5	22(fc)	5.2(fc)	140(h)	2.7(fc)	2.7(fc)	140(h)
4,4'-DDD (p,p'-TDE)	72-54-8			0.00031(hc)			0.00031(hc)
4,4'-DDE	72-55-9			0.00022(hc)			0.00022(hc)
4,4'-DDT	50-29-3	1.1	0.0010	0.00022(hc)	0.13	0.0010	0.00022(hc)
Demeton	8065-48-3		0.1			0.1	
Dibenz(a,h)anthracene	53-70-3			0.0038(hc)			0.018(hc)
Dibromochloromethane (Chlorodibromomethane)	124-48-1			0.40(hc)			13(hc)
Di-n-butyl phthalate	84-74-2			2,000(h)			4,500(h)
1,2-Dichlorobenzene	95-50-1			2,000(h)			6,200(h)
1,3-Dichlorobenzene	541-73-1			2,200(h)			8,300(h)
1,4-Dichlorobenzene	106-46-7			550(h)			2,200(h)
3,3'-Dichlorobenzidine	91-94-1			0.021(hc)			0.028(hc)
1,2-Dichloroethane	107-06-2			0.29(hc)			28(hc)
1,1-Dichloroethylene	75-35-4			4.7(h)			100(h)
trans-1,2-Dichloroethylene	156-60-5			590(h)			43,000(h)
2,4-Dichlorophenol	120-83-2			77(h)			290(h)
1,2-Dichloropropane	78-87-5			0.50(hc)			15(hc)
1,3-Dichloropropene (cis and trans)	542-75-6			0.34(hc)			21(hc)

Toxic Substance	CAS Number	Fresh Water (FW2) Criteria			Saline Water (SE & SC) Criteria		
		Aquatic		Human Health	Aquatic		Human Health
		Acute	Chronic		Acute	Chronic	
Dieldrin	60-57-1	0.24	0.056	0.000052(hc)	0.71	0.0019	0.000054(hc)
Diethyl phthalate	84-66-2			17,000(h)			44,000(h)
2,4-Dimethyl phenol	105-67-9			380(h)			850(h)
4,6-Dinitro-o-cresol	534-52-1			13(h)			280(h)
2,4-Dinitrophenol	51-28-5			69(h)			5,300(h)
2,4-Dinitrotoluene	121-14-2			0.11(hc)			3.4(hc)
1,2-Diphenylhydrazine	122-66-7			0.036(hc)			0.20(hc)
Endosulfans (alpha and beta)	115-29-7	0.22	0.056	62(h)	0.034	0.0087	89(h)
Endosulfan sulfate	1031-07-8			62(h)			89(h)
Endrin	72-20-8	0.086	0.036	0.059(h)	0.037	0.0023	0.060(h)
Endrin aldehyde	7421-93-4			0.059(h)			0.060(h)
Ethylbenzene	100-41-4			530(h)			2,100(h)
Fluoranthene	206-44-0			130(h)			140(h)
Fluorene	86-73-7			1,100(h)			5,300(h)
Guthion	86-50-0		0.01			0.01	
Heptachlor	76-44-8	0.52	0.0038	0.000079(hc)	0.053	0.0036	0.000079(hc)
Heptachlor epoxide	1024-57-3	0.52	0.0038	0.000039(hc)	0.053	0.0036	0.000039(hc)
Hexachlorobenzene	118-74-1			0.00028(hc)			0.00029(hc)
Hexachlorobutadiene	87-68-3			0.44(hc)			18(hc)
Hexachlorocyclopenta-diene	77-47-4			40(h)			1,100(h)
Hexachloroethane	67-72-1			1.4(hc)			3.3(hc)
Indeno(1,2,3-cd)pyrene	193-39-5			0.038(hc)			0.18(hc)
Isophorone	78-59-1			35(hc)			960(hc)
Lead	7439-92-1	38(d)(s)	5.4(d)(s)	5.0(h)(T)	210(d)(s)	24(d)(s)	
Malathion	121-75-5		0.1			0.1	
Manganese	7439-96-5						100(h)(T)
Mercury	7439-97-6	1.4(d)(s)	0.77(d)(s)	0.050(h)(T)	1.8(d)(s)	0.94(d)(s)	0.051(h)(T)
Methoxychlor	72-43-5		0.03	40(h)		0.03	
Methyl bromide (bromomethane)	74-83-9			47(h)			1,500(h)
Methyl t-butyl ether (MTBE)	1634-04-4			70(h)			

Federal and NJ State Primary and Secondary Drinking Water Standards as of June 2020

Volatile Organic Compounds

Contaminants	**Maximum Contaminant Levels [MCL]** [µg/l or ppb]
Benzene	1*
Carbon Tetrachloride	2*
1,2-Dichlorobenzene	600
1,3- Dichlorobenzene	600*
1,4- Dichlorobenzene	75
1,1-Dichloroethane	50*
1,2-Dichloroethane	2*
1,1-Dichloroethylene	2*
cis- 1,2-Dichloroethylene	70
trans- 1,2-Dichloroethylene	100
1,2-Dichloropropane	5
Ethylbenzene	700
Methyl tertiary Butyl Ether	70*
Methylene Chloride	3*
Monochlorobenzene	50*
Naphthalene	300*
Styrene	100
1, 1,2,2-Tetrachloroethane	1*
Tetrachloroethylene	1*
Toluene	1,000
1,2,4-Trichlorobenzene	9*
1,1,1-Trichloroethane	30*
1,1,2-Trichloroethane	3*
Trichloroethylene	1*
Vinyl Chloride	2
Xylenes [Total]	1,000*

Radionuclides

Contaminants	**Maximum Contaminant Levels [MCL]**
Combined radium 226/228	5 pCi/L
Gross alpha particles	15 pCi/L
Beta/photon emitters	4 mrem/year
Uranium	30 µg/L

Other Contaminants

Turbidity No more than 5% of the samples may exceed 0.3 NTU, nor any sample exceed 1 NTU.

Coliform bacteria standards are based on an MCL for E. coli, and uses E. coli and total coliforms to initiate a "find and fix" approach to address fecal contamination that could enter into the distribution system. It requires public water systems to perform assessments to identify sanitary defects and subsequently take action to correct them.

Inorganic Chemicals

Contaminants	**Maximum Contaminant Levels [MCL]** [µg/l or ppb]
Antimony	6
Arsenic	5 *
Asbestos	7 x 10^6 fibers/l >10 µm
Barium	2,000
Beryllium	4
Cadmium	5
Chromium	100
Copper	1,300**[AL]
Cyanide	200
Fluoride	4,000
Lead	15**[AL]
Mercury	2
Nickel	+
Nitrate [as nitrogen]	10,000
Nitrite	1,000
[combined nitrate/nitrite]	10,000
Selenium	50
Thallium	2

Disinfection Byproducts

Contaminants	**Maximum Contaminant Levels** [MCL] µg/L or ppb (as running annual averages per group)
Dichlorobromomethane	80 (TTHM)
Chlorodibromomethane	80 (TTHM)
Bromofrom	80 (TTHM)
Chloroform	80 (TTHM)
Monochloroacetic acid	60 (HAA5)
Dichloroacetic acid	60 (HAA5)
Trichloroacetic acid	60 (HAA5)
Bromoacetic acid	60 (HAA5)
Dibromoacetic acid	60 (HAA5)
Bromate	10
Chlorite	1,000

TTHM- Trihalomethanes
HAA5- Haloacetic Acids
Bromate (only for treatment plants using ozone)
Chlorite (only for treatment plants using chlorine dioxide), requries daily/follow-up monitoring, not annual

For a detailed explanation of the Safe Drinking Water Program, refer to the Federal Safe Drinking Water Act regulations [40 CFR Parts 141, 142, 143] and the New Jersey Safe Drinking Water regulations [N.J.A.C. 7:10-1 et seq.].

Synthetic Organic Compounds

Contaminants	**Maximum Contaminant Levels [MCL]** [µg/l or ppb]
Alachlor	2
Aldicarb	+
Aldicarb Sulfone	+
Aldicarb Sulfoxide	+
Atrazine	3
Benzo[a]pyrene	0.2
Carbofuran	40
Chlordane	0.5*
Dalapon	200
Dibromochloropropane [DBCP]	0.2
Di[2-ethylhexyl]adipate	400
Di[2-ethylhexyl]phthalate	6
Dinoseb	7
Diquat	20
Endothall	100
Endrin	2
Ethylene dibromide [EDB]	0.05
Glyphosate	700
Heptachlor	0.4
Heptachlor Epoxide	0.2
Hexachlorobenzene	1
Hexachloroclyclopentadiene	50
Lindane	0.2
Methoxychlor	40
Oxamyl	200
PCBs	0.5
Pentachlorophenol	1
Perfluorononanoic acid (PFNA)	0.013*
Perfluorooctanoic acid (PFOA)	0.014*
Perfluorooctane sulfonic acid (PFOS)	0.013*
Picloram	500
Simazine	4
Toxaphene	3
2,3,7,8—TCDD [Dioxin]	$3x10^{-5}$
2,4-D	70
2,4,5-TP [Silvex]	50
1,2,3-Trichloropropane (1,2,3-TCP)	0.030*

Per- and polyfluoroalkyl substances (PFAS such as PFNA, PFOA & PFOS) are considered to be Synthetic Organic Compounds due to their chemical makeup, however, their regulatory framework follows that of Volatile Organic Compounds

Secondary Standards

Physical Characteristics	**Recommended Upper Limit or Optimum Range**
Color	10 color units (standard cobalt scale)
pH	6.5 to 8.5 (optimum range)
Odor	3 Threshold odor number
Taste	No objectionable taste

Chemical Characteristics	**Recommended Upper Limit** [mg/l or ppm]
ABS/L.A.S.	0.5
Aluminum	0.2
Chloride	250
Fluoride	2
Hardness (as $CaCO_3$)	250
Iron	0.3
Manganese	0.05
Silver	0.1
Sodium	50
Sulfate	250
Total Dissolved Solids (TDS)	500
Zinc	5

Key:
* N.J. MCL [A-280]
** An [AL] action level is not an MCL. It is a trigger point at which remedial action is to take place
+ No MCL – Monitoring Required

One milligram per liter [mg/l] = one part per million = one cent in $10,000 or one second in 12 days.
One microgram per liter [µg//l] = one part per billion = one cent in $10,000,000 or one second in 32 years.

New Jersey Department of Environmental Protection

Division of Water Supply and Geoscience

Bureau of Safe Drinking Water
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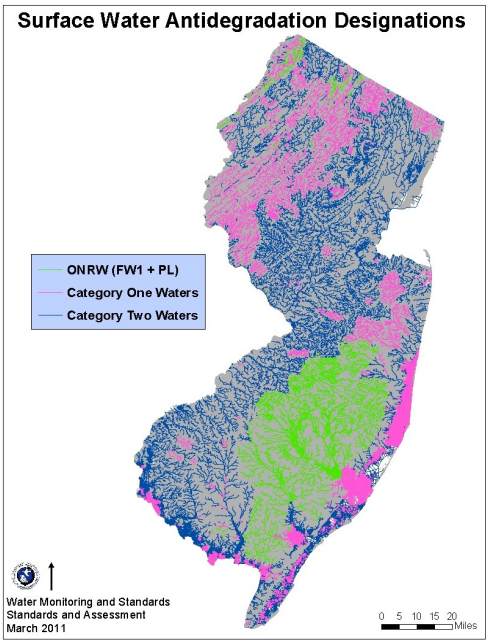
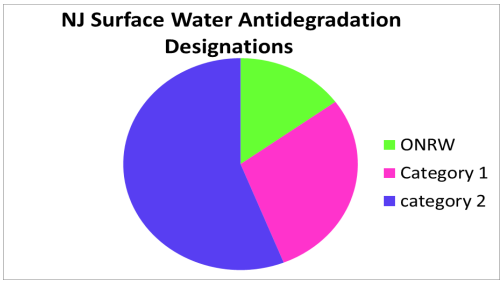
New Jersey
Surface Water Quality Standards
Antidegradation Designations

July 2017

Three Tiers of Antidegradation

- **Outstanding National Resource Waters (ONRW)**
  -Freshwater 1 (FW1)
  -Pinelands (PL)
- **Category One (C1)-** Exceptional Resource waters
- **Category Two (C2)-**All other waters





The **Surface Water Quality Standards** (SWQS) establish antidegradation policies for all surface waters of the State at N.J.A.C. 7:9B. The SWQS require that all existing and designated uses shall be maintained and protected for all surface waters of the State. Impaired waters must be restored to meet SWQS. Existing water quality shall be maintained. The three tiers of antidegradation designations are described below.

The most protective tier of antidegradation designation is **Outstanding National Resource Waters** (ONRW) which include surface waters classified as FW1 and PL. These waters are set aside for posterity because of their unique significance. The Department cannot approve any activity which might alter existing water quality in these waters.

The second tier of antidegradation designation is **Category One** (C1). C1 waters are designated through rulemaking for protection from measurable changes in water quality because of their Exceptional Ecological Significance, Exceptional Water Supply, Exceptional Recreation, and Exceptional Fisheries to protect and maintain their water quality, aesthetic value, and ecological integrity.

All waters not designated in the SWQS as ONRW (FW1 or PL) or C1 are designated as **Category Two** (C2). The same criteria apply in C1 and C2 waters. In all cases, existing and designated uses must be maintained and protected. Waterbodies that are generally not meeting criteria must be improved to meet water quality criteria.

The SWQS operate in conformance with the Federal Clean Water Act at 33 U.S.C. 1313(c) and the Federal Water Quality Standards Regulations at 40 C.F.R. 131. New Jersey's statutory authority is granted by the Water Pollution Control Act at N.J.S.A. 58:10A and the Water Quality Planning Act at N.J.S.A. 58:11A.

New Jersey Department of Environmental Protection
Division of Water Monitoring and Standards
Bureau of Environmental Analysis, Restoration and Standards
http://www.state.nj.us/dep/wms/bears/
(609) 633-1441

New Jersey
Surface Water Quality Standards
Antidegradation Designations:
Category One

Category One (C1) designation provides additional protection to waterbodies that help prevent water quality degradation and discourage development where it would impair or destroy natural resources and water quality. The maintenance of water quality is important to all residents, particularly to the many communities that depend upon surface waters for drinking water supplies, recreation, fishing, and shellfish harvesting.

Category One waters were originally designated in 1985 based on parks, wildlife management areas, and trout production waters. After 1985, additional streams upgraded to FW2-trout production were routinely designated as C1. In 2002, the Department began an intensive effort to identify additional waters that warranted enhanced protections afforded by this designation. The Department adopted new definitions of Exceptional Ecological Significance, Exceptional Fisheries Resource(s), and Exceptional Water Supply Significance to clarify data requirements for a waterbody to be designated as C1.

Under the definition of Exceptional Ecological Significance, the Department considers those waterbodies supporting certain aquatic-dependent T&E (bog turtles and mussels) or exceptional aquatic community can qualify for C1. Waterbodies that support unimpaired benthic macroinvertebrates and indicate exceptional value for only two of the four data sources: habitat, physical/chemical water quality data, fish assemblage, and low impervious surface can qualify under exceptional aquatic community.

Under the definition of Exceptional Fisheries Resource(s), trout production waters classified as FW2-TP and approved shellfish harvesting waters can qualify for C1.

Under the definition of Exceptional Water Supply Significance, waterbodies that are part of the water supply system that serves a population greater than 100,000, including any reservoirs and streams that directly flow into those reservoirs can qualify for C1. See http://www.state.nj.us/dep/wms/bears/c1waters.htm.

Implementation of Category One Waters

- **New Jersey Pollutant Discharge Elimination System (NJPDES) Rules at N.J.A.C. 7:14A**: New or expanded wastewater discharges must maintain the existing water quality of the receiving stream. If the discharge is located above a C1 segment the applicant must meet "no measurable change" at the C1 boundary. See www.nj.gov/dep/dwq/.
- **Flood Hazard Area Control Act Rules at N.J.A.C. 7:13**: 300 foot riparian zones are imposed through Flood Hazard Area Control Act rule permits to all C1 waters and their upstream tributaries within the same sub-watershed or HUC 14. See www.nj.gov/dep/landuse/.

For additional information, please see http://www.state.nj.us/dep/wms/bears/c1waters.htm.

Parameter	Units	CAS No.	Dec-24
Ammonia	mg TAN/L	7664-41-7	

Acute	Chronic	Classification
2.35	0.54	FW2-TM,TP
5.80	0.54	FW2-NT
	0.54	FW2

FW2-TM,TP

FW2-TM,TP		pH	Temp (C)	
	2.35	8.45	14.5	Used field measured pH and temp from October 16, 2024 sampling event
	0.275	0.26		
	1.00			
	0.06	8.45		
	39.00	2.09		
	1.00			
	17.62	8.45		
FW2-TM,TP	**2.35**			

Acute 2.35

FW2-TM,TP		pH	
	2.58	8.45	14.5
	0.72	0.72	
	0.01	0.01	
	1.00		
	0.06	8.45	
	1.62	0.09	
	1.00		
	17.62	8.45	
	23.12		
	36.47	36.47	14.5
FW2-TM,TP	**2.58**		

Acute 2.58

FW2-NT

FW2-NT		pH	
	5.80	8.45	14.5
	0.72	0.72	
	0.01	0.01	
	1.00		
	0.06	8.45	
	1.62	0.09	
	1.00		
	17.62	8.45	
	51.93		
	81.93	81.93	14.5
FW2-NT	**5.80**		

Acute 5.80

Chronic

FW2		pH	
	0.54	8.45	14.5
	0.89	0.89	
	0.03	0.02	
	1.00		
	0.17	8.45	
	1.20	0.18	
	1.00		
	5.78	8.45	
	2.13		
	3.03	3.03	14.5
FW2	**0.54**		

Chronic 0.54

Source: NJAC 7:9B **Dec-23**

3. Ammonia, total (mg TAN/L)	7664-41-7		FW2-TP, FW2-TM

i.

$$\text{MIN}\left(\begin{array}{c}\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\\ \left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times10^{0.036\times(20-T)}\right)\right)\end{array}\right) \text{ (acute)}$$

ii. FW2-NT

$$0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times MIN\left(51.93,23.12\times10^{0.036\times(20-T)}\right) \text{ (acute)}$$

iii. All FW2

$$0.8876\times\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\times\left(2.126\times10^{0.028\times(20-MAX(T,7))}\right) \text{ (chronic)}$$

Parameter	Units	CAS No.
Ammonia	mg TAN/L	7664-41-7

Acute	Chronic	Classification
0.98	0.25	FW2-TM,TP
2.21	0.25	FW2-NT
	0.25	FW2

FW2-TM,TP

FW2-TM,TP		pH	Temp (C)
	2.14	8.5	25
	0.275	0.26	
	1.00		
	0.05	8.5	
	39.00	1.88	
	1.00		
	19.77	8.5	
FW2-TM,TP	**2.14**		

Acute 2.14

FW2-TM,TP		pH	
	0.98	8.5	25
	0.72	0.72	
	0.01	0.01	
	1.00		
	0.05	8.5	
	1.62	0.08	
	1.00		
	19.77	8.5	
	23.12		
	15.28	15.28	25
FW2-TM,TP	**0.98**		

Acute 0.98

FW2-NT

FW2-NT		pH	
	2.21	8.5	25
	0.72	0.72	
	0.01	0.01	
	1.00		
	0.05	8.5	
	1.62	0.08	
	1.00		
	19.77	8.5	
	51.93		
	34.31	34.31	25
FW2-NT	**2.21**		

Acute 2.21

Chronic

FW2	pH

		0.25		8.5	25
		0.89	0.89		
		0.03	0.02		
		1.00			
		0.15		8.5	
		1.20	0.16		
		1.00			
		6.49		8.5	
		2.13			
		1.54	1.54		25
Chronic	0.25	FW2	**0.25**		

Source: NJAC 7:9B Dec-23

3. Ammonia, total (mg TAN/L) 7664-41-7

FW2-TP, FW2-TM

i.

$$\text{MIN}\left(\begin{array}{c}\left(\frac{0.275}{1+10^{7.204-pH}}+\frac{39.0}{1+10^{pH-7.204}}\right),\\ \left(0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times\left(23.12\times10^{0.036\times(20-T)}\right)\right)\end{array}\right)\ \text{(acute)}$$

ii. FW2-NT

$$0.7249\times\left(\frac{0.0114}{1+10^{7.204-pH}}+\frac{1.6181}{1+10^{pH-7.204}}\right)\times MIN\left(51.93,23.12\times10^{0.036\times(20-T)}\right)\ \text{(acute)}$$

iii. All FW2

$$0.8876\times\left(\frac{0.0278}{1+10^{7.688-pH}}+\frac{1.1994}{1+10^{pH-7.688}}\right)\times\left(2.126\times10^{0.028\times(20-MAX(T,7))}\right)\ \text{(chronic)}$$

United States Environmental Protection Agency
Office of Water
MC 4304T
820-F-13-013
August 2013

Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater (2013)

Summary

EPA has published national recommended ambient water quality criteria for the protection of aquatic life from the toxic effects of ammonia, a constituent of nitrogen pollution. These recommended criteria will help States, Territories, and authorized Tribes update their water quality standards with concentration levels for ammonia in surface waters at or below which aquatic organisms will be protected, if not exceeded more frequently than once every three years on average. Acute and chronic criteria were developed to protect organisms from both immediate effects, such as mortality, and longer-term effects on reproduction, growth and survival, respectively.

EPA's final *Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater* (2013) incorporate scientific views received on EPA's 2009 draft updated ammonia criteria and supersede EPA's previously recommended 1999 ammonia criteria.

What are national recommended aquatic life ambient water quality criteria?

Ambient water quality criteria for the protection of aquatic life are numeric concentrations of pollutants, with specific associated duration and frequency information, in surface waters that are protective of aquatic life designated uses. Under Clean Water Act section 304(a), EPA is required to develop and publish water quality criteria that reflect the latest scientific knowledge. Water quality criteria are based solely on data and scientific judgments about the relationship between pollutant concentrations and potential environmental and human health effects. EPA's recommended water quality criteria are not rules, nor do they automatically become part of a state's water quality standards. States must adopt into their standards water quality criteria that protect the designated uses of the water bodies within their area. These can include scientifically defensible site-specific criteria that are different from EPA's national recommended criteria, as long as the site-specific criteria are protective of the designated use. Water quality criteria are not effective under the Clean Water Act until they have been adopted into a state's water quality standards and approved by EPA.

What is ammonia?

Ammonia is one of several forms of nitrogen that exist in aquatic environments. Unlike other forms of nitrogen, which can cause nutrient over-enrichment of a water body at elevated concentrations and indirect effects on aquatic life, ammonia causes direct toxic effects on aquatic life.

Ammonia is produced for commercial fertilizers and other industrial applications. Natural sources of ammonia include the decomposition or breakdown of organic waste matter, gas exchange with the atmosphere, forest fires, animal and human waste, and nitrogen fixation processes.

How does ammonia enter surface waters?

Ammonia can enter the aquatic environment via direct means such as municipal effluent discharges and the excretion of nitrogenous wastes from animals, and indirect means such as nitrogen fixation, air deposition, and runoff from agricultural lands.

How does ammonia affect aquatic life?

When ammonia is present in water at high enough levels, it is difficult for aquatic organisms to sufficiently excrete the toxicant, leading to toxic buildup in internal tissues and blood, and potentially death. Environmental factors, such as pH and temperature, can affect ammonia toxicity to aquatic animals.

What is the history of EPA's development of ammonia criteria?

EPA first published ammonia criteria for the protection of aquatic life in 1976. The criteria were then updated in 1985 and 1999 to reflect scientific information available at that time. The 1999 recommended aquatic life criteria for ammonia were based on the most sensitive endpoints known at the time: the acute criterion was based on salmonid fish toxicity information, and the chronic criterion was based on bluegill sunfish early life stage toxicity.

In 2003, EPA became aware of new toxicity studies indicating the relative sensitivity of freshwater mussels to ammonia and began to update the 1999 criteria to reflect this new information. In 2009, following external peer review, EPA published draft recommended ammonia criteria, for waters with and without mussels. Since the publication of the draft 2009 ammonia criteria, additional toxicity testing has validated information on the effects of ammonia on sensitive freshwater gill-breathing snail species. In April 2013, EPA finalized the updated ammonia criteria that are applicable nationally, taking into account the latest toxicity information for freshwater species, including unionid mussels and gill-breathing snails. The 2013 criteria incorporate scientific views received on the draft (2009) ammonia criteria and supersede EPA's previously recommended 1999 criteria.

What are the 2013 recommended water quality criteria for ammonia?

EPA recommends an acute criterion magnitude of 17 mg Total Ammonia Nitrogen (TAN) per liter at pH 7 and 20°C for a one-hour average duration, not to be exceeded more than once every three years on average. EPA recommends a chronic criterion magnitude of 1.9 mg TAN/L at pH 7 and 20°C for a 30-day average duration, not to be exceeded more than once every three years on average. In addition, the highest four-day average within a 30-day period should not exceed 2.5 times the chronic criterion magnitude (e.g. 1.9 mg TAN/L x 2.5 = 4.8 mg TAN/L at pH 7 and 20°C) more than once in three years on average.

How do the 2013 criteria compare to the previously recommended 1999 criteria and the draft 2009 criteria?

The 2013 ammonia criteria recommendations take into account the latest freshwater toxicity information for ammonia, including toxicity studies for sensitive unionid mussels and gill-breathing snails. These new criteria are based on robust toxicity data available for 69 genera (acute) and 16 genera (chronic). The updated criteria magnitudes are more stringent than the previously recommended 1999 criteria magnitudes (see *Table 1*). The duration components of the 1999, 2009 and 2013 criteria remain the same - a one-hour average duration for the acute criterion and 30-day average duration for the chronic criterion. The frequency component for the acute and chronic criteria remains once in three years on average.

Table 1. Comparison of past and current EPA-recommended aquatic life water quality criteria magnitudes for ammonia. Criteria magnitudes are expressed as total ammonia nitrogen (mg TAN/L) at pH 7 and 20°C.

Criterion Duration	1999 Criteria	2009 Draft Updated Criteria	2013 Final Updated Criteria
Acute (1-hour average)	24	19	17
Chronic (30-day rolling average)	4.5*	0.91*	1.9*
*Not to exceed 2.5 times the criterion continuous concentration as a 4-day average within a 30-day period.			
Criteria frequency: Not to be exceeded more than once in three years on average.			

Additional EPA Resources

EPA has developed three supporting documents to aid states considering adoption of the 2013 recommended ammonia criteria.

Flexibilities for States Applying EPA's Ammonia Criteria Recommendations provides an overview of a number of implementation approaches available for state consideration, including the recalculation procedure for site-specific criteria derivation, variances, revisions to designated uses, dilution allowances, and compliance schedules. The document describes how each of these flexibilities fits within a state's water quality standards adoption and implementation processes.

EPA has also developed a *Revised Deletion Process for the Site-Specific Recalculation Procedure for Aquatic Life Criteria* that describes a recalculation procedure and includes a spreadsheet that may be used to derive site-specific water quality criteria for the protection of aquatic life in order to best reflect the organisms that reside at a specific site.

A third document, which EPA expects to publish in 2013, *Technical Support Document for Conducting and Reviewing Freshwater Mussel Studies for the Development of Site-specific Water Quality Criteria for Ammonia,* will help states determine if sensitive freshwater mussels are present in their waters. Commonly-used mussel sampling methods will be described and an overview will be provided of various study approaches, considerations, and limitations, including real-life examples.

How to View the Criteria Document and Supporting Information

EPA has established an official public docket for this action under Docket ID No. EPA-HQ-OW-2009-0921, accessed at www.regulations.gov. You may also download the document and supporting information from http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/ammonia/index.cfm.

For More Information

Contact Lisa Huff by telephone at (202) 566-0787, by email at huff.lisa@epa.gov, or by mail at U.S. EPA, MC: 4304T, 1200 Pennsylvania Ave., N.W., Washington, D.C. 20460.

Understanding Water Quality Parameters to Better Manage Your Pond

Rossana Sallenave[1]

aces.nmsu.edu/pubs • Cooperative Extension Service • Guide W-104

The College of Agricultural, Consumer and Environmental Sciences is an engine for economic and community development in New Mexico, improving the lives of New Mexicans through academic, research, and Extension programs.

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INTRODUCTION

Successful pond management requires an understanding of the role of nutrients and other water quality parameters, as well as regular monitoring of environmental conditions within the pond's ecosystem. Water quality is often overlooked in pond management, and poor water quality can lead to common problems, such as excessive algal blooms, overgrowth of plants, noxious smells, or dead and dying fish. In order to prevent these problems, an understanding of basic water chemistry and other physical parameters is necessary. This publication describes the most important water quality factors that influence the health of ponds. Some factors that are particularly important in recreational fish ponds to ensure fish health and pond productivity are also discussed. A basic understanding of how these factors interact with one another will help pond owners maintain good water quality and a healthy pond ecosystem. Many companies produce kits and other materials to monitor water quality on your own, or you can send water samples to commercial laboratories for analysis.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is probably the single most important water quality factor for pond owners. Oxygen is needed by fish and other aquatic organisms, and levels of DO will determine the ability of ponds and other water bodies to support aquatic life. Oxygen dissolves in water at very low concentrations measured in parts per million (ppm, which can be used interchangeably with milligrams per liter [mg/L]). Ponds will rarely have more than 10 ppm DO. Most oxygen in water is produced by algae and green plants through photosynthesis, the process whereby green plants use solar energy to convert water and carbon dioxide (CO_2) to oxygen and carbohydrates. Oxygen is also naturally incorporated into water from the atmosphere through surface diffusion and turbulence caused by wind.

Daily fluctuations and seasonal changes in DO

Dissolved oxygen levels can vary dramatically in a 24-hour period. During the day, DO concentrations generated by photosynthesis will increase. During the

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night, DO levels will decline as oxygen is removed from water through respiration, the process whereby plants and animals consume oxygen and release carbon dioxide as they convert organic material to energy. For this reason, DO levels are typically highest at dusk and lowest just before dawn. There is also a strong relationship between temperature and DO: the warmer the water, the less oxygen it can hold. For example, water at 52°F (11°C) can hold 40% more oxygen than water at 80°F (27°C). Warm water increases the metabolism of fish and therefore increases their consumption of oxygen. Bacteria also consume oxygen as they decompose organic matter. Therefore, during the summer months, DO levels will be lower because of increased oxygen demands of fish, warmer water that holds less oxygen, and increased bacterial decomposition of dead plant and algal material toward the end of the growing season.

Effects of low DO

Oxygen depletion occurs when the demands for oxygen are greater than what is being produced. Oxygen depletion can occur for different reasons. Situations typically associated with oxygen depletion are

- Hot, cloudy, and still (windless) days;
- Pond stratification followed by turnovers (the mixing of stratified layers, which develop during the summer in ponds 8 ft deep or greater);
- After a sudden algal bloom die-off (from natural causes or after a chemical application); and
- Organic waste decomposition (oxygen depletion will occur in the presence of excessive organic matter from waste products, such as uneaten feed).

Whenever DO levels fall below 3 to 4 ppm, oxygen stress will occur. Lack of adequate dissolved oxygen is the leading cause of fish kills. Normal oxygen content in a healthy pond will range from 5 to 10 ppm. Warmwater fish (e.g., bass, bluegill, catfish) require about 5 ppm and coldwater fish (e.g., trout, salmon) require about 6.5 ppm to maintain good health. Dissolved oxygen levels of less than 3 ppm will kill warmwater fish and levels less than 5 ppm will kill coldwater fish. Fish exposed to low, nonlethal levels of DO over prolonged periods will be chronically stressed, stop eating, and be more susceptible to disease. Low oxygen concentrations also increase the activity of anaerobic bacteria, which create methane and hydrogen sulfide gases during anaerobic decomposition. Ponds with oxygen-poor bottoms and accumulated organic matter can release these gases when the bottom sediment is disturbed. Hydrogen sulfide has a rotten egg smell and is very toxic to fish.

Preventing low DO conditions

To help maintain safe DO levels in ponds, particularly in deeper ponds in which fish are intensively cultured, mechanical aeration is often needed. Aerators help keep pond water mixed so that layering is minimized and the surface water is well-oxygenated. However, aeration should only be thought of as one of many management tools to help maintain healthy oxygen levels. External nutrient loading is still the critical issue that must be addressed because excessive nutrients can lead to an overabundance of aquatic weeds and algae, which can result in oxygen depletions when they die and decompose.

NUTRIENTS (PHOSPHORUS AND NITROGEN)

It is important to understand the sources and basic pathways of nutrients because there is a direct correlation between available nutrients and populations of algae and aquatic weeds. The most important nutrients in aquatic systems are phosphorus (P) and nitrogen (N) in the forms of phosphates (PO_3) and nitrates (NO_3). These nutrients are critical to the growth of plants and animals in aquatic systems. Phosphorus has been identified as the limiting factor for algal growth in most lakes and, as such, is the largest contributor to aquatic plant growth. One gram of phosphorus will produce 100 grams of algal biomass. Excessive amounts of nutrients will lead to over-fertilization, or eutrophic conditions, which can result in an over-abundance of aquatic plants and algal blooms. When the excess plants and/or algae die, they decompose, which leads to a depletion of oxygen that can affect water clarity and smell and can lead to fish kills.

Sources of nutrients

The main sources of nutrients in ponds are bottom silt, dead vegetation, landscape debris, runoff from the surrounding area, poorly functioning septic systems, and wastes from livestock and waterfowl. As aquatic plants and algae grow and die, they sink to the bottom of the pond and provide a source of nutrients for future aquatic growth, a phenomenon known as nutrient cycling. This, along with landscape debris such as grass clippings, leaves, and pine needles, contributes nutrients to ponds, and these nutrients must be managed to prevent eutrophic conditions from developing. Runoff from fertilized fields and lawns in immediate surrounding areas as well as roads, farms, and outlying areas can also be major sources of nutrient enrichment.

Dissolved and particulate phosphorus

Phosphorus in water comes in two forms: dissolved and particulate. Dissolved phosphorus enters the aquatic environment from fertilizers, crop residues, or human or animal wastes, and is the form that is readily available to aquatic plants and algae. Particulate phosphorus is bound to soil particles and minerals that contain aluminum, iron, or calcium, as well as to organic matter, and enters aquatic systems primarily through soil erosion and surface runoff. While it may not be as readily available to aquatic plants, particulate phosphorus can accumulate in sediments and can be a source of slow release of phosphorus into the water for years.

NITROGENOUS WASTE (AMMONIA)

Ammonia is another compound that can affect the health and performance of your pond.

Sources of ammonia

Ammonia is a form of nitrogen found in organic materials and many fertilizers. It is the first form of nitrogen released when organic matter decays and is the main nitrogenous waste excreted by most fish and freshwater invertebrates. It is very unlikely that ammonia levels in your pond will reach levels that are lethal to fish. However, under conditions where fish are cultured intensively and fed protein-rich diets, they can produce high concentrations of ammonia, and fish may be exposed to sub-lethal levels (greater than 0.02 ppm) for extended periods of time. This can lead to reduced growth and increased susceptibility to disease.

Forms of ammonia

Ammonia can exist in two forms: un-ionized ammonia (NH_3) and ionized ammonia, also known as ammonium ion (NH_4^+). The ratio of un-ionized to ionized ammonia depends on pH and water temperature. Un-ionized ammonia (NH_3) is extremely toxic to fish and is the predominant form of ammonia when pH is high. Ionized ammonia (NH_4^+) is nontoxic except at extremely high levels and is the predominant form in water when pH is low. As a general rule, less than 10% of the ammonia will be the toxic un-ionized form when water pH values are lower than 8; however, this proportion increases greatly as pH increases. Water temperature will also affect the equilibrium between NH_3 and NH_4^+. At any given pH, more toxic NH_3 will be present in warmer water than in cooler water.

Ammonia removal and transformation processes

There are two processes that remove or transform ammonia released into the water. The first is uptake of ammonia by plants and algae, which readily use the nitrogen in ammonia as a nutrient for growth. For this reason, ammonia levels are usually low in ponds during summer months when algae are most productive, but can increase rapidly after the crash of an algal bloom. This is also one of the reasons why ammonia levels will tend to be higher in ponds during the winter months when algal production is low.

The second process, which transforms ammonia, is a step in the nitrogen cycle known as nitrification, the biological conversion of ammonia and ammonium to nitrate nitrogen. Nitrification is a two-step process. First, *Nitrosomonas* bacteria convert ammonia and ammonium to nitrite (NO_2). Nitrite, which is also highly toxic to fish, is then converted to nitrate (NO_3) by *Nitrobacter* bacteria. These reactions are usually coupled, and nitrite is rapidly converted to nitrate, so nitrite levels are usually low. The rate of nitrification is affected by water temperature. Maximum rates of nitrification occur at water temperatures between 86 and 95°F (30–35°C). At temperatures of 104°F (40°C) and higher, nitrification rates fall to near zero. At temperatures below 68°F (20°C), nitrification proceeds at a slower rate, but will continue at temperatures of 50°F (10°C) or less. For this reason, ammonia levels tend to be higher in fall and early spring before nitrification rates have increased as a result of increasing temperatures.

pH

The term pH refers to the concentration of hydrogen ions, and is a measure of whether a substance is an acid, a base, or neutral. The "p" in pH stands for "power" and the "H" for hydrogen ions. The scale of pH values ranges from 0 to 14; 7 represents neutral conditions, values less than 7 indicate more acidic conditions, and values above 7 indicate more alkaline or basic conditions.

Daily fluctuations in pH

The pH of freshwater ponds can fluctuate considerably both daily and seasonally; the magnitude of this fluctuation will depend on how well-buffered the freshwater system is. These fluctuations are due to photosynthesis and respiration by plants and animals, which results in the highest pH typically occurring at dusk and the lowest at dawn. This is because during the night respiration increases concentrations of carbon, which interacts with water to produce carbonic acid (H_2CO_3), lowering the pH. During the day, carbon dioxide concentrations decrease because of photosynthesis, driving pH values up.

How pH affects animals and other water quality variables

Optimum pH for fish growth and health is between 6 and 9. If pH is outside this range, fish growth will be reduced. Mortalities will occur when pH values are less than 4.5 or greater than 10. In addition to the direct effects pH can have on fish and other aquatic animals, pH interacts with other water quality variables such as ammonia, hydrogen sulfide, and dissolved metals, affecting their aqueous equilibria and toxicity as well. For example, as previously mentioned, high pH increases the toxicity of ammonia to fish, whereas low pH increases toxicity of aluminum and copper. Hydrogen sulfide (H_2S) is a toxic, colorless gas that can form in pond sediments when bacteria feed on organic debris in areas that are low or depleted of oxygen, giving off a rotten egg smell when the sediments are stirred up. When dissolved in water, H_2S can undergo two chemical steps, which go back and forth depending on the pH. At pH less than 6, most of the hydrogen sulfide will be in the toxic H_2S form, whereas at higher pH (8–12), most of the hydrogen sulfide will be in the less toxic HS^- form.

ALKALINITY

Alkalinity refers to the water's buffering capacity, or its ability to withstand changes in pH. It is a measure of the total concentration of bases in pond water, including carbonates, bicarbonates, hydroxides, phosphates, and borates, and is expressed in ppm calcium carbonate. All these

bases react with and neutralize acids, which in turn buffers changes in pH. The pH of well-buffered water will normally fluctuate between 6.5 and 9. Carbonates and bicarbonates are the most common and important components of alkalinity. In an established pond, the ideal alkalinity measurement should be around 100 ppm, but readings from 50 to 200 ppm are acceptable. If the alkalinity is low, even a small amount of acid can cause a large change in pH. Alkalinity values greater than 300 ppm will not adversely affect fish, but such high values will render some commonly used chemicals, such as copper sulfate, ineffective. Alkalinity can be increased by adding agricultural limestone [$CaCO_3$ and $CaMg(CO_3)_2$] to ponds.

HARDNESS

Hardness is a measure of divalent salts, or positively charged ions, particularly calcium (Ca^{2+}) and magnesium (Mg^{2+}), in water. Total hardness is the sum of the concentrations of Ca^{2+} and Mg^{2+}, expressed in ppm calcium carbonate. Calcium carbonate hardness is a general term that indicates the total amount of divalent salts present, but it does not specify which salts are causing water hardness. Hardness and alkalinity are often confused because both are expressed using the same term (ppm calcium carbonate), and sometimes both parameters have similar values in a given water body. However, alkalinity measures negative ions (carbonate and bicarbonate) and hardness measures positive ions (calcium and magnesium), and sometimes these values can differ greatly. If limestone (calcium carbonate) is the cause of hardness and alkalinity, these values will be similar or identical. However, if sodium bicarbonate ($NaHCO_3$) is responsible for high alkalinity, it is possible for water to have high alkalinity and low hardness and calcium. Calcium and magnesium are essential to fish for biological processes such as bone and scale formation. If your pond is used to culture fish, water hardness should be above 50 ppm and can be adjusted by adding agricultural limestone.

SUMMARY

A basic understanding of the chemical components of aquatic ecosystems is important to successfully manage any pond or lake. The interaction between temperature, nutrients, and oxygen plays a critical role in many common problems encountered by pond owners, such as excessive algal growth, oxygen depletion, and fish kills. A healthy pond ecosystem is easier to achieve by understanding this interaction and managing excessive nutrient loading to the pond system. Other parameters, such as pH, alkalinity, and hardness, can also affect fish growth and survival and can influence toxicity of other compounds, such as ammonia and metals. Water quality testing should be considered if your pond is to be used for intensive fish culture. A variety of methods are available to monitor water quality. Several companies produce kits and materials to monitor water quality, or water samples can be sent off to commercial laboratories for testing.

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Environmental Assessment and Risk Analysis Element

Research Project Summary

May, 2003

Ambient Levels of Metals in New Jersey Soils

Paul F. Sanders, Ph.D.

Abstract

Between 1996 and 2001, three studies were conducted to determine the ambient levels of extractable metals in New Jersey soils. These studies were conducted to gather information to support the development of soil cleanup criteria, which cannot be set below ambient levels. A total of 248 soil samples were taken from the urban Piedmont region, the urban Coastal Plain region, and rural regions of the Valley and Ridge, Highlands, and Coastal Plain provinces. Local or point sources of contamination were avoided by the use of Geographic Information System databases and by following sample location guidelines in the field. Surface soil samples (0-6") were analyzed for acid-extractable Target Analyte List (TAL) metals using USEPA SW-846 methods that are normally used to conduct initial investigations at hazardous waste sites. With one exception, median and 90th percentile concentrations of all metals were below current soil cleanup criteria. The exception was the 90th percentile arsenic concentration from the urban Piedmont study, which slightly exceeded the arsenic criterion. Otherwise, only certain individual samples contained metal concentrations above current criteria. A single rural soil sample yielded a beryllium concentration slightly above the corresponding criterion. For the urban Coastal Plain study, three of the 91 samples contained levels of arsenic above the current criterion. The urban Piedmont study yielded eight samples out of 67 where levels of arsenic or lead exceeded the criteria.

Introduction

Current New Jersey law requires that the NJDEP determine background levels of contaminants in soils and that "Remediation [of contaminated areas] shall not be required below regional natural background levels for any particular contaminant" [N.J.S.A. 58:10B-12(g)(4)]. "Natural background level" is further defined as "…the concentration of a contaminant consistently present in the environment of the region of the site and which has not been influenced by localized human activities…." Therefore, naturally occurring constituents in soil and those resulting from regional deposition are included, but not those from point contamination sources. The concentrations of contaminants included in this definition are referred to as "ambient concentrations." To support the above directive, three studies were conducted to determine ambient levels of metals in several regions of New Jersey (BEM Systems, Inc., 1997, 1998, 2002). The first two studies investigated metal concentrations in the urban Piedmont and urban Coastal Plain regions of New Jersey. These two areas contain a majority of the hazardous waste sites in the state. Furthermore, the high population density and significant industrial activity in these regions yields an upper estimate of ambient metal concentrations, due to a larger impact of regional atmospheric deposition. The third study focused on rural areas of the Ridge and Valley, Highlands and Coastal Plain provinces, and provided an indication of metals concentrations in areas less impacted by atmospheric deposition.

Methods

A total of 248 soil samples were taken in the three studies: 67 from the urban Piedmont region, 91 from the urban Coastal Plain region, and 90 from the three rural provinces (Figure. 1). The rural soil samples were distributed among the predominant soil types in each of the regions on a rural acreage basis. The sample locations for the urban studies were generally distributed among municipalities classified as "urban" by population density criteria. For the urban Piedmont studies, the criterion usually applied was a population density of 7,500 or more people per square mile, as per the State Development and Redevelopment Plan. For the urban Coastal Plain study, the population density criteria was reduced to 4,000 or more people per square mile because a

higher population density would have resulted in only eight municipalities being sampled. In addition, municipalities were added to both urban studies that did not meet the density criteria because they contained high population density regions or substantial industrial activity. For the urban studies, samples were located in public parks because of ease of access, a likelihood that these soils have been undisturbed for some time, and because they usually met a specified 50% open space (lawn) requirement. This latter requirement was specified because forest cover or other obstructions could reduce the impact of atmospheric deposition. Sports fields or other manicured areas were not acceptable locations because of turf maintenance issues often associated with them, including chemical applications. For the rural study, sampling in forested areas was usually unavoidable since this is the natural vegetation cover of much of New Jersey, and it was desired to avoid areas impacted by human activity. For all studies, sample locations were also required to be specified minimum distances from known hazardous waste sites, roadways, and railroads.

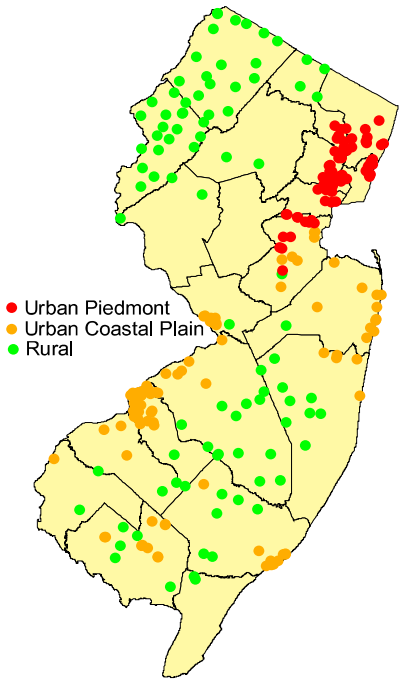

Figure 1. Sample locations

Soil samples were taken from a depth of 0-6 inches after removing surface litter. Samples were analyzed for acid-extractable Target Analyte List (TAL) metals using New Jersey certified laboratories. The methods used were those used to conduct site investigations at hazardous waste sites, specifically the U.S. Environmental Protection Agency Office of Solid Waste SW-846 methods. The extraction method used was Method 3050. Many metals were analyzed using inductively coupled plasma – atomic emission spectrometry (Method 6010). For certain metals, lower detection limits were desired because of low ambient concentrations or low soil ingestion criteria based on toxicity concerns. Atomic absorption furnace methods were used for arsenic, lead, selenium and thallium (Methods 7060, 7421, 7740 and 7841, respectively). Mercury was analyzed via cold vapor atomic adsorption (Method 7471).

Results

Acid-extractable median and 90th percentile concentrations, and the corresponding method detection limits for the twenty-three target analyte metals in 248 surface soil samples from the three studies were calculated (Table 1). The rural study results are separately presented for each of the three physiographic provinces.

Aluminum, iron, calcium, sodium, potassium, magnesium and manganese are abundant in soils and were frequently measured at several hundred to several thousand mg/kg. (Sodium concentrations are lower because it is largely leached from soils in humid climates.) Barium, chromium, vanadium and zinc are also relatively common in soils and were frequently measured at concentrations between 10 and 100 mg/kg. Zinc showed some indication of anthropogenic contribution in urban areas in that a few samples yielded concentrations in the 150-350 mg/kg range. (Naturally occurring total zinc concentrations in soil do not commonly exceed 100 mg/kg [Kabata-Pendias and Pendias, 1984].)

Nickel, copper, cobalt and lead are somewhat less common. The first three of these metals were generally measured at levels less than 50 mg/kg. Some samples in urban areas had copper concentrations in the 50-150 mg/kg range, while rural samples never exceeded 30 mg/kg. This suggests urban contribution above natural levels. Lead is well known to be elevated in surface soils due to industrial activities and the historical use of leaded gasoline (Kabata-Pendias and Pendias, 1984). Lead concentrations were highest in the urban Piedmont region (several samples in the 300 mg/kg range), somewhat lower in the urban Coastal plain (usually less than 200 mg/kg), and lowest in the rural study (only two samples greater than 125 mg/kg).

Mean total arsenic concentrations in United States soils have been reported to be 5-8 mg/kg (Kabata-Pendias and Pendias, 1984). In this study, median

Table 1. Ambient Concentration of Extractable Metals Measured in 248 New Jersey soil samples.

	Urban Piedmont				Urban Coastal Plain			
	Method Detection Limit (mg/kg)	No. of detects n=67	Median Concentration (mg/kg)	90th Percentile Concentration (mg/kg)	Method Detection Limit (mg/kg)	No. of detects n=91	Median Concentration (mg/kg)	90th Percentile Concentration (mg/kg)
Aluminum	1.5	67	10500	14400	20	91	6800	10800
Antimony	1.7	17	<DL	3.48	6	0	<DL	<DL
Arsenic	0.13	67	5.2	24.2	1	82	5.2	13.6
Barium	0.22	67	80.6	168	20	60	28.3	65.8
Beryllium	0.14	65	0.51	0.82	0.5	15	<DL	0.68
Cadmium	0.4	21	<DL	0.67	0.5	5	<DL	<DL
Calcium	11.2	67	1425	3010	500	59	995	2000
Chromium	0.9	67	18.5	29.9	1	91	11.8	34.7
Cobalt	0.5	67	6.3	10.4	5	7	<DL	<DL
Copper	0.52	67	29.5	75.5	2.5	82	9.3	33.3
Iron	2.2	67	14600	20000	10	91	8830	21100
Lead	0.063	67	111	297	10	82	37.6	144
Magnesium	5	67	2190	4614	500	54	673	1870
Manganese	0.21	67	311	859	1.5	91	62.4	206
Mercury	0.1	50	0.18	0.63	0.1	39	<DL	0.21
Nickel	0.9	67	12.4	24.6	4	43	<DL	12.3
Potassium	32	67	693	1524	500	45	<DL	1750
Selenium	0.5	61	0.41	0.71	1	0	<DL	<DL
Silver	0.22	28	<DL	0.86	1	3	<DL	<DL
Sodium	16.4	60	90.1	141	500	0	<DL	<DL
Thallium	0.2	28	<DL	0.25	1	2	<DL	<DL
Vanadium	0.95	67	29.6	41.7	5	86	16	35.5
Zinc	2	67	75.3	162	2	88	39.9	106

	Rural Areas of New Jersey									
	Rural studies	Ridge and Valley Province			Highlands Province			Coastal Plain Province		
	Method Detection Limit (mg/kg)	No. of detects n=23	Median Concentration (mg/kg)	90th Percentile Concentration (mg/kg)	No. of detects n=23	Median Concentration (mg/kg)	90th Percentile Concentration (mg/kg)	No. of detects n=44	Median Concentration (mg/kg)	90th Percentile Concentration (mg/kg)
Aluminum	3.23	23	15300	21080	23	16800	28980	44	1375	6760
Antimony	0.42	0	<DL	<DL	0	<DL	<DL	11	<DL	0.56
Arsenic	0.28	23	4.9	7.32	23	4.8	9.96	36	1.15	6.15
Barium	0.09	19	60.2	101.16	22	69.6	96.64	34	7.25	55.31
Beryllium	0.01	8	<DL	0.91	19	0.73	1.08	9	<DL	0.14
Cadmium	0.03	0	<DL	<DL	11	<DL	0.32	9	<DL	0.13
Calcium	41.7	10	<DL	2272	20	1160	4518	33	76.4	341.7
Chromium	0.17	23	14.3	21.2	23	17.7	26.64	44	2.9	11.76
Cobalt	0.18	12	7.3	11.4	18	6.8	12.44	32	0.37	1.18
Copper	0.33	23	17.2	26.04	23	16	28.96	44	4.2	11.43
Iron	4	23	14800	28540	23	18700	27860	44	1795	10587
Lead	0.22	23	31.6	54	23	26.6	59.02	44	17.5	54.05
Magnesium	14.4	19	2600	7182	23	2340	4024	34	79.65	513.2
Manganese	0.27	23	470	1192	23	407	836.8	44	11.65	35.39
Mercury	0.016	22	0.1	0.15	23	0.09	0.18	28	0.04	0.14
Nickel	0.21	20	15.7	22.5	23	11.6	19.04	30	0.84	3.87
Potassium	6.63	17	961	1660	21	955	1456	30	76	328
Selenium	0.49	0	<DL	<DL	10	<DL	0.99	7	<DL	0.68
Silver	0.1	0	<DL	<DL	5	<DL	0.21	0	<DL	<DL
Sodium	6.78	0	<DL	<DL	8	<DL	85.1	28	54.65	91.9
Thallium	0.41	0	<DL	<DL	0	<DL	<DL	1	<DL	<DL
Vanadium	0.07	23	20.7	29.68	23	32.3	52.98	40	7.8	20.68
Zinc	0.18	23	75.8	112.3	23	69.7	111.6	44	6.7	27.64

extractable arsenic concentrations were typically about 5 mg/kg, and concentrations never exceeded 15 mg/kg in the rural study. In the urban studies, the maximum concentration was 83 mg/kg, and 95th percentile values were below 30 mg/kg. These higher concentrations are within the normal ranges for soils, particularly glauconitic soils naturally high in arsenic (Dooley, 2001). Some soil samples in the urban Coastal Plain study were taken from glauconitic soils, and they yielded some of the higher concentrations measured (including the maximum value measured, 83 mg/kg). However, other samples from this study with elevated arsenic were not from glauconitic regions. Furthermore, the urban Piedmont study did not include glauconitic soils, where a significant percentage of the samples also exhibited elevated levels of arsenic relative to the rural study. This suggests some anthropogenic contribution of arsenic to urban surface soils.

Mean total beryllium concentrations in United States soils are about 1-2 ppm (Kabata-Pendias and Pendias, 1984). Extractable concentrations of beryllium in this study ranged from non-detectable to

3 mg/kg. Total antimony concentrations in United States soils are generally less than 1 ppm (Kabata-Pendias and Pendias, 1984). This study yielded extractable antimony concentrations that ranged from non-detectable levels to 13 mg/kg, with the higher concentrations being associated with the urban Piedmont samples. Thallium, mercury, cadmium, silver and selenium are naturally present at only trace levels in soils (usually less than 1 ppm) in soils (Kabata-Pendias and Pendias, 1984). In this study, thallium and silver were seldom detected, and selenium, cadmium and mercury were either not detected or measured at concentrations that were usually less than 1 mg/kg. A few samples, mostly from urban areas, contained cadmium at concentrations above 0.5 mg/kg or mercury above 1.0 mg/kg, which suggests contribution from industrial activity or regional atmospheric deposition.

Statistically, several metals were found at lower concentrations in the coastal plain regions of the state relative to the remainder of the state. Coastal Plain soils have high sand contents, lower organic carbon contents and lower pH values than soils in the remainder of the state, which decrease their affinity for metals.

Discussion

The metals concentration data collected in these series of studies are useful for determining typical ambient levels of the various metals in the geographical regions studied. Levels significantly above these concentrations may indicate a spill or discharge has occurred. The metals of greatest environmental concern are those in which ambient levels in surface soils equal or exceed concentrations that are considered hazardous to human health. In such cases, regulatory levels applicable for remedial activities at contaminated sites may be limited by prevailing ambient concentrations. The most important example of this situation occurs with arsenic. The health-based soil ingestion criterion for arsenic (0.4 mg/kg) is significantly below observed ambient levels, even in soils unaffected by human activity. All studies except the rural Coastal Plain study yielded median extractable arsenic concentrations of about 5 mg/kg, more than ten times the health-based number. The rural Coastal Plain median concentration (1 mg/kg) was also above the health-based ingestion criteria.

The current soil cleanup criterion for arsenic in soil is 20 mg/kg, based on an earlier assessment of ambient levels. The 90th percentile concentration of arsenic from the urban Piedmont study (26 mg/kg) is somewhat higher than this value. In the urban Coastal Plain study, three of the ninety-one samples yielded arsenic levels above 20 mg/kg. The rural areas of the state yielded 95th percentile concentrations ranging from 5-10 mg/kg, and no samples exceeded 20 mg/kg.

Total arsenic levels in glauconite-bearing soils in New Jersey have been reported to range from 13-131 mg/kg, with a median of 30 mg/kg (Dooley, 2001). When only extractable arsenic from 0-6" soil samples are considered from the glauconite study, the median, 90th percentile and maximum concentrations are 8.2, 27.5, and 63.3 mg/kg, respectively. These concentrations are only moderately higher than those observed for the urban studies.

The health-based non-residential soil criterion for hexavalent chromium based on soil inhalation is 20 mg/kg, which is below the 90th percentile ambient concentrations reported in this study. However, chromium in soil has been reported to be dominated by the much less toxic trivalent form, so ambient concentrations are not likely to be of concern for this metal. A hexavalent chromium-specific method would be recommended for analysis of soil when this metal is known to be of concern.

With regards to the remaining metals, only one sample yielded a result where current criteria were exceeded. This sample was taken from the urban Piedmont region and yielded a lead concentration of 464 mg/kg, which is slightly greater than the current lead criterion of 400 mg/kg.

Other than arsenic, the only other metal with the current soil criterion set by ambient levels is beryllium (criterion = 2 mg/kg, based on earlier New Jersey data and other literature). In this study, 90th percentile concentrations frequently approached 1 mg/kg (Table 1), 95th percentile concentrations in the rural highlands exceeded 1 mg/kg (1.4 mg/kg), and overall, ten samples out of 248 yielded concentrations between 1 and 2 mg/kg. Only one sample exceeded 2 mg/kg (2.8 mg/kg from the rural Highlands province).

The thallium criterion is currently set by the Practical Quantitation Level (2 mg/kg), since the health-based criteria is lower (zero). Reporting Levels and/or Practical Quantitation Levels for this metal from the two New Jersey certified laboratories used in this study were somewhat lower (1 mg/kg or less), which suggests that analytical capabilities may have improved since the thallium criterion was set.

Metal concentrations reported in this summary were acid-extractable metals, not necessarily total metal concentrations. The extraction method (USEPA

Method 3050) is a vigorous extraction method designed to remove all metals that could become "environmentally available". In practice, the extraction method likely overestimates metals that could become available, since the sample is refluxed with both concentrated nitric acid and hydrogen peroxide. However, by design, the method will not extract chemicals incorporated in silica minerals, as they are usually not mobile in the environment. Thus, concentrations reported in these studies may be lower than those indicated from analyses using methods designed to measure total metal concentrations, such as x-ray fluorescence methods.

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RESEARCH PROJECT SUMMARY

United States Environmental Protection Agency

Office of Water
EPA **820-F-17-002**
July 2017

Fact Sheet: Draft Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwaters

Summary

EPA published a draft update of aluminum aquatic life ambient water quality criteria for freshwaters under Section 304(a)(1) of the Clean Water Act to reflect the latest scientific knowledge. EPA will accept public comment on the draft criteria for 60 days upon publication of the Federal Register notice. Once final, the criteria will serve as recommendations to states and tribes by defining the concentration of aluminum in water that will protect against harmful effects to aquatic life.

Background

EPA first published criteria for aluminum in 1988 to protect aquatic life from harmful effects of aluminum toxicity in freshwaters. Aluminum can inhibit an aquatic organism's ability to regulate salt concentrations and clog fish gills, potentially resulting in death or affecting growth and reproduction. EPA is updating the aluminum criteria to better reflect the latest science. Unfortunately, there are not enough data to support the development of estuarine/marine criteria at this time.

Unlike the fixed acute and chronic values found in the 1988 document, this draft document provides users the flexibility to develop site-specific criteria based on a site's water chemistry using the *Aluminum Criteria Calculator V.1.0.xlsx* or by using the lookup tables provided in the criteria appendix. Studies have shown that three water chemistry parameters, pH, dissolved organic carbon (DOC), and hardness, can affect the toxicity of aluminum by affecting the bioavailability of aluminum in the water to aquatic species.

What is Aluminum and How Does it Enter the Water?

Aluminum is found in most soils and rocks and is the third most abundant element and the most common metal in the earth's crust. Aluminum can enter the water via natural processes, like weathering of rocks. Aluminum is also released to water by mining, industrial processes using aluminum, and waste water treated with alum, an aluminum compound.

How does Aluminum Affect Aquatic Life?

Aluminum is considered a non-essential metal because fish and other aquatic life don't need it to function. Elevated levels of aluminum can affect some species ability to regulate ions, like salts, and inhibit respiratory functions, like breathing. Aluminum can accumulate on the surface of a fish's gill, leading to respiratory dysfunction, and possibly death. Aquatic plants are generally less sensitive to aluminum than fish and other aquatic life.

What is a Water Quality Parameter and Why is it Important?

Bioavailability is the measure whether a substance in the environment is available to enter living organisms, like fish. The bioavailability of aluminum is dependent on the chemical properties of water, otherwise known as water quality parameters. The more bioavailable the aluminum is, the more likely it is to cause a toxic effect. The water quality parameters that have the greatest impact on aluminum's bioavailability are pH, DOC, and hardness.

- pH: a low pH generally makes it easier for aluminum to be dissolved, and therefore more bioavailable. At higher pH, aluminum speciation changes make it more bioavailable.

- DOC: higher dissolved organic carbon reduces the bioavailability of aluminum because it binds to form aluminum complexes.
- Hardness: higher hardness values mean there are more ions present that compete with aluminum. This makes aluminum less bioavailable.

What is the Recommended Level of Aluminum in Freshwater for the Protection of Aquatic Life?

The recommended level of aluminum in freshwater depends on a site's water quality parameters. Unlike the fixed values found in the 1988 criteria document, these criteria use a Multiple Linear Regression (MLR) model to normalize the data, and the criteria are based on a site's pH, DOC, and hardness. See Table 1 for a comparison of existing and draft criteria values.

For freshwater criteria, users can put their site's water quality parameters into the *Aluminum Criteria Calculator V.1.0.xlsx* or use the lookup tables in the document's appendix. The resulting acute criterion would have an appropriate level of protection if the one-hour average concentration is not exceeded more than once every three years on average. If the four-day average concentration is not exceeded more than once every three years on average, the chronic criterion is protective.

Where can I find more information?

For more information please visit EPA's website at www.epa.gov/wqc/aquatic-life-criteria-aluminum or contact Diana Eignor at Eignor.Diana@epa.gov.

Table 1: 2017 Draft Aluminum Aquatic Life Criteria Compared to Current 1988 Criteria[a]

Version	Freshwater Acute (1 day, total aluminum)	Freshwater Chronic (4-day, total aluminum)
2017 Draft AWQC Criteria (MLR normalized to pH = 7, hardness = 100 mg/L, DOC = 1 mg/L)	1,400 µg/L	390 µg/L
1988 AWQC Criteria (pH 6.5 – 9.0, across all hardness and DOC ranges)	750 µg/L	87 µg/L

[a] Values are recommended not to be exceeded more than once every three years on average.

Note: Values will be different under differing water chemistry conditions as identified in this document.

United States Environmental Protection Agency

Office of Water EPA - 820-F-12-061

4305T December 2012

2012 Recreational Water Quality Criteria

Summary

EPA has released its 2012 recreational water quality criteria (RWQC) recommendations for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. EPA provides two sets of recommended criteria. Primary contact recreation is protected if either set of criteria recommendations are adopted into state water quality standards.

These recommendations are intended as guidance to states, territories and authorized tribes in developing water quality standards to protect swimmers from exposure to water that contains organisms that indicate the presence of fecal contamination.

Background

EPA last issued ambient water quality criteria recommendations for recreational waters in 1986. EPA issues such recommendations under the authority of the Clean Water Act (CWA). Amendments to the CWA by the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 direct EPA to conduct studies associated with pathogens and human health, and to publish new or revised criteria recommendations for pathogens and pathogen indicators based on those studies. These 2012 RWQC meet those requirements.

The 2012 RWQC rely on the latest research and science, including studies that show a link between illness and fecal contamination in recreational waters. They are based on the use of two bacterial indicators of fecal contamination, *E. coli* and enterococci. The new criteria are designed to protect primary contact recreation, including swimming, bathing, surfing, water skiing, tubing, water play by children, and similar water contact activities where a high degree of bodily contact with the water, immersion and ingestion are likely.

What are the recommendations?

The 2012 RWQC offer two sets of numeric concentration thresholds, either of which would protect the designated use of primary contact recreation and, therefore, would protect the public from exposure to harmful levels of pathogens. Illness rates upon which these recommendations are based use the National Epidemiological and Environmental Assessment of Recreational Water (NEEAR) definition of gastrointestinal illness, which is not limited to illnesses which exhibit a fever.

The RWQC consist of three components: magnitude, duration and frequency. The magnitude of the bacterial indicators are described by both a geometric mean (GM) and a statistical threshold value (STV) for the bacteria samples. The STV approximates the 90th percentile of the water quality distribution and is intended to be a value that should not be exceeded by more than 10 percent of the samples taken. The table summarizes the magnitude component of the recommendations. All three components are explained in more detail in the sections below.

CRITERIA ELEMENTS	Recommendation 1 Estimated Illness Rate 36/1,000		Recommendation 2 Estimated Illness Rate 32/1,000	
Indicator	GM (cfu/100 mL)	STV (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
Enterococci (marine & fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

Water quality criteria recommendations are intended as guidance in establishing new or revised water quality standards. They are not regulations themselves. States and authorized tribes have the discretion to adopt, where appropriate, other scientifically defensible water quality criteria that differ from EPA's recommended criteria.

RECOMMENDATION 1: MAGNITUDE

Enterococci: Culturable enterococci at a

geometric mean (GM) of 35 colony forming units (CFU per 100 milliliters (mL) and a statistical threshold value (STV) of 130 cfu per 100 mL, measured using *EPA Method 1600*, or any other equivalent method that measures culturable enterococci.

E. coli: Culturable *E. coli* at a GM of 126 cfu per 100 mL and an STV of 410 cfu per 100 mL measured using *EPA Method 1603*, or any other equivalent method that measures culturable *E. coli*.

RECOMMENDATION 2: MAGNITUDE

Enterococci: Culturable enterococci at a GM of 30 cfu per 100 mL and an STV of 110 cfu per 100 mL, measured using *EPA Method 1600*, or any other equivalent method that measures culturable enterococci.

E. coli: Culturable *E. coli* at a GM of 100 cfu per 100 mL and an STV of 320 cfu per 100 mL measured using *EPA Method 1603*, or any other equivalent method that measures culturable *E. coli*.

FOR BOTH RECOMMENDATIONS

Duration and Frequency: The waterbody GM should not be greater than the selected GM magnitude in any 30-day interval. There should not be greater than a ten percent excursion frequency of the selected STV magnitude in the same 30-day interval.

How are these criteria different from the 1986 criteria?

Similar Protection for Fresh and Marine Waters: The EPA used an analysis of NEEAR water quality data to refine the illness rate estimate for the recommended marine criterion for entercocci. The 2012 RWQC values now protect public health similarly in both marine and fresh waters.

A New Measurement Value: EPA is introducing a new term, Statistical Threshold Value (STV), to be used in conjunction with the recommended GM value.

New Early Alert Tool: In addition to recommending criteria values, EPA is now also providing states with Beach Action Values (BAVs) for use in notification programs. The BAV is provided for states to use as a precautionary tool to provide an early alert to beachgoers, including families with children.

A Single Level of Beach Use: The 1986 bacteria criteria document included four single sample maximum (SSM) values appropriate for different levels of beach usage (use intensities). In the 2012 RWQC, EPA removed those recommendations and instead provided states with optional, precautionary BAVs for use in monitoring and notification programs.

More Tools for Assessing and Managing Recreational Waters: EPA is providing information on tools for evaluating and managing recreational waters, such as predictive modeling and sanitary surveys. The Agency is also providing tools for developing site-specific criteria such as epidemiological studies, quantitative microbial risk assessment, and use of alternative indicators or methods. The EPA has developed and validated a molecular testing method using quantitative polymerase chain reaction (qPCR) as a rapid analytical technique for the detection of enterococci in recreational water (EPA Method 1611). For the purposes of beach monitoring, a state may use a qPCR method on a site-specific basis.

Where can I find more information?

EPA has put the 2012 RWQC document, support documents, and the Federal Register Notice, in the docket (Docket identification No. EPA-HQ-OW-2011-0466) which can be accessed via EPA's website at http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/index.cfm.

You can also contact Sharon Nappier at nappier.sharon@epa.gov or (202)566-0740, or contact Tracy Bone at bone.tracy@epa.gov or (202) 564-5257 for more information.

Total Nitrogen

Total Nitrogen is an essential nutrient for plants and animals. However, an excess amount of nitrogen in a waterway can lead to low levels of dissolved oxygen and negatively alter various plant life and organisms. Sources of nitrogen include: wastewater treatment plants, runoff from fertilized lawns and croplands, failing septic systems, runoff from animal manure and storage areas, and industrial discharges that contain corrosion inhibitors.

Storm runoff from a cattle operation can increase Total Nitrogen levels in a water body.

Understanding Total Nitrogen: There are three forms of nitrogen that are commonly measured in water bodies: ammonia, nitrates and nitrites. Total nitrogen is the sum of total kjeldahl nitrogen (organic and reduced nitrogen), ammonia, and nitrate-nitrite. It can be derived by monitoring for total kjeldahl nitrogen (TKN), ammonia and nitrate-nitrite individually and adding the components together. An acceptable range of total nitrogen is 2 mg/L to 6 mg/L, though it is recommended to check tribal, state, or federal standards for an adequate comparison of your data.

Trash areas like this may leach chemicals that can increase Total Nitrogen during a storm event into a water body.

Monitoring Equipment: Depending upon monitoring objectives set forth in an environmental program, the following equipment options are commonly used to collect total nitrogen data from the field.

Readily available and economically priced:

- Total Nitrogen Kits

For each component of total nitrogen, the following can be used and are of greater precision and higher cost:

- Meters
- Multiparameter Probes
- Contract Laboratories (if necessary)

For additional information:
www.epa.gov/owow/monitoring/volunteer/stream

United States Environmental Protection Agency

www.epa.gov August 1993

Method 351.2, Revision 2.0: Determination of Total Kjeldahl Nitrogen by Semi-Automated Colorimetry

METHOD 351.2

DETERMINATION OF TOTAL KJELDAHL NITROGEN BY SEMI-AUTOMATEDCOLORIMETRY

Edited by James W. O'Dell
Inorganic Chemistry Branch
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Revision 2.0
August 1993

ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

METHOD 351.2

DETERMINATION OF TOTAL KJELDAHL NITROGEN BY SEMI-AUTOMATED COLORIMETRY

1.0 SCOPE AND APPLICATION

1.1 This method covers the determination of total Kjeldahl nitrogen in drinking, ground, and surface waters, domestic and industrial wastes. The procedure converts nitrogen components of biological origin such as amino acids, proteins and peptides to ammonia, but may not convert the nitrogenous compounds of some industrial wastes such as amines, nitro compounds, hydrazones, oximes, semicarbazones and some refractory tertiary amines.

1.2 The applicable range is 0.1-20 mg/L TKN. The range may be extended with sample dilution.

2.0 SUMMARY OF METHOD

2.1 The sample is heated in the presence of sulfuric acid, H_2SO_4 for two and one half hours. The residue is cooled, diluted to 25 mL and analyzed for ammonia. This digested sample may also be used for phosphorus determination.

2.2 Total Kjeldahl nitrogen is the sum of free-ammonia and organic nitrogen compounds which are converted to ammonium sulfate $(NH_4)_2SO_4$, under the conditions of digestion described.

2.3 Organic Kjeldahl nitrogen is the difference obtained by subtracting the free-ammonia value from the total Kjeldahl nitrogen value.

2.4 Reduced volume versions of this method that use the same reagents and molar ratios are acceptable provided they meet the quality control and performance requirements stated in the method.

2.5 Limited performance-based method modifications may be acceptable provided they are fully documented and meet or exceed requirements expressed in Section 9.0, Quality Control.

3.0 DEFINITIONS

3.1 **Calibration Blank (CB)** -- A volume of reagent water fortified with the same matrix as the calibration standards, but without the analytes, internal standards, or surrogate analytes.

3.2 **Calibration Standard (CAL)** -- A solution prepared from the primary dilution standard solution or stock standard solutions and the internal standards and

surrogate analytes. The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 **Instrument Performance Check Solution (IPC)** -- A solution of one or more method analytes, surrogates, internal standards, or other test substances used to evaluate the performance of the instrument system with respect to a defined set of criteria.

3.4 **Laboratory Fortified Blank (LFB)** -- An aliquot of reagent water or other blank matrices to which known quantities of the method analytes are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.5 **Laboratory Fortified Sample Matrix (LFM)** -- An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the LFM corrected for background concentrations.

3.6 **Laboratory Reagent Blank (LRB)** -- An aliquot of reagent water or other blank matrices that are treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with other samples. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

3.7 **Linear Calibration Range (LCR)** -- The concentration range over which the instrument response is linear.

3.8 **Material Safety Data Sheet (MSDS)** -- Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.

3.9 **Method Detection Limit (MDL)** -- The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.

3.10 **Quality Control Sample (QCS)** -- A solution of method analytes of known concentrations that is used to fortify an aliquot of LRB or sample matrix. The QCS is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

3.11 **Stock Standard Solution (SSS)** -- A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

4.0 INTERFERENCES

4.1 High nitrate concentrations (10X or more than the TKN level) result in low TKN values. If interference is suspected, samples should be diluted and reanalyzed.

4.2 Method interferences may be caused by contaminants in the reagent water, reagents, glassware, and other sample processing apparatus that bias analyte response.

5.0 SAFETY

5.1 The toxicity or carcinogenicity of each reagent used in this method have not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be as low as reasonably achievable. Cautions are included for known extremely hazardous materials or procedures.

5.2 Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets (MSDS) should be made available to all personnel involved in the chemical analysis. The preparation of a formal safety plan is also advisable.

5.3 The following chemicals have the potential to be highly toxic or hazardous, consult MSDS.

5.3.1 Mercury (Sections 7.2 and 7.3)

5.3.2 Sulfuric acid (Sections 7.2, 7.3, and 7.4)

5.3.3 Sodium nitroprusside (Section 7.9)

6.0 EQUIPMENT AND SUPPLIES

6.1 Balance - Analytical, capable of accurately weighing to the nearest 0.000l g.

6.2 Glassware - Class A volumetric flasks and pipets as required.

6.3 Block digestor with tubes.

6.4 Automated continuous flow analysis equipment designed to deliver and react sample and reagents in the required order and ratios.

6.4.1 Sampling device (sampler)

6.4.2 Multichannel pump

6.4.3 Reaction unit or manifold

6.4.4 Colorimetric detector

6.4.5 Data recording device

7.0 REAGENTS AND STANDARDS

7.1 Reagent water: Ammonia free distilled or deionized water, free of the analyte of interest. ASTM Type II or equivalent.

7.2 Mercuric sulfate: Dissolve 8 g red mercuric oxide (HgO) (CASRN 21908-53-2) in 50 mL of 1:4 sulfuric acid (10 mL conc. H_2SO_4: [CASRN 7664-93-9] 40 mL reagent water) and dilute to 100 mL with reagent water.

7.3 Digestion solution: (Sulfuric acid-mercuric sulfate-potassium sulfate solution): Dissolve 133 g of K_2SO_4 (CASRN 7778-80-5) in 700 mL of reagent water and 200 mL of conc. H_2SO_4. Add 25 mL of mercuric sulfate solution (Section 7.1) and dilute to 1 L.

Note 1: An alternate mercury-free digestion solution can be prepared by dissolving 134 g K_2SO_4 and 7.3 g $CuSO_4$ in 800 mL reagent water and then adding 134 mL conc. H_2SO_4 and diluting to 1 L. Use 10 mL solution per 25 mL of sample.

7.4 Sulfuric Acid solution (4%): Add 40 mL of conc. sulfuric acid to 800 mL of reagent water, cool and dilute to 1 L.

Note 2: If alternate mercury-free digestion solution is used, adjust the above solution to equal the acid concentration of the digested sample (Section 11.6).

7.5 Stock Sodium Hydroxide (20%): Dissolve 200 g of sodium hydroxide (CASRN 1310-73-2) in 900 mL of reagent water and dilute to 1 L.

7.6 Stock Sodium Potassium Tartrate solution (20%): Dissolve 200 g sodium potassium tartrate (CASRN 6381-59-5) in about 800 mL of reagent water and dilute to 1 L.

7.7 Stock Buffer solution: Dissolve 134.0 g of sodium phosphate, dibasic (Na_2HPO_4) (CASRN 7558-79-4) in about 800 mL of reagent water. Add 20 g of sodium hydroxide and dilute to 1 L.

7.8 Working Buffer solution: Combine the reagents in the stated order, add 250 mL of stock sodium potassium tartrate solution (Section 7.6) to 200 mL of stock buffer solution (Section 7.7) and mix. Add xx mL sodium hydroxide solution

(Section 7.5) and dilute to 1 L. See concentration ranges, Table 2, for composition of working buffer.

7.9 Sodium Salicylate/Sodium Nitroprusside solution: Dissolve 150 g of sodium salicylate (CASRN 54-21-7) and 0.3 g of sodium nitroprusside (CASRN 13755-38-9 or 14402-89-2) in about 600 mL of reagent water and dilute to 1 L.

7.10 Sodium Hypochlorite solution: Dilute 6.0 mL sodium hypochlorite solution (CASRN 7681-52-9) (Clorox) to 100 mL with reagent water.

7.11 Ammonium chloride, stock solution: Dissolve 3.819 g NH_4Cl (CASRN 12125-02-9) in reagent water and bring to volume in a 1 L volumetric flask. 1 mL = 1.0 mg NH_3-N.

7.12 Teflon boiling chips.

8.0 SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 Samples should be collected in plastic or glass bottles. All bottles must be thoroughly cleaned and rinsed with reagent water. Volume collected should be sufficient to insure a representative sample, allow for replicate analysis (if required), and minimize waste disposal.

8.2 Samples must be preserved with H_2SO_4 to a pH <2 and cooled to 4°C at the time of collection.

8.3 Samples should be analyzed as soon as possible after collection. If storage is required, preserved samples are maintained at 4°C and may be held for up to 28 days.

9.0 QUALITY CONTROL

9.1 Each laboratory using this method is required to operate a formal quality control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, and the periodic analysis of laboratory reagent blanks, fortified blanks and other laboratory solutions as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of the data that are generated.

9.2 INITIAL DEMONSTRATION OF PERFORMANCE

9.2.1 The initial demonstration of performance is used to characterize instrument performance (determination of linear calibration ranges and analysis of QCS) and laboratory performance (determination of MDLs) prior to performing analyses by this method.

9.2.2 Linear Calibration Range (LCR) -- The LCR must be determined initially and verified every 6 months or whenever a significant change

in instrument response is observed or expected. The initial demonstration of linearity must use sufficient standards to insure that the resulting curve is linear. The verification of linearity must use a minimum of a blank and three standards. If any verification data exceeds the initial values by ±10%, linearity must be reestablished. If any portion of the range is shown to be nonlinear, sufficient standards must be used to clearly define the nonlinear portion.

9.2.3 Quality Control Sample (QCS) -- When beginning the use of this method, on a quarterly basis, or as required to meet data-quality needs, verify the calibration standards and acceptable instrument performance with the preparation and analyses of a QCS. If the determined concentrations are not within ±10% of the stated values, performance of the determinative step of the method is unacceptable. The source of the problem must be identified and corrected before either proceeding with the initial determination of MDLs or continuing with on-going analyses.

9.2.4 Method Detection Limit (MDL) -- MDLs must be established for all analytes, using reagent water (blank) fortified at a concentration of two to three times the estimated instrument detection limit.[6] To determine MDL values, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (S)$$

where, t = Student's t value for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom [t = 3.14 for seven replicates]
S = standard deviation of the replicate analyses

MDLs should be determined every six months, when a new operator begins work, or whenever there is a significant change in the background or instrument response.

9.3 ASSESSING LABORATORY PERFORMANCE

9.3.1 Laboratory Reagent Blank (LRB) -- The laboratory must analyze at least one LRB with each batch of samples. Data produced are used to assess contamination from the laboratory environment. Values that exceed the MDL indicate laboratory or reagent contamination should be suspected and corrective actions must be taken before continuing the analysis.

9.3.2 Laboratory Fortified Blank (LFB) -- The laboratory must analyze at least one LFB with each batch of samples. Calculate accuracy as percent recovery (Section 9.4.2). If the recovery of any analyte falls outside the required control limits of 90-110%, that analyte is judged out of control, and the source of the problem should be identified and resolved before continuing analyses.

9.3.3 The laboratory must use LFB analyses data to assess laboratory performance against the required control limits of 90-110%. When sufficient internal performance data become available (usually a minimum of 20-30 analyses), optional control limits can be developed from the percent mean recovery (x) and the standard deviation (S) of the mean recovery. These data can be used to establish the upper and lower control limits as follows:

$$\text{UPPER CONTROL LIMIT} = x + 3S$$
$$\text{LOWER CONTROL LIMIT} = x - 3S$$

The optional control limits must be equal to or better than the required control limits of 90-110%. After each five to ten new recovery measurements, new control limits can be calculated using only the most recent 20-30 data points. Also, the standard deviation (S) data should be used to establish an on-going precision statement for the level of concentrations included in the LFB. These data must be kept on file and be available for review.

9.3.4 Instrument Performance Check Solution (IPC) -- For all determinations the laboratory must analyze the IPC (a mid-range check standard) and a calibration blank immediately following daily calibration, after every 10th sample (or more frequently, if required), and at the end of the sample run. Analysis of the IPC solution and calibration blank immediately following calibration must verify that the instrument is within ±10% of calibration. Subsequent analyses of the IPC solution must verify the calibration is still within ±10%. If the calibration cannot be verified within the specified limits, reanalyze the IPC solution. If the second analysis of the IPC solution confirms calibration to be outside the limits, sample analysis must be discontinued, the cause determined and/or in the case of drift the instrument recalibrated. All samples following the last acceptable IPC solution must be reanalyzed. The analysis data of the calibration blank and IPC solution must be kept on file with the sample analyses data.

9.4 ASSESSING ANALYTE RECOVERY AND DATA QUALITY

9.4.1 Laboratory Fortified Sample Matrix (LFM) -- The laboratory must add a known amount of analyte to a minimum of 10% of the routine samples. In each case the LFM aliquot must be a duplicate of the aliquot used for sample analysis. The analyte concentration must be high enough to

be detected above the original sample and should not be less than four times the MDL. The added analyte concentration should be the same as that used in the laboratory fortified blank.

9.4.2 Calculate the percent recovery for each analyte, corrected for concentrations measured in the unfortified sample, and compare these values to the designated LFM recovery range 90-110%. Percent recovery may be calculated using the following equation:

$$R = \frac{C_s - C}{s} \times 100$$

where, R = percent recovery
C_s = fortified sample concentration
C = sample background concentration
s = concentration equivalent of analyte added to sample

9.4.3 If the recovery of any analyte falls outside the designated LFM recovery range and the laboratory performance for that analyte is shown to be in control (Section 9.3), the recovery problem encountered with the LFM is judged to be either matrix or solution related, not system related.

9.4.4 Where reference materials are available, they should be analyzed to provide additional performance data. The analysis of reference samples is a valuable tool for demonstrating the ability to perform the method acceptably.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Prepare a series of at least three standards, covering the desired range, and a blank by diluting suitable volumes of standard solution (Section 7.11) with reagent water.

10.2 Process standards and blanks as described in Section 11.0, Procedure.

10.3 Set up manifold as shown in Figure 1 and Table 2.

10.4 Prepare flow system as described in Section 11.0, Procedure.

10.5 Place appropriate standards in the sampler in order of decreasing concentration and perform analysis.

10.6 Prepare standard curve by plotting instrument response against concentration values. A calibration curve may be fitted to the calibration solutions concentration/response data using computer or calculator based regression curve fitting techniques. Acceptance or control limits should be established

using the difference between the measured value of the calibration solution and the "true value" concentration.

10.7 After the calibration has been established, it must be verified by the analysis of a suitable quality control sample (QCS). If measurements exceed ±10% of the established QCS value, the analysis should be terminated and the instrument recalibrated. The new calibration must be verified before continuing analysis. Periodic reanalysis of the QCS is recommended as a continuing calibration check.

11.0 PROCEDURE

11.1 Pipet 25.0 mL of sample, standard or blank in the digestor tube.

11.2 Add 5 mL of digestion solution (Section 7.3) and mix with a vortex mixer (See Note 1).

11.3 Add four to eight Teflon boiling chips (Section 7.12). **CAUTION:** An excess of Teflon chips may cause the sample to boil over.

11.4 Place tubes in block digestor preheated to 160°C and maintain temperature for one hour.

11.5 Reset temperature to 380°C and continue to heat for one and one half hour.

(380°C MUST BE MAINTAINED FOR 30 MINUTES)

11.6 Remove digestion tubes, cool and dilute to 25 mL with reagent water.

11.7 Excluding the salicylate line, place all reagent lines in their respective containers, connect the sample probe to the sampler and start the pump.

11.8 Flush the sampler wash receptacle with about 25 mL of 4% sulfuric acid (Section 7.4) (See Note 2).

11.9 When reagents have been pumping for at least five minutes, place the salicylate line in its respective container and allow the system to equilibrate. If a precipitate forms after the addition of salicylate, the pH is too low. Immediately stop the proportioning pump and flush the coils with water using a syringe. Before restarting the system, check the concentration of the sulfuric acid solutions and/or the working buffer solution.

11.10 To prevent precipitation of sodium salicylate in the waste tray, which can clog the tray outlet, keep the nitrogen flowcell pump tube and the nitrogen Colorimeter "To Waste" tube separate from all other lines or keep tap water flowing in the waste tray.

11.11 After a stable baseline has been obtained, start the sampler and perform analysis.

12.0 DATA ANALYSIS AND CALCULATIONS

12.1 Prepare a calibration curve by plotting instrument response against standard concentration. Compute sample concentration by comparing sample response with the standard curve. Multiply answer by appropriate dilution factor.

12.2 Report only those values that fall between the lowest and the highest calibration standards. Samples exceeding the highest standard should be diluted and reanalyzed.

l2.3 Report results in mg N/L.

13.0 METHOD PERFORMANCE

13.1 In a single laboratory (EMSL-Cincinnati) using sewage samples at concentrations of 1.2, 2.6, and 1.7 mg N/L, the precision was ±0.07, ±0.03, and ±0.15, respectively.

13.2 In a single laboratory (EMSL-Cincinnati) using sewage samples at concentrations 4.7 and 8.74 mg N/L, the recoveries were 99% and 99%, respectively.

13.3 The interlaboratory precision and accuracy data in Table 1 were developed using a reagent water matrix. Values are in mg N/L.

l4.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 The quantity of chemicals purchased should be based on expected usage during its shelf life and disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

14.3 For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the American

Chemical Society's Department of Government Regulations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036, (202) 872-4477.

15.0 WASTE MANAGEMENT

15.1 The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. Excess Reagents and samples and method process wastes should be characterized and disposed of in an acceptable manner. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any waste discharge permit and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management consult "The Waste Management Manual for Laboratory Personnel", available from the American Chemical Society at the address listed in Section 14.3.

16.0 REFERENCES

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2. Gales, M.E. and Booth, R.L., "Evaluation of Organic Nitrogen Methods", EPA Office of Research and Monitoring, June, 1972.

3. Gales, M.E. and Booth, R.L., "Simultaneous and Automated Determination of Total Phosphorus and Total Kjeldahl Nitrogen", Methods Development and Quality Assurance Research Laboratory, May 1974.

4. Technicon "Total Kjeldahl Nitrogen and Total Phosphorus BD-40 Digestion Procedure for Water", August 1974.

5. Gales, M.E., and Booth, R.L., "Evaluation of the Technicon Block Digestor System for the Measurement of Total Kjeldahl Nitrogen and Total Phosphorus", EPA-600/4-78-015, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1978.

6. Code of Federal Regulations 40, Ch. 1, Pt. 136, Appendix B.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

TABLE 1. INTERLABORATORY PRECISION AND ACCURACY DATA

Number of Values Reported	True Value (T)	Mean (X)	Residual for X	Standard Deviation (S)	Residual for S
115	0.380	0.3891	-0.0091	0.0750	-0.0135
134	0.451	0.4807	0.0125	0.1181	0.0238
127	1.00	1.0095	-0.0000	0.1170	-0.0227
164	3.10	3.0992	0.0191	0.2821	-0.0310
138	3.50	3.4765	0.0020	0.3973	0.0512
115	5.71	5.6083	-0.0452	0.4869	-0.0417
175	7.00	6.9246	-0.0008	0.6623	0.0272
121	8.00	7.9991	0.0877	0.6283	-0.0894
120	15.0	15.0213	0.2080	1.2495	-0.0462
127	21.0	20.4355	-0.2937	1.7267	-0.0644
164	25.0	24.7157	0.0426	2.0147	-0.1067
175	26.9	26.1464	-0.4000	2.9743	0.6960

REGRESSIONS: $X = 0.986T + 0.024$, $S = 0.083T + 0.057$

TABLE 2. CONCENTRATION RANGES

Range mg/LN	Pump mL/min.		mL NaOH Buffer (Section 7.7)
	Sample	Resample	
0-1.5	0.80	0.32	250
0-5.0	0.16	0.32	120
0-10.0	0.16	0.16	80

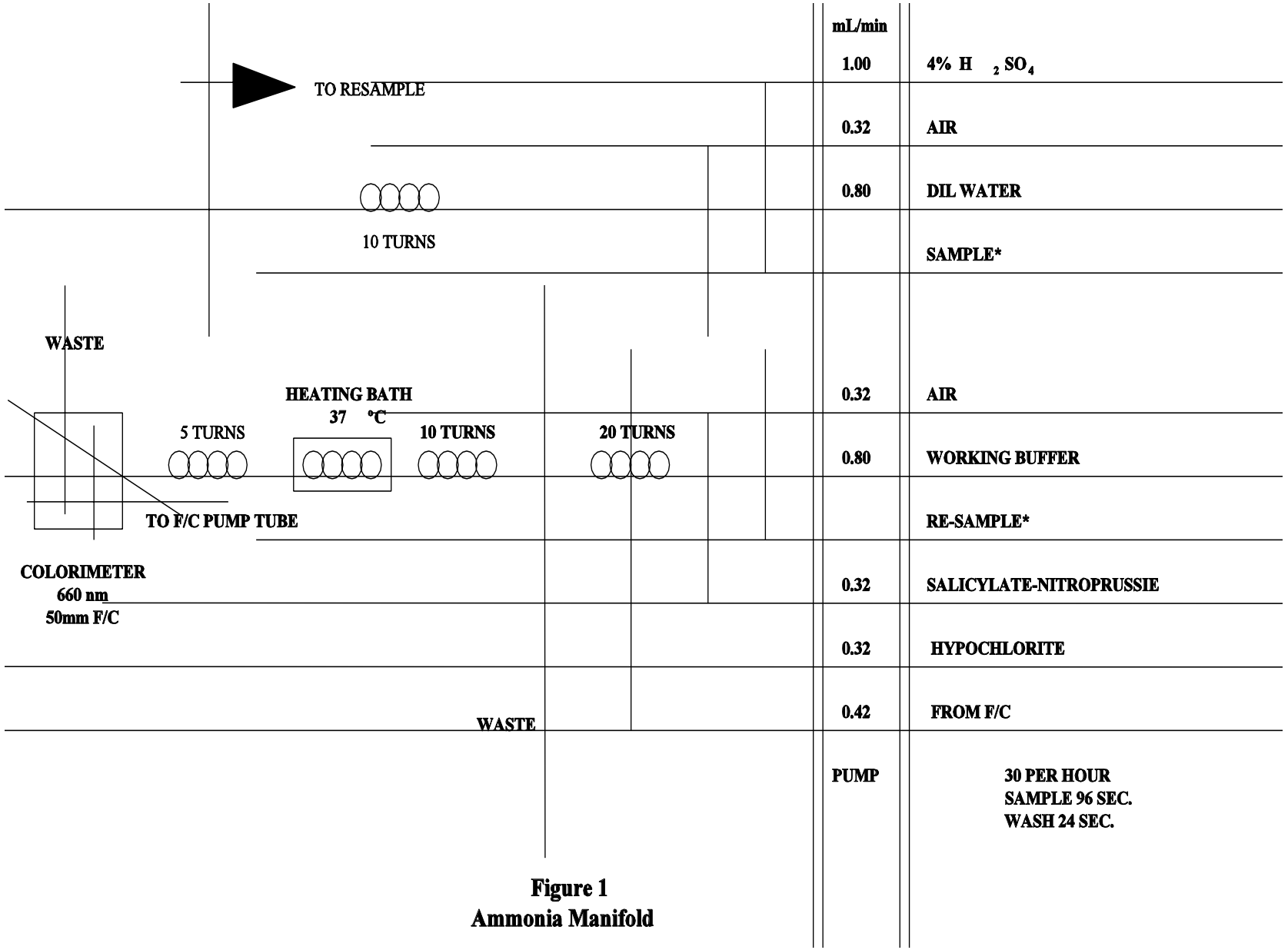

Figure 1
Ammonia Manifold

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Technical Note 14

Total Dissolved Solids from conductivity

Glenn Carlson, Technical Support, In-Situ Inc.
May 26, 2005

Total Solids is the term applied to material residue left in a vessel after evaporation of a water sample and subsequent drying of the residue. Total Solids includes Total Suspended Solids (TSS), the portion of total solids in a sample that can be retained by a filter, and Total Dissolved Solids (TDS), the portion that passes through a filter.

The amount of dissolved material in a sample correlates to electrical conductivity. TDS values reported by Win-Situ software are derived from conductivity readings. This calculation, as with other calculations in Win-Situ, is per the 20th edition of *Standard Methods for the Examination of Water and Wastewater*. It should only be used as a rough field check of a sample, though. TDS derived from conductivity is not recommended for critical quantitative reporting purposes. The reason for this is that there is not a relationship between conductivity and TDS that is very repeatable across different locations and different dissolved material. The calculation used is:

TDS = SC * 0.65

where:

TDS = Total Dissolved Solids in mg/L
SC = Specific Conductance (temperature corrected) in uS/cm

The constant of 0.65 is only a VERY crude average for natural samples. The actual constant for any particular sample with a specific mix of dissolved materials and measurement temperature can vary widely. The actual multiplier necessary depends on the activity of each specific dissolved species present and the average activity of all species in a sample. These activities are influenced by sample temperature, the relative amounts of each species (they can influence each other) and the total concentration of dissolved solids in the sample (can be a non-linear relationship).

While the default average value for this calculation can give good results for some samples, this calculation from conductivity only represents a very crude index for other samples and should not be used as the sole method to accurately quantify the actual amount of dissolved material in a sample. If measurements will always be made at the same location, then it would be far better practice to determine the actual constant that would be appropriate for those samples and then manually do the TDS calculation from Specific Conductance. Ideally, measuring TDS of preliminary samples gravimetrically and regressing those results against the measured Specific Conductance of the samples would determine the constant.

The composition of dissolved material in samples will certainly change from one site to another. Even for the same site, however, the type of dissolved material may also change over time. If the composition of dissolved solids changes appreciably, then it will be necessary to again determine a new constant for the site gravimetrically.

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1-970-498-1500 (tel)
www.in-situ.com

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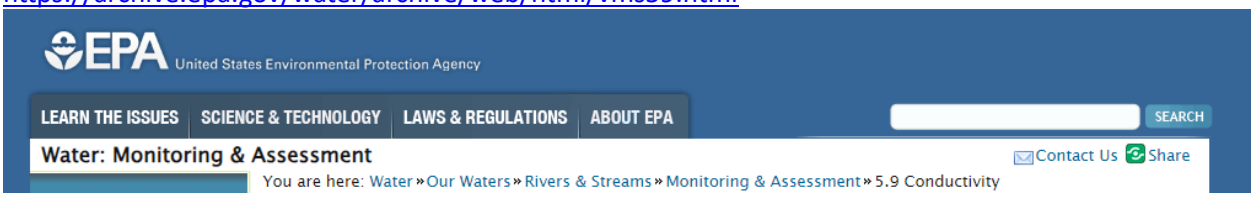

5.9 Conductivity

What is conductivity and why is it important?

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25 C).

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not ionize (dissolve into ionic components) when washed into the water. On the other hand, streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Ground water inflows can have the same effects depending on the bedrock they flow through.

Discharges to streams can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity.

The basic unit of measurement of conductivity is the mho or siemens. Conductivity is measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm). Distilled water has a conductivity in the range of 0.5 to 3 µmhos/cm. The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates. Industrial waters can range as high as 10,000 µmhos/cm.

Sampling and equipment Considerations

Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for

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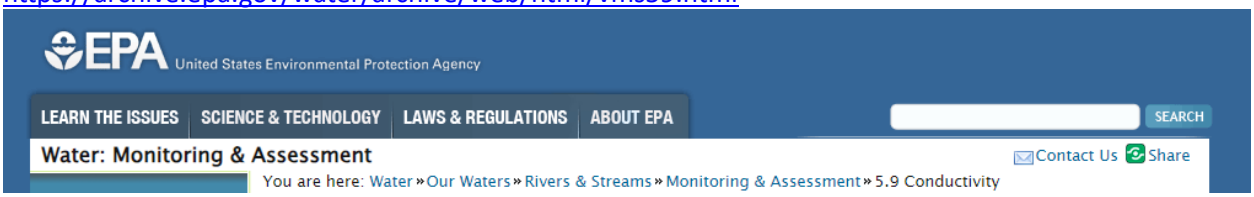

comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream.

Conductivity is measured with a probe and a meter. Voltage is applied between two electrodes in a probe immersed in the sample water. The drop in voltage caused by the resistance of the water is used to calculate the conductivity per centimeter. The meter converts the probe measurement to micromhos per centimeter and displays the result for the user. NOTE: Some conductivity meters can also be used to test for total dissolved solids and salinity. The total dissolved solids concentration in milligrams per liter (mg/L) can also be calculated by multiplying the conductivity result by a factor between 0.55 and 0.9, which is empirically determined (see Standard Methods #2510, APHA 1992).

Suitable conductivity meters cost about $350. Meters in this price range should also measure temperature and automatically compensate for temperature in the conductivity reading. Conductivity can be measured in the field or the lab. In most cases, it is probably better if the samples are collected in the field and taken to a lab for testing. In this way several teams of volunteers can collect samples simultaneously. If it is important to test in the field, meters designed for field use can be obtained for around the same cost mentioned above.

If samples will be collected in the field for later measurement, the sample bottle should be a glass or polyethylene bottle that has been washed in phosphate-free detergent and rinsed thoroughly with both tap and distilled water. Factory-prepared Whirl-pak® bags may be used.

How to sample

The procedures for collecting samples and analyzing conductivity consist of the following tasks:

TASK 1 Prepare the sample containers

If factory-sealed, disposable Whirl-pak® bags are used for sampling, no preparation is needed. Reused sample containers (and all glassware used in this procedure) must be cleaned before the first run and after each sampling run by following Method A as described in MEthod A in Table 1 in Chapter 5 - Water Quality Conditions.

TASK 2 Prepare before leaving for the sampling site

Refer to section 2.3 - Safety Considerations for details on confirming sampling date and time, safety considerations, checking supplies, and checking weather and directions. In addition to the standard sampling equipment and apparel, when sampling for conductivity, include the following equipment:

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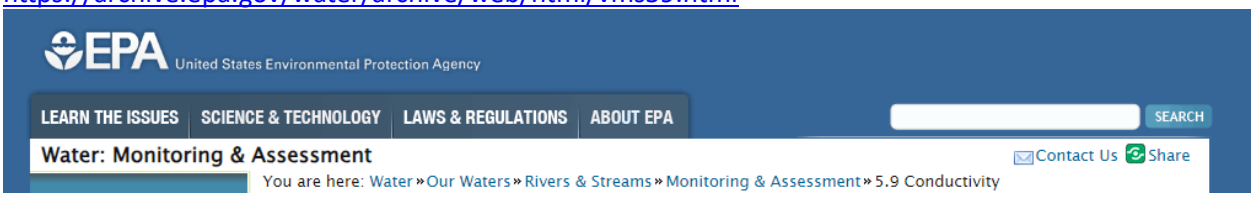

- Conductivity meter and probe (if testing conductivity in the field)
- Conductivity standard appropriate for the range typical of the stream
- Data sheet for conductivity to record results

Be sure to let someone know where you are going and when you expect to return.

TASK 3 Collect the sample (if samples will be tested in the lab)

Refer to Task 2 in Chapter 5 – Water Quality Conditions for details on how to collect water samples using screw-cap bottles or Whirl-pak® bags.

TASK 4 Analyze the sample (field or lab)

The following procedure applies to field or lab use of the conductivity meter.

1. Prepare the conductivity meter for use according to the manufacturer's directions.
2. Use a conductivity standard solution (usually potassium chloride or sodium chloride) to calibrate the meter for the range that you will be measuring. The manufacturer's directions should describe the preparation procedures for the standard solutio n.
3. Rinse the probe with distilled or deionized water.
4. Select the appropriate range beginning with the highest range and working down. Read the conductivity of the water sample. If the reading is in the lower 10 percent of the range, switch to the next lower range. If the conductivity of the sample ex ceeds the range of the instrument, you may dilute the sample. Be sure to perform the dilution according to the manufacturer's directions because the dilution might not have a simple linear relationship to the conductivity.
5. Rinse the probe with distilled or deionized water and repeat step 4 until finished.

TASK 5 Return the samples and the field data sheets to the lab/drop-off point.

Samples that are sent to a lab for conductivity analysis must be tested within 28 days of collection. Keep the samples on ice or refrigerated.

References

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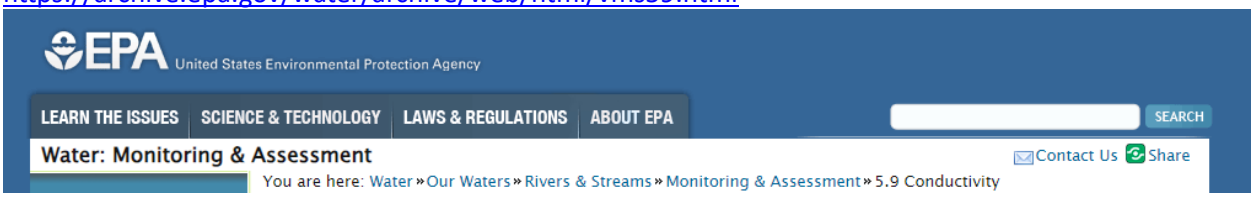
https://archive.epa.gov/water/archive/web/html/vms59.html



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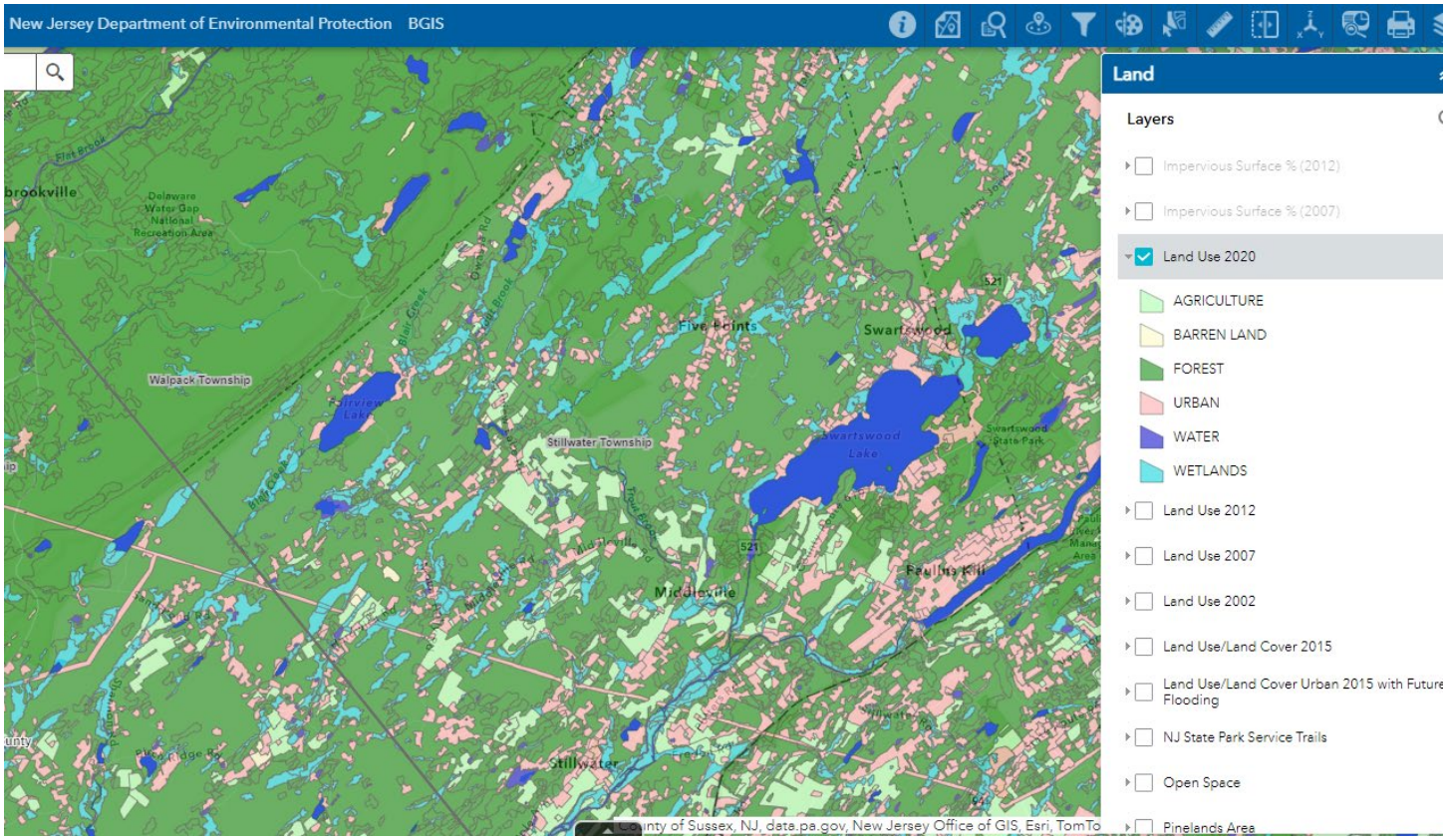
Source: https://archive.epa.gov/water/archive/web/html/vms59.html (accessed March 23, 2024)

Appendix C

NJDEP GeoWeb Map Information Excerpts

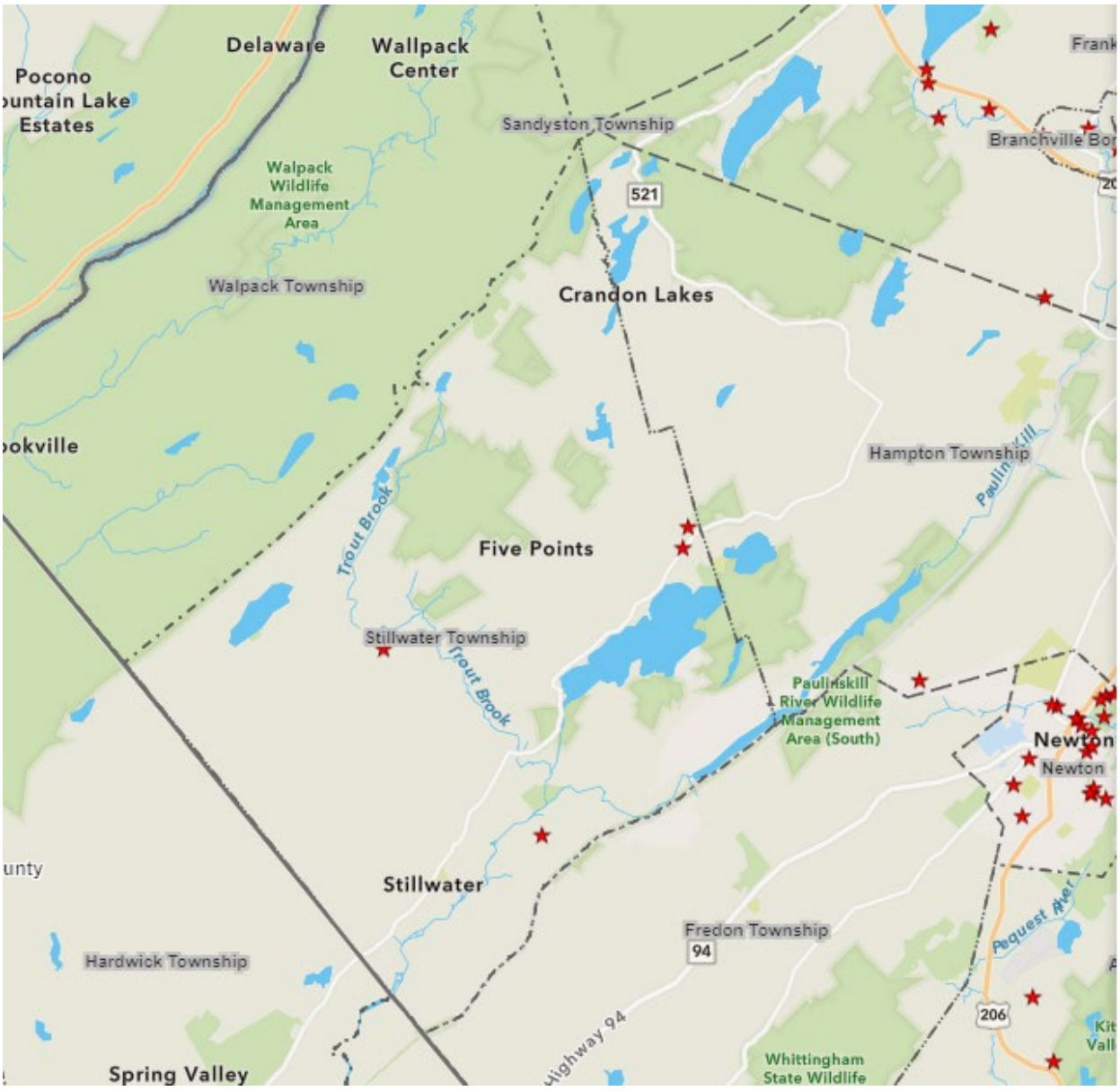
Appendix C
NJDEP GeoWeb Map Information Excerpts
Stillwater, NJ

Land Use

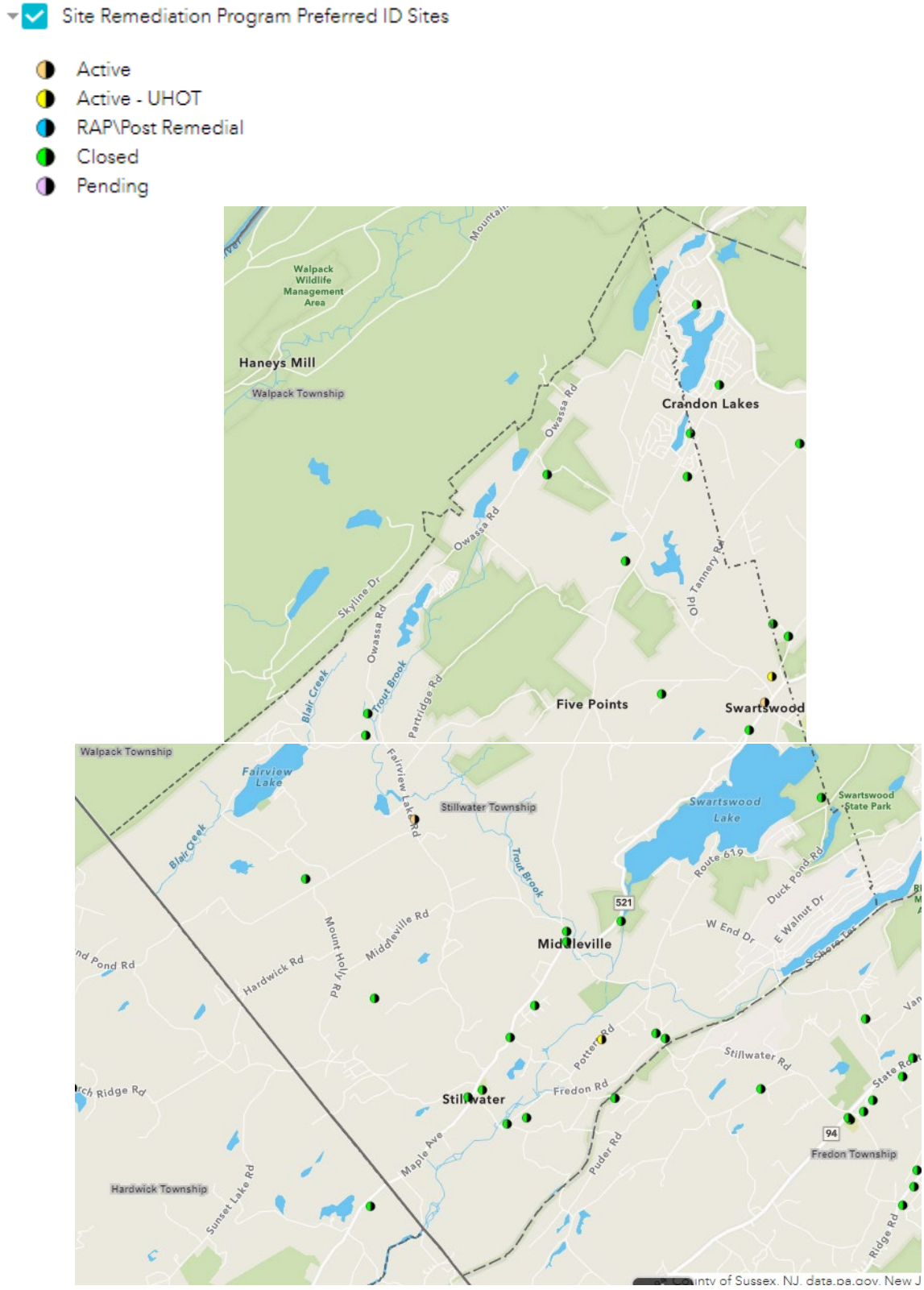


Appendix C
NJDEP GeoWeb Map Information Excerpts
Stillwater, NJ

Known Contaminated Sites

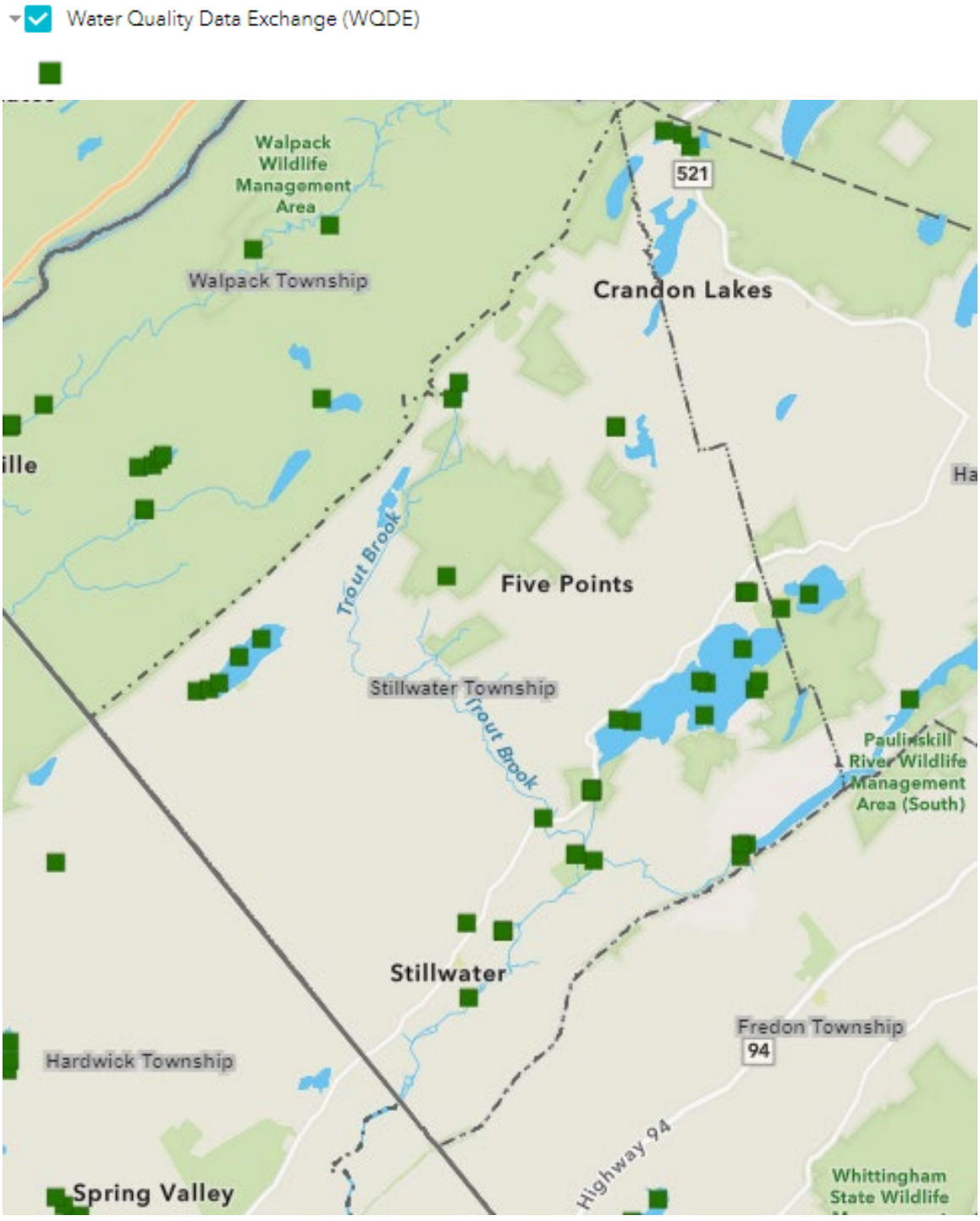


Site Remediation Preferred ID Sites



Appendix C
NJDEP GeoWeb Map Information Excerpts
Stillwater, NJ

NJDEP WQDE Sample Stations



Appendix D

Summary of 95UCL and Statistical Trend Analysis Results

Appendix D
Summary of SWMP 95UCL and Trend Analysis Results
Surface Water Monitorng Program (1984-2024) - Stillwater, NJ

Parameter	Station #	P-value	Signifcant Trend?	Trend Direction	95 UCL*	Units	Sample Size (n)
Alkalinity	1	0.254	No	No Trend	20.8	mg/L	26
Alkalinity	2	0.474	No	No Trend	14.8	mg/L	26
Alkalinity	3	0.056	No	No Trend	25.4	mg/L	26
Alkalinity	4	0.233	No	No Trend	22.4	mg/L	26
Alkalinity	5	0.005	Yes	Increasing	35.5	mg/L	25
Alkalinity	6	0.034	Yes	No Trend	31.9	mg/L	26
Alkalinity	7	0.362	No	No Trend	137.1	mg/L	26
Alkalinity	8	0.175	No	No Trend	77.3	mg/L	16
Alkalinity	9	0.242	No	No Trend	149.3	mg/L	10
Aluminum	1	0.184	No	No Trend	0.143	mg/L	18
Aluminum	2	0.048	Yes	Decreasing	0.139	mg/L	18
Aluminum	3	0.041	Yes	Decreasing	0.149	mg/L	18
Aluminum	4	0.048	Yes	Decreasing	0.184	mg/L	18
Aluminum	5	0.026	Yes	Decreasing	0.265	mg/L	16
Aluminum	6	0.054	No	No Trend	0.086	mg/L	17
Aluminum	7	0.038	Yes	Decreasing	0.161	mg/L	17
Aluminum	8	0.460	No	No Trend	N/A	mg/L	9
Aluminum	9	N/A		N/A	0.163	mg/L	3
Ammonia	1	0.003	Yes	Decreasing	0.174	mg/L	25
Ammonia	2	0.002	Yes	Decreasing	0.227	mg/L	25
Ammonia	3	0.005	Yes	Decreasing	0.134	mg/L	25
Ammonia	4	0.001	Yes	Decreasing	0.155	mg/L	25
Ammonia	5	0.003	Yes	Decreasing	0.118	mg/L	25
Ammonia	6	0.005	Yes	Decreasing	0.110	mg/L	25
Ammonia	7	0.002	Yes	Decreasing	0.114	mg/L	25
Ammonia	8	0.385	No	No Trend	0.073	mg/L	15
Ammonia	9	0.460	No	No Trend	0.151	mg/L	9
E. Coli	10	0.500	No	No Trend	370.1	col/100ml	7
Fecal Coliforms	1	0.121	No	No Trend	59.7	col/100ml	25
Fecal Coliforms	2	0.217	No	No Trend	56.8	col/100ml	25
Fecal Coliforms	3	0.226	No	No Trend	35.5	col/100ml	25
Fecal Coliforms	4	0.007	Yes	Decreasing	19.0	col/100ml	25
Fecal Coliforms	5	0.017	Yes	Decreasing	84.2	col/100ml	24
Fecal Coliforms	6	0.168	No	No Trend	31.1	col/100ml	25
Fecal Coliforms	7	0.023	Yes	Decreasing	180.8	col/100ml	25
Fecal Coliforms	8	0.225	No	No Trend	24.2	col/100ml	16
Fecal Coliforms	9	0.431	No	No Trend	158.4	col/100ml	10
Fecal Coliforms	10	0.281	No	No Trend	354.6	col/100ml	7
Lead	1	0.034	Yes	Decreasing	0.015	mg/L	19
Lead	2	0.093	No	No Trend	0.015	mg/L	19
Lead	3	0.105	No	No Trend	0.014	mg/L	19
Lead	4	0.105	No	No Trend	0.014	mg/L	19
Lead	5	0.010	Yes	Decreasing	0.015	mg/L	19
Lead	6	0.082	No	No Trend	0.015	mg/L	19
Lead	7	0.005	Yes	Decreasing	0.023	mg/L	19
Lead	8	0.130	No	No Trend	0.004	mg/L	9
Lead	9	N/A	N/A	N/A	N/A	mg/L	3
Nitrate	1	0.012	Yes	Decreasing	0.199	mg/L	26

Nitrate	2	0.012	Yes	Decreasing	0.232	mg/L	26
Nitrate	3	0.131	No	No Trend	0.167	mg/L	26
Nitrate	4	0.295	No	No Trend	0.217	mg/L	26
Nitrate	5	0.121	No	No Trend	0.231	mg/L	26
Nitrate	6	0.066	No	No Trend	0.199	mg/L	26
Nitrate	7	0.430	No	No Trend	0.636	mg/L	26
Nitrate	8	0.199	No	No Trend	0.201	mg/L	16
Nitrate	9	0.364	No	No Trend	0.508	mg/L	10
Nitrite	1	0.093	No	No Trend	0.037	mg/L	25
Nitrite	2	0.259	No	No Trend	0.035	mg/L	25
Nitrite	3	0.267	No	No Trend	0.035	mg/L	25
Nitrite	4	0.195	No	No Trend	0.047	mg/L	25
Nitrite	5	0.275	No	No Trend	0.035	mg/L	25
Nitrite	6	0.202	No	No Trend	0.036	mg/L	25
Nitrite	7	0.060	No	No Trend	0.039	mg/L	24
Nitrite	8	0.423	No	No Trend	0.047	mg/L	15
Nitrite	9	0.000	Yes	No Trend	0.096	mg/L	9
Orthophosphate	1	0.041	Yes	Decreasing	0.038	mg/L	26
Orthophosphate	2	0.033	Yes	Decreasing	0.036	mg/L	26
Orthophosphate	3	0.094	No	No Trend	0.033	mg/L	26
Orthophosphate	4	0.030	Yes	Decreasing	0.037	mg/L	26
Orthophosphate	5	0.029	Yes	No Trend	0.034	mg/L	25
Orthophosphate	6	0.049	Yes	Decreasing	0.033	mg/L	26
Orthophosphate	7	0.023	Yes	Decreasing	0.038	mg/L	25
Orthophosphate	8	0.345	No	No Trend	0.038	mg/L	16
Orthophosphate	9	0.242	No	No Trend	0.054	mg/L	10
pH	1	0.330	No	No Trend	6.90	su	26
pH	2	0.166	No	No Trend	6.77	su	26
pH	3	0.421	No	No Trend	7.20	su	26
pH	4	0.370	No	No Trend	7.08	su	26
pH	5	0.249	No	No Trend	7.23	su	25
pH	6	0.195	No	No Trend	7.26	su	26
pH	7	0.338	No	No Trend	8.02	su	26
pH	8	0.253	No	No Trend	7.76	su	16
pH	9	0.190	No	No Trend	8.04	su	10
Phosphorus	1	0.086	No	No Trend	0.065	mg/L	25
Phosphorus	2	0.234	No	No Trend	0.104	mg/L	25
Phosphorus	3	0.044	Yes	Decreasing	0.070	mg/L	25
Phosphorus	4	0.035	Yes	Decreasing	0.061	mg/L	25
Phosphorus	5	0.178	No	No Trend	0.062	mg/L	24
Phosphorus	6	0.241	No	No Trend	0.060	mg/L	25
Phosphorus	7	0.009	Yes	Decreasing	0.069	mg/L	25
Phosphorus	8	0.349	No	No Trend	0.091	mg/L	15
Phosphorus	9	0.460	No	No Trend	0.134	mg/L	9
Specific conductivity	1	0.261	No	No Trend	118.2	umohs/cm	26
Specific conductivity	2	0.183	No	No Trend	130.5	umohs/cm	26
Specific conductivity	3	0.330	No	No Trend	134.0	umohs/cm	26
Specific conductivity	4	0.076	No	No Trend	131.7	umohs/cm	26
Specific conductivity	5	0.000	Yes	Increasing	201.1	umohs/cm	25
Specific conductivity	6	0.003	Yes	Increasing	167.8	umohs/cm	26
Specific conductivity	7	0.100	No	No Trend	455.6	umohs/cm	26
Specific conductivity	8	0.199	No	No Trend	245.3	umohs/cm	16
Specific conductivity	9	0.078	No	No Trend	553.5	umohs/cm	10
TKN	1	0.395	No	No Trend	0.856	mg/L	23

TKN	2	0.110	No	No Trend	2.832	mg/L	24
TKN	3	0.263	No	No Trend	0.803	mg/L	24
TKN	4	0.231	No	No Trend	0.520	mg/L	24
TKN	5	0.162	No	No Trend	0.782	mg/L	24
TKN	6	0.264	No	No Trend	0.723	mg/L	24
TKN	7	0.226	No	No Trend	0.853	mg/L	24
TKN	8	0.225	No	No Trend	1.033	mg/L	14
TKN	9	0.238	No	No Trend	0.565	mg/L	9
TSS	1	0.424	No	No Trend	6.58	mg/L	25
TSS	2	0.032	Yes	Decreasing	4.01	mg/L	25
TSS	3	0.015	Yes	Decreasing	2.82	mg/L	25
TSS	4	0.005	Yes	Decreasing	4.26	mg/L	25
TSS	5	0.109	No	Decreasing	9.44	mg/L	25
TSS	6	0.006	Yes	Decreasing	3.36	mg/L	25
TSS	7	0.453	No	No Trend	6.61	mg/L	25
TSS	8	0.218	No	No Trend	16.87	mg/L	15
TSS	9	0.540	No	No Trend	15.92	mg/L	9

Notes:

* 95UCL qulaified due to low sample size (n<10)

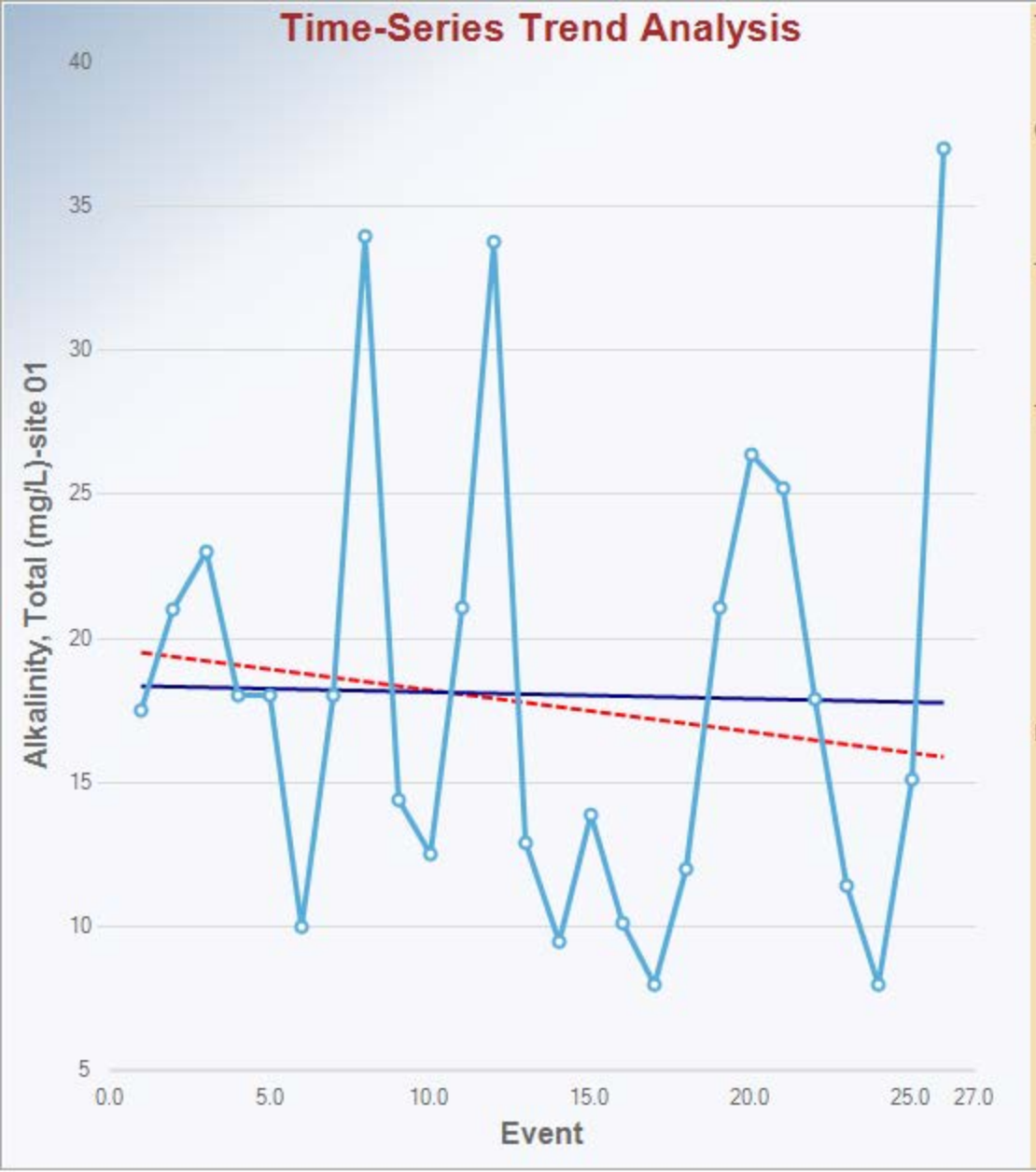
N/A = not applicable; 95UCL not calculated due to small sample size (n).

ND = Not Detected or not detected above SWCS; 95UCL not calculated due to low detection frequency.

Significant trend identified if P>0.05.

95UCL based on 95% Student's-t UCL.

Alkalinity Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0227
OLS Regression Intercept	18.3746

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1450
Theil-Sen Intercept	19.6575

Theil-Sen Trend Analysis

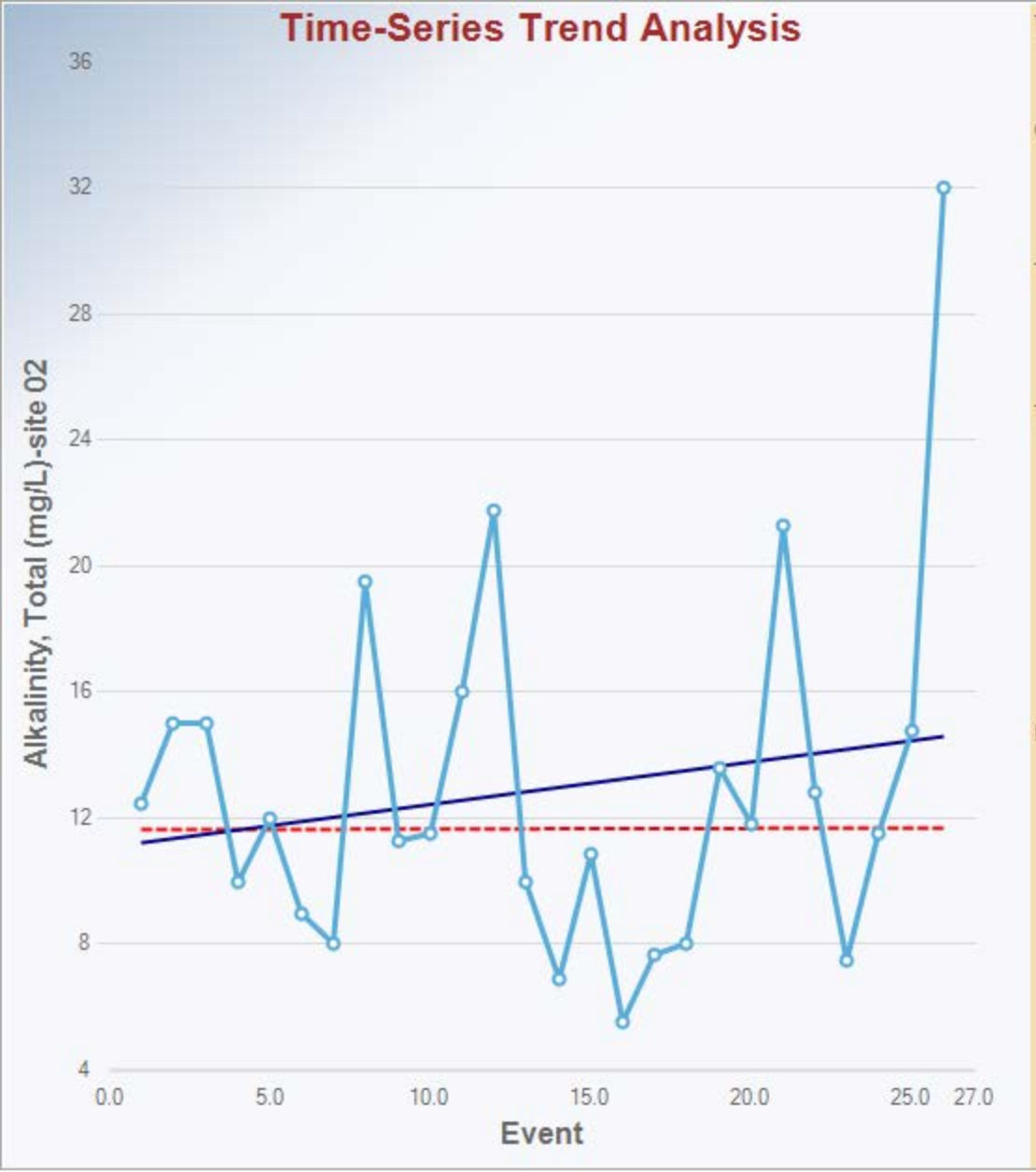
Level of Significance	0.0500
M1	118.0898
M2	206.9102
LCL of Slope	-0.5663
UCL of Slope	0.2675

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3174
M-K Standardized Val (S)	-0.6620
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2540

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.1367
OLS Regression Intercept	11.0735

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0027
Theil-Sen Intercept	11.6132

Theil-Sen Trend Analysis

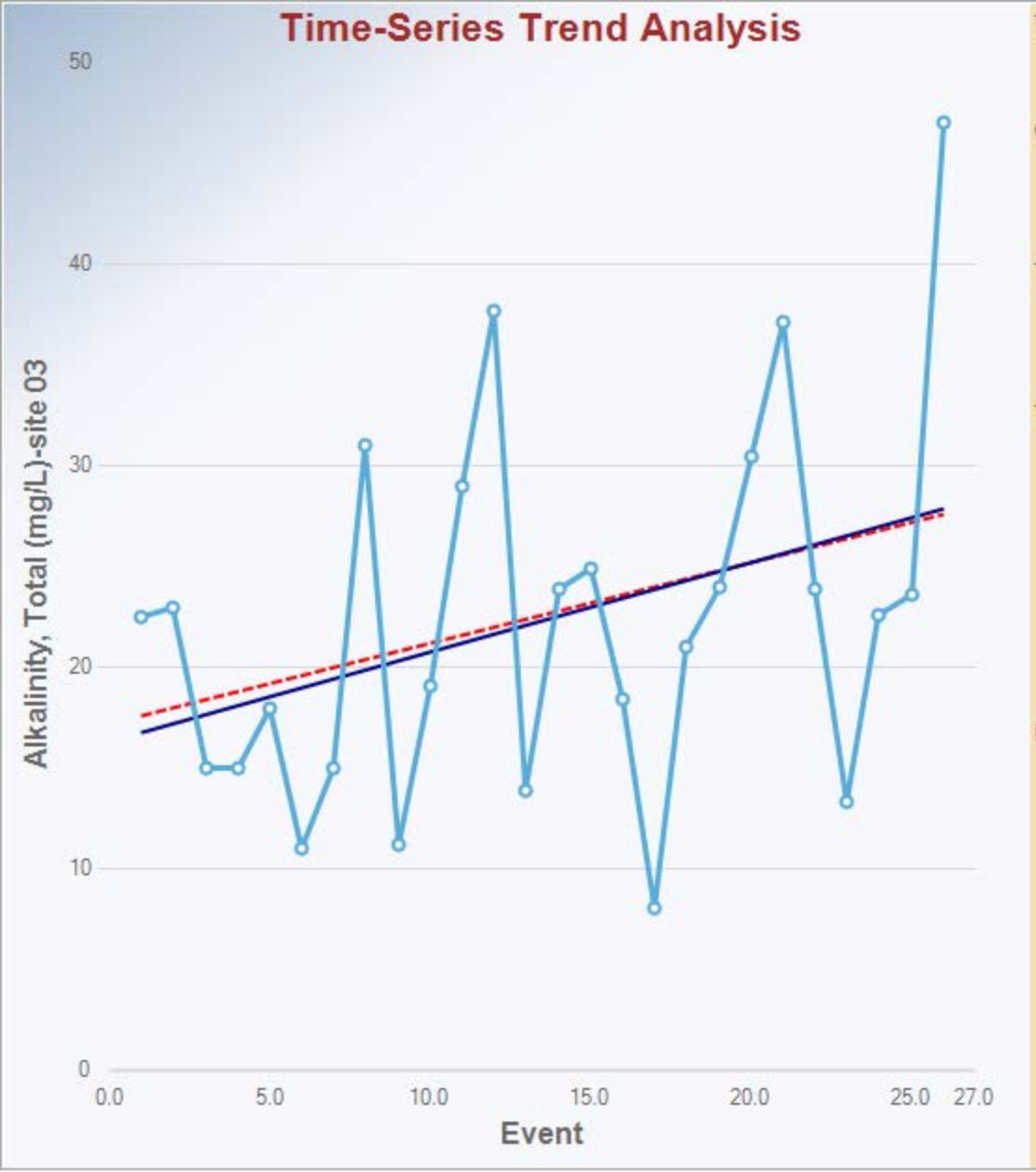
Level of Significance	0.0500
M1	118.0717
M2	206.9283
LCL of Slope	-0.2500
UCL of Slope	0.2916

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3358
M-K Standardized Val (S)	0.0662
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.4736

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.4442
OLS Regression Intercept	16.2972

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.4000
Theil-Sen Intercept	17.1500

Theil-Sen Trend Analysis

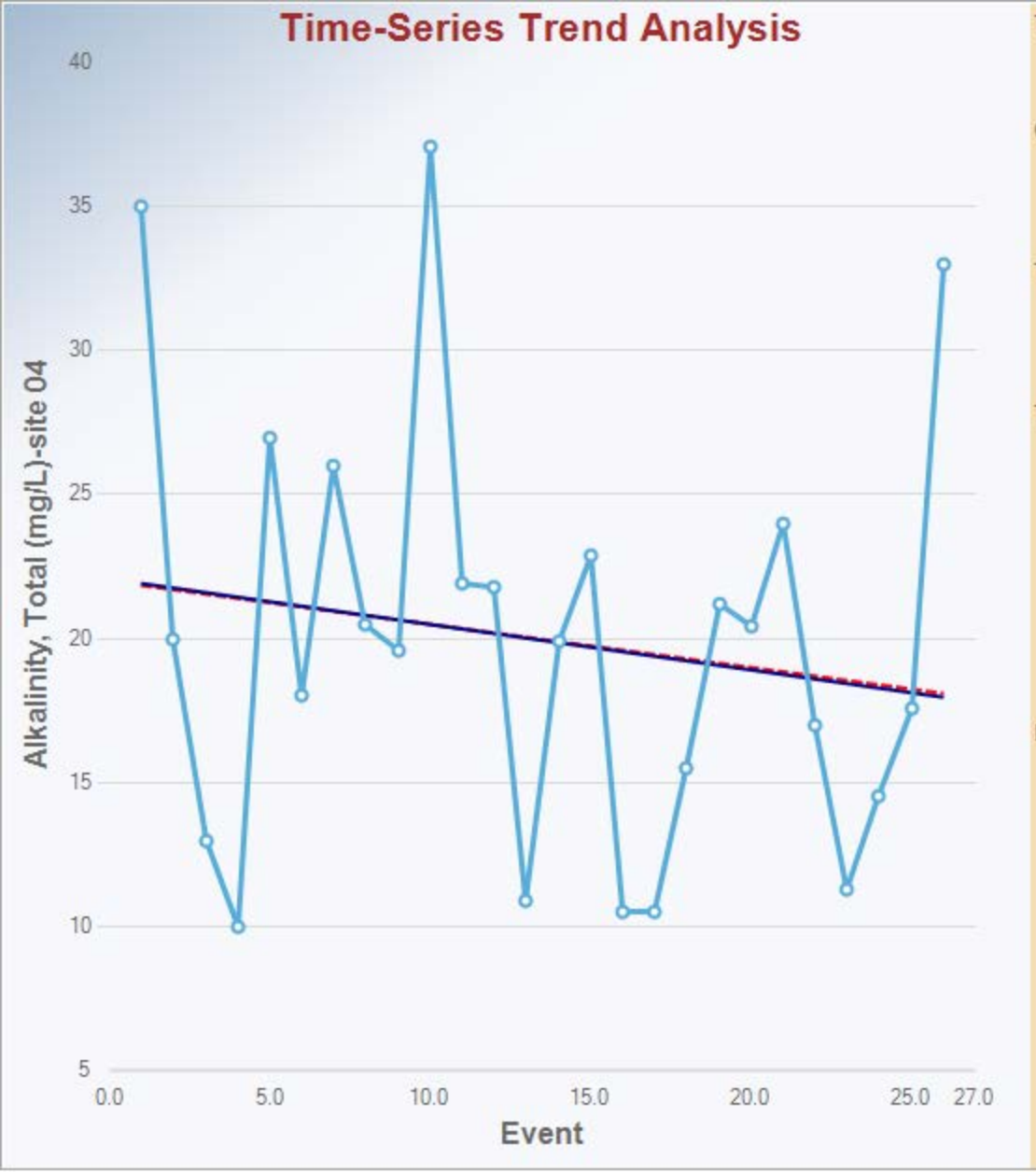
Level of Significance	0.0500
M1	118.0898
M2	206.9102
LCL of Slope	-0.0667
UCL of Slope	0.8333

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3174
M-K Standardized Val (S)	1.5888
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0561

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.1579
OLS Regression Intercept	22.0972

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1500
Theil-Sen Intercept	21.9750

Theil-Sen Trend Analysis

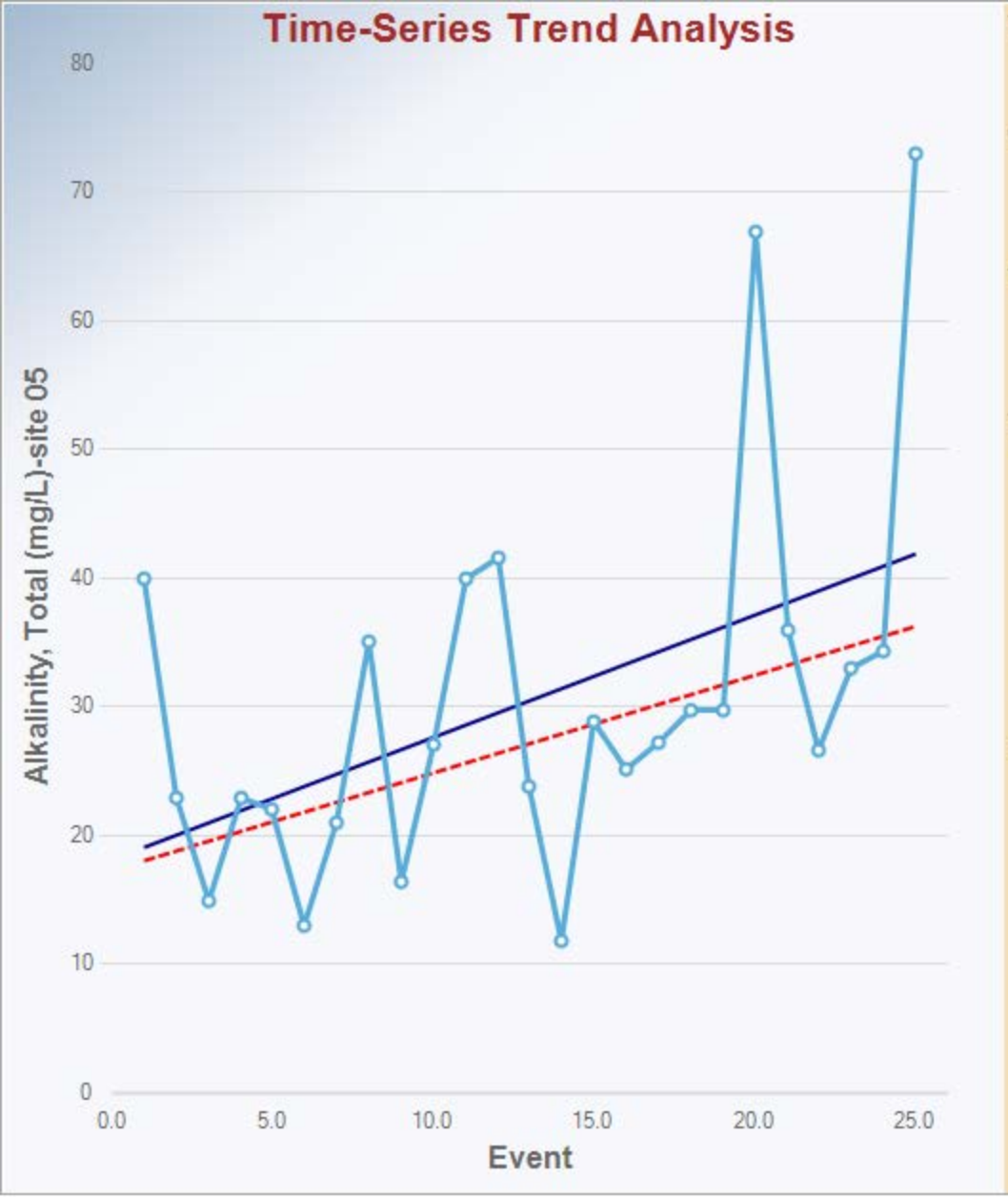
Level of Significance	0.0500
M1	118.0501
M2	206.9499
LCL of Slope	-0.5873
UCL of Slope	0.2225

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3578
M-K Standardized Val (S)	-0.7275
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2334

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.9511
OLS Regression Intercept	18.2015

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.7605
Theil-Sen Intercept	17.3138

Theil-Sen Trend Analysis

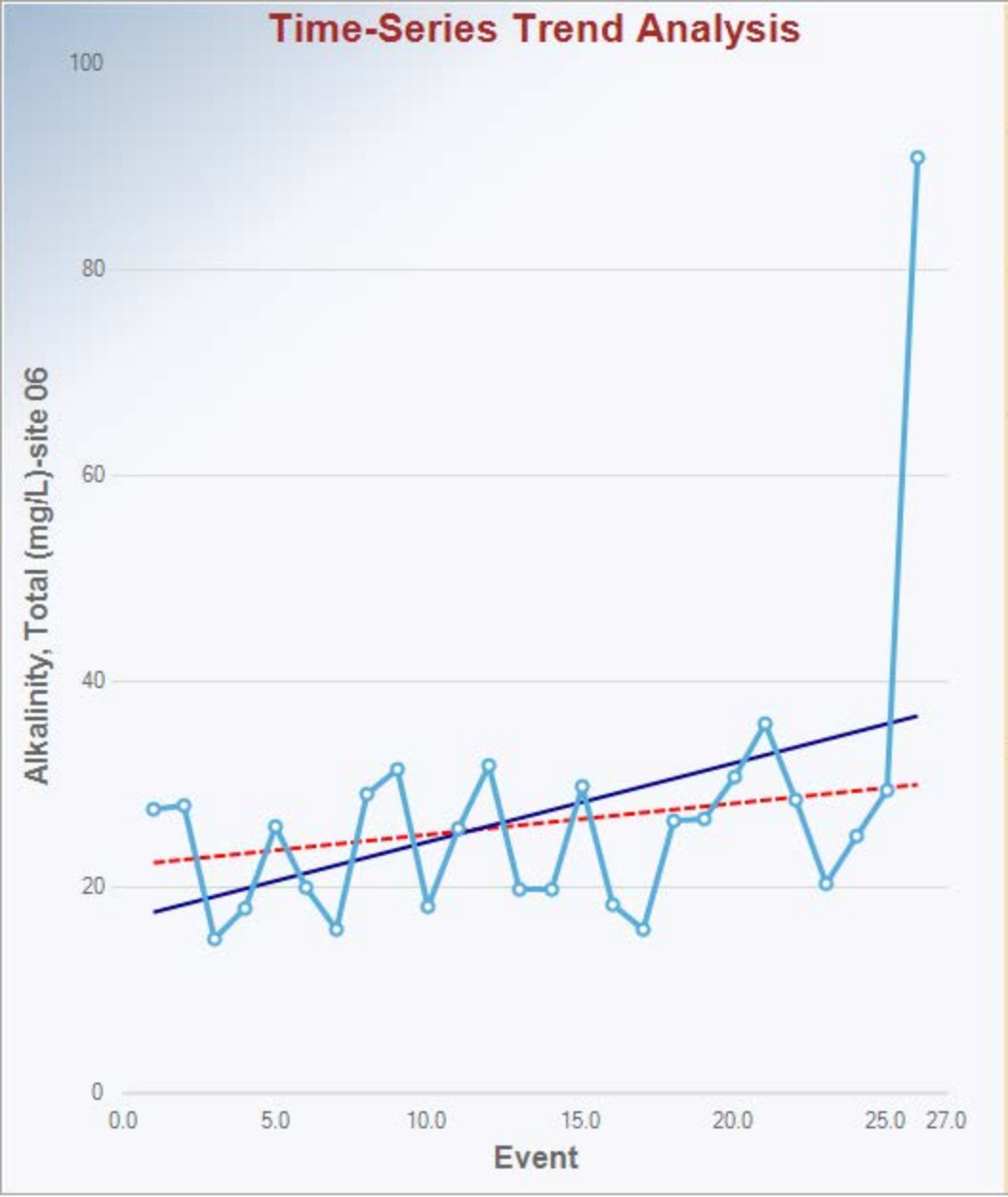
Level of Significance	0.0500
M1	108.0740
M2	191.9260
LCL of Slope	0.2384
UCL of Slope	1.2922

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.7824
M-K Standardized Val (S)	2.5712
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0051

Significant evidence of an increasing trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.7600
OLS Regression Intercept	16.8443

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.3000
Theil-Sen Intercept	22.1500

Theil-Sen Trend Analysis

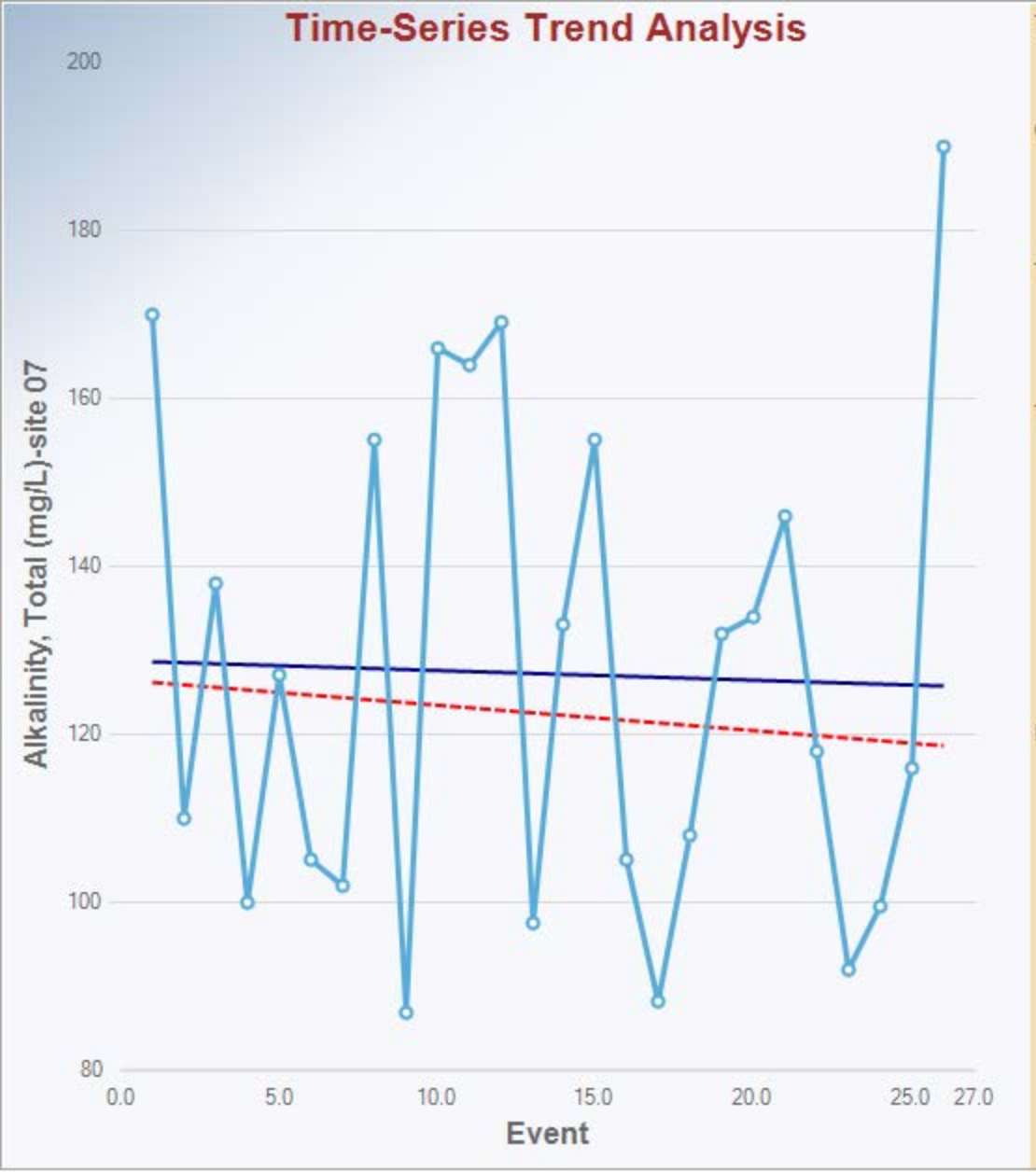
Level of Significance	0.0500
M1	118.0501
M2	206.9499
LCL of Slope	-0.0142
UCL of Slope	0.7150

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3578
M-K Standardized Val (S)	1.8299
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0336

Significant evidence of an increasing trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.1197
OLS Regression Intercept	128.8154

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.3000
Theil-Sen Intercept	126.5500

Theil-Sen Trend Analysis

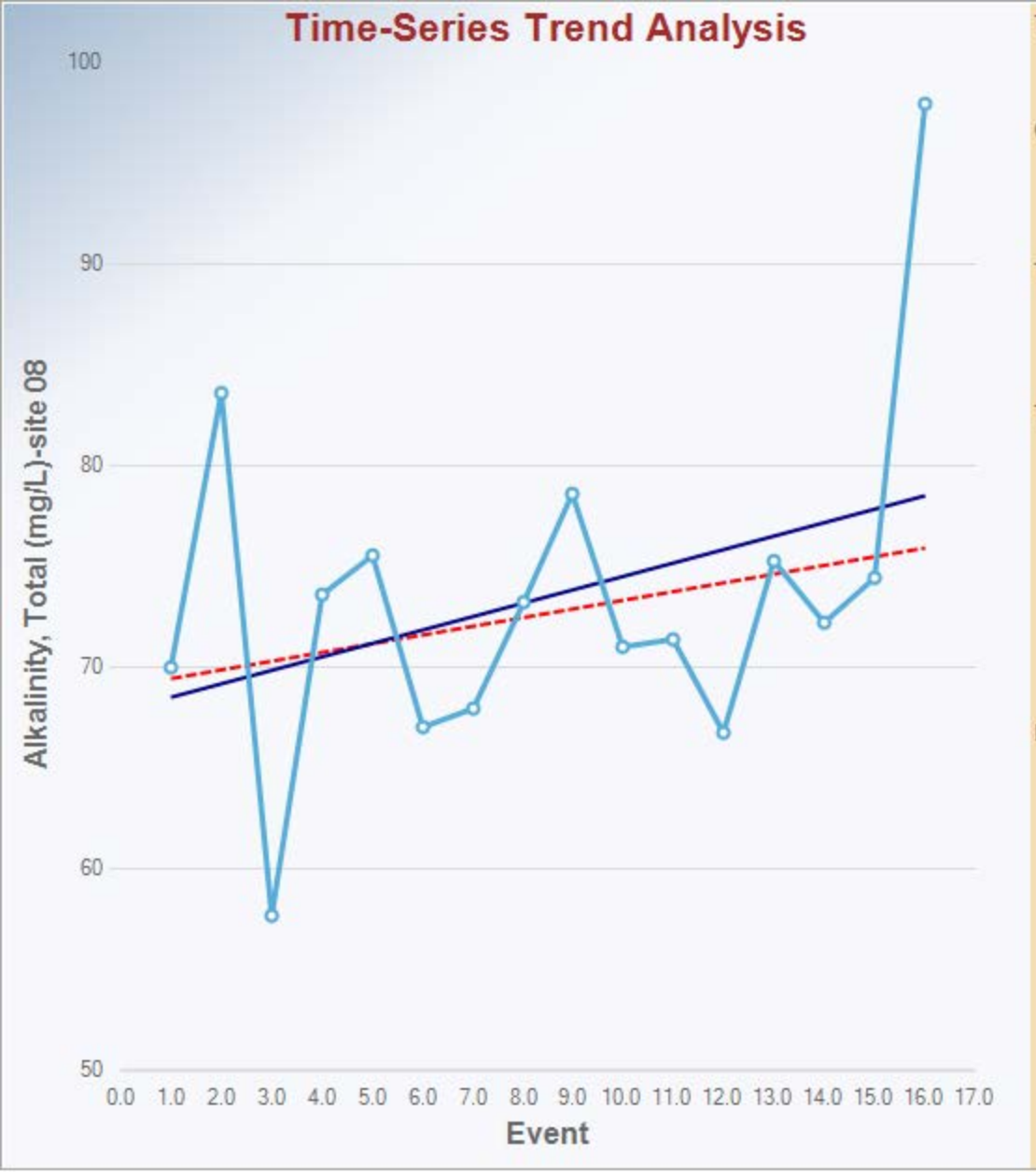
Level of Significance	0.0500
M1	118.0609
M2	206.9391
LCL of Slope	-2.0000
UCL of Slope	1.5000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3468
M-K Standardized Val (S)	-0.3528
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.3621

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	0.6618
OLS Regression Intercept	67.9000

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.4308
Theil-Sen Intercept	69.0379

Theil-Sen Trend Analysis

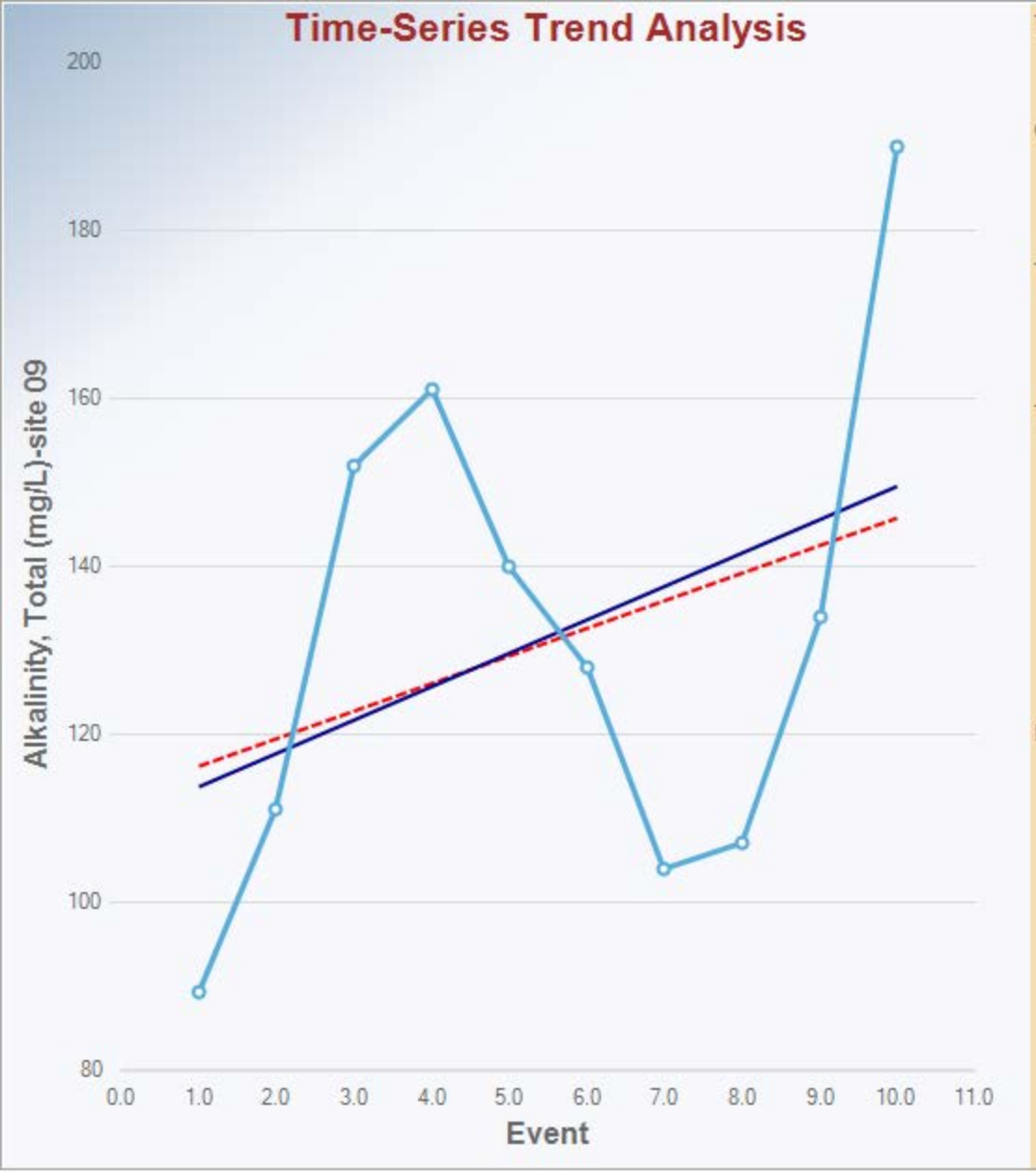
Level of Significance	0.0500
M1	38.2335
M2	81.7665
LCL of Slope	-0.4204
UCL of Slope	1.2945

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	22.2111
M-K Test Value (S)	22
Tabulated p-value	0.1750

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	3.9903
OLS Regression Intercept	109.6933

Theil-Sen Trend Line (Red)

Theil-Sen Slope	3.2857
Theil-Sen Intercept	112.9286

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	11.5435
M2	33.4565
LCL of Slope	-8.4565
UCL of Slope	11.8499

Insufficient evidence to identify a significant trend at the specified level of significance.

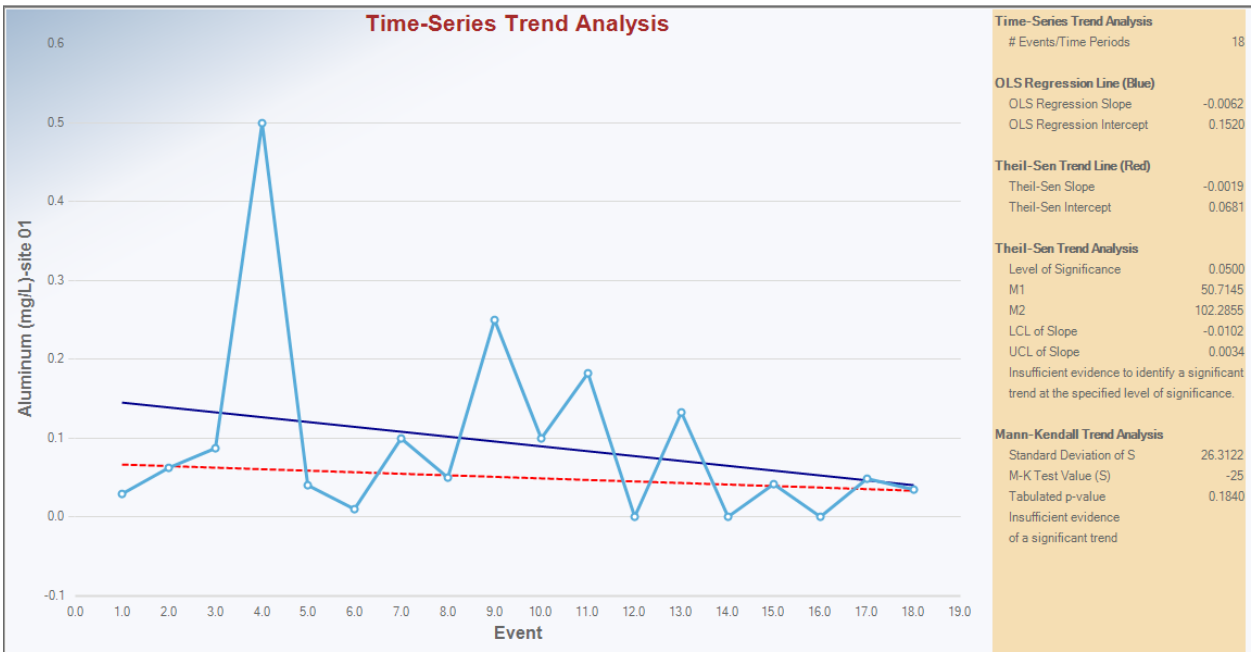
Mann-Kendall Trend Analysis

Standard Deviation of S	11.1803
M-K Test Value (S)	9
Tabulated p-value	0.2420

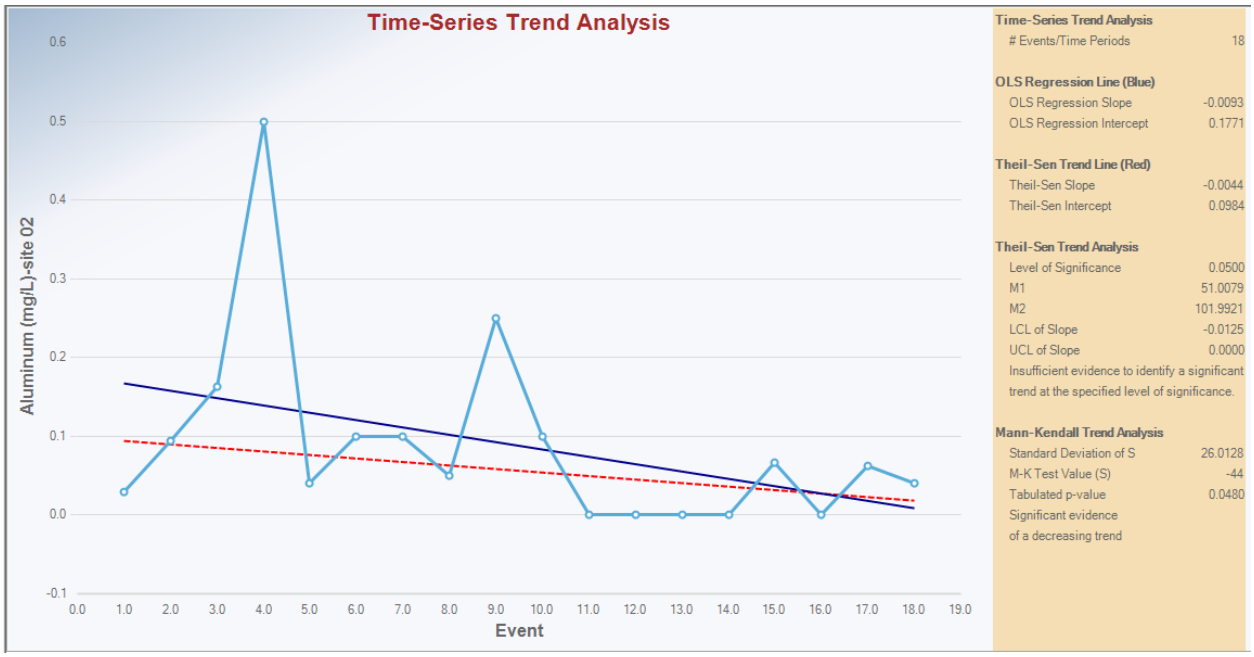
Insufficient evidence of a significant trend

Aluminum graphs

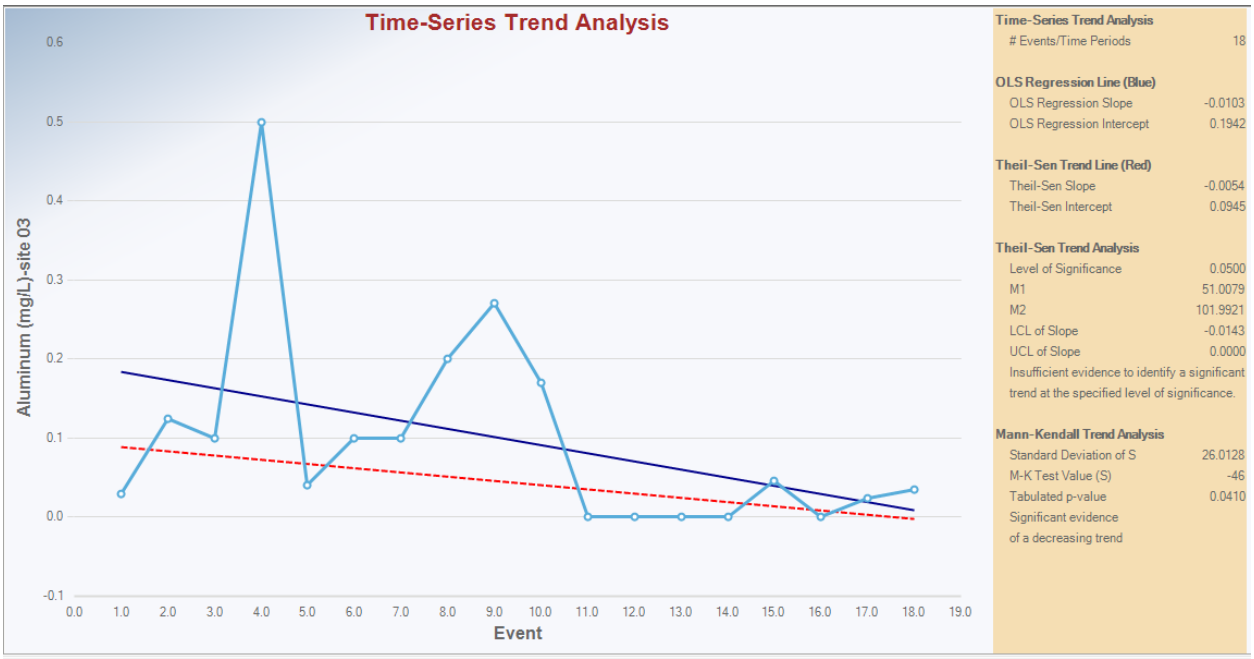
Site 1:



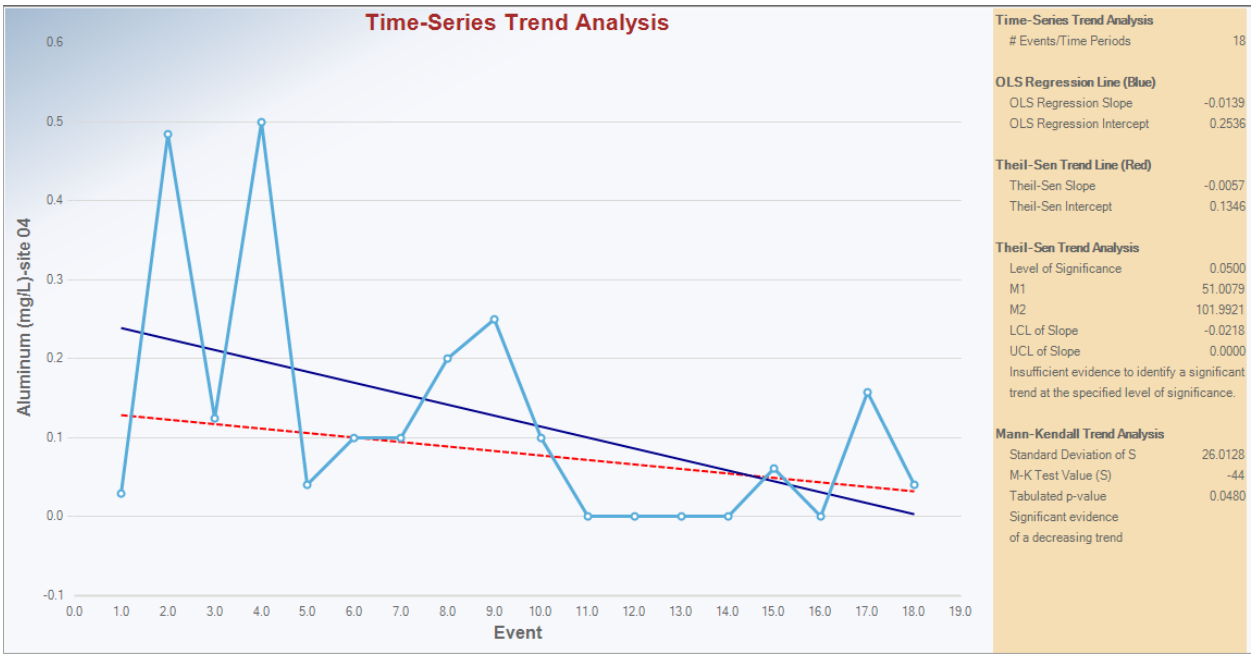
Site 2:



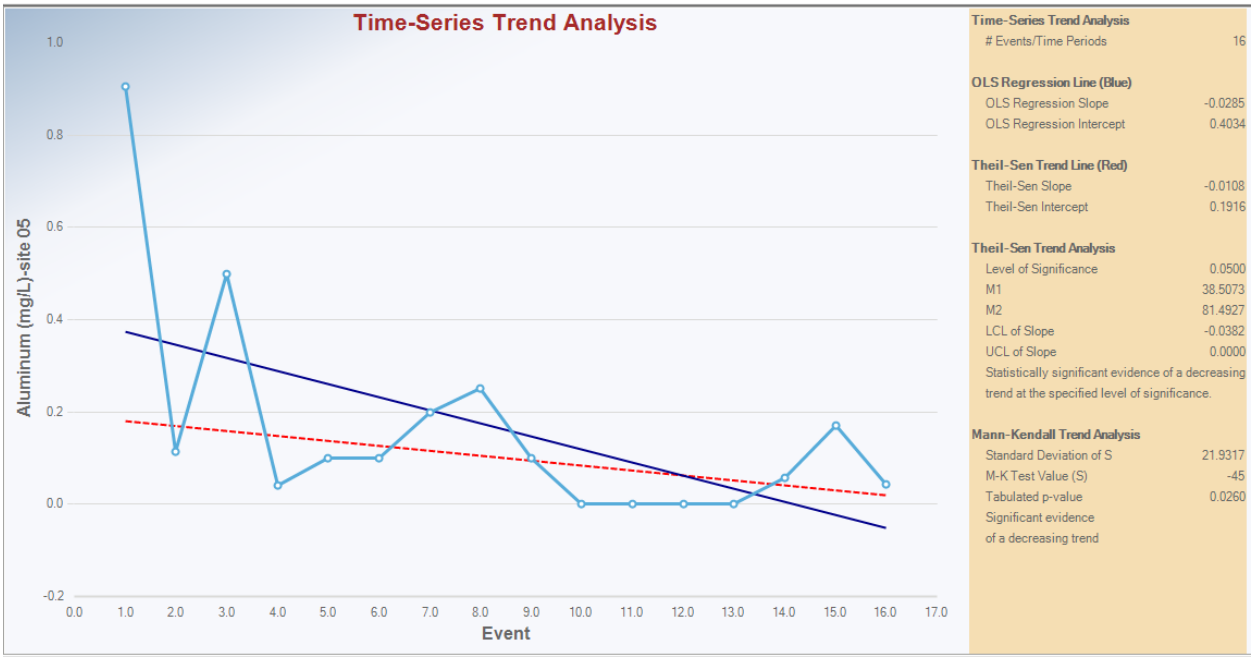
Site 3:


Time-Series Trend Analysis
Aluminum (mg/L)-site 03
Event
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0
Time-Series Trend Analysis
Events/Time Periods 18
OLS Regression Line (Blue)
OLS Regression Slope -0.0103
OLS Regression Intercept 0.1942
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0054
Theil-Sen Intercept 0.0945
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 51.0079
M2 101.9921
LCL of Slope -0.0143
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 26.0128
M-K Test Value (S) -46
Tabulated p-value 0.0410
Significant evidence of a decreasing trend

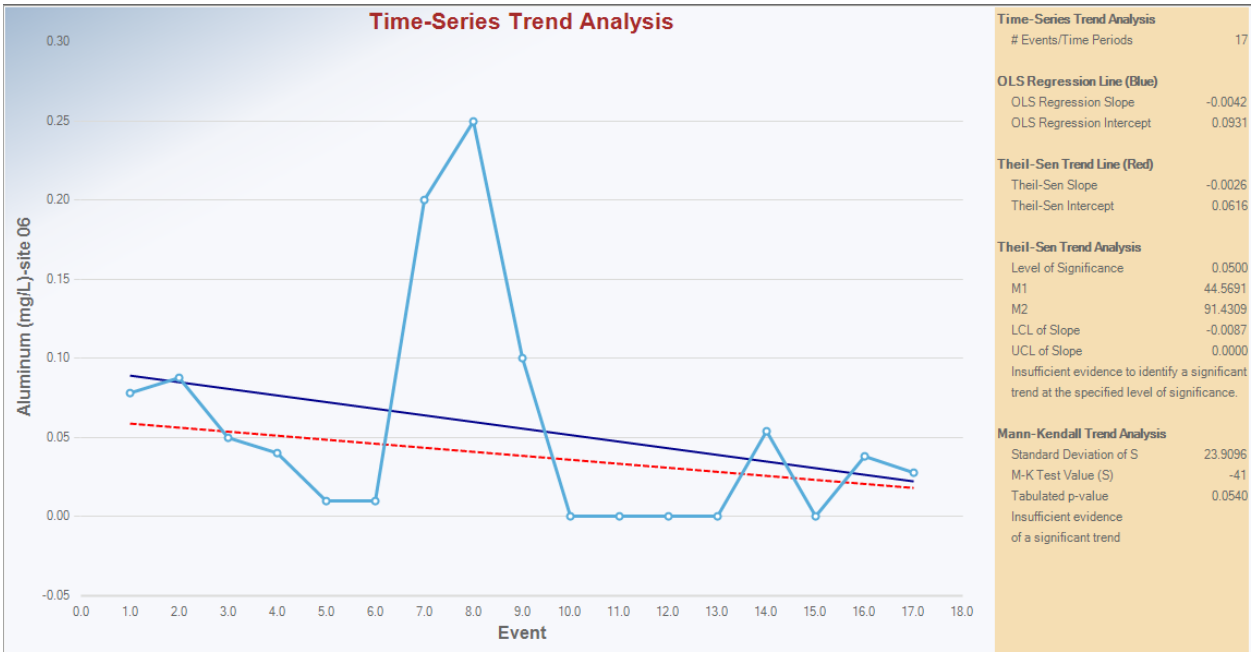
Site 4:


Time-Series Trend Analysis
Aluminum (mg/L)-site 04
Event
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0
Time-Series Trend Analysis
Events/Time Periods 18
OLS Regression Line (Blue)
OLS Regression Slope -0.0139
OLS Regression Intercept 0.2536
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0057
Theil-Sen Intercept 0.1346
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 51.0079
M2 101.9921
LCL of Slope -0.0218
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 26.0128
M-K Test Value (S) -44
Tabulated p-value 0.0480
Significant evidence of a decreasing trend

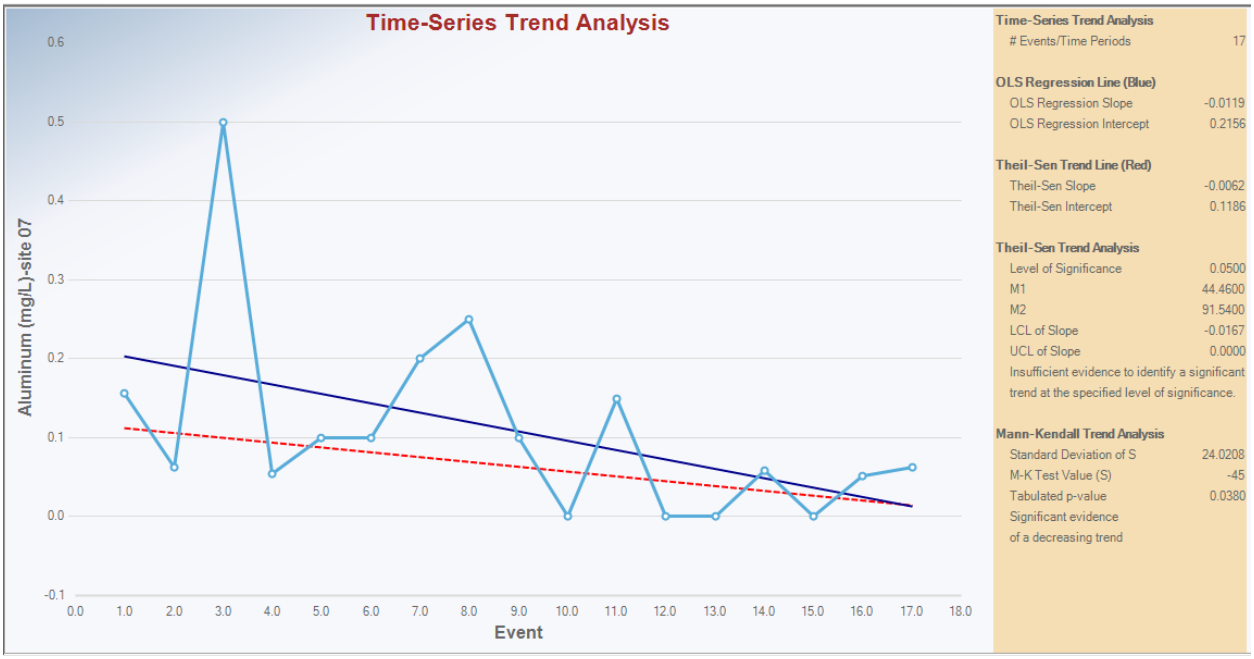
Site 5:


Time-Series Trend Analysis
Aluminum (mg/L)-site 05
Event
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0
Time-Series Trend Analysis
Events/Time Periods 16
OLS Regression Line (Blue)
OLS Regression Slope -0.0285
OLS Regression Intercept 0.4034
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0108
Theil-Sen Intercept 0.1916
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 38.5073
M2 81.4927
LCL of Slope -0.0382
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 21.9317
M-K Test Value (S) -45
Tabulated p-value 0.0260
Significant evidence of a decreasing trend

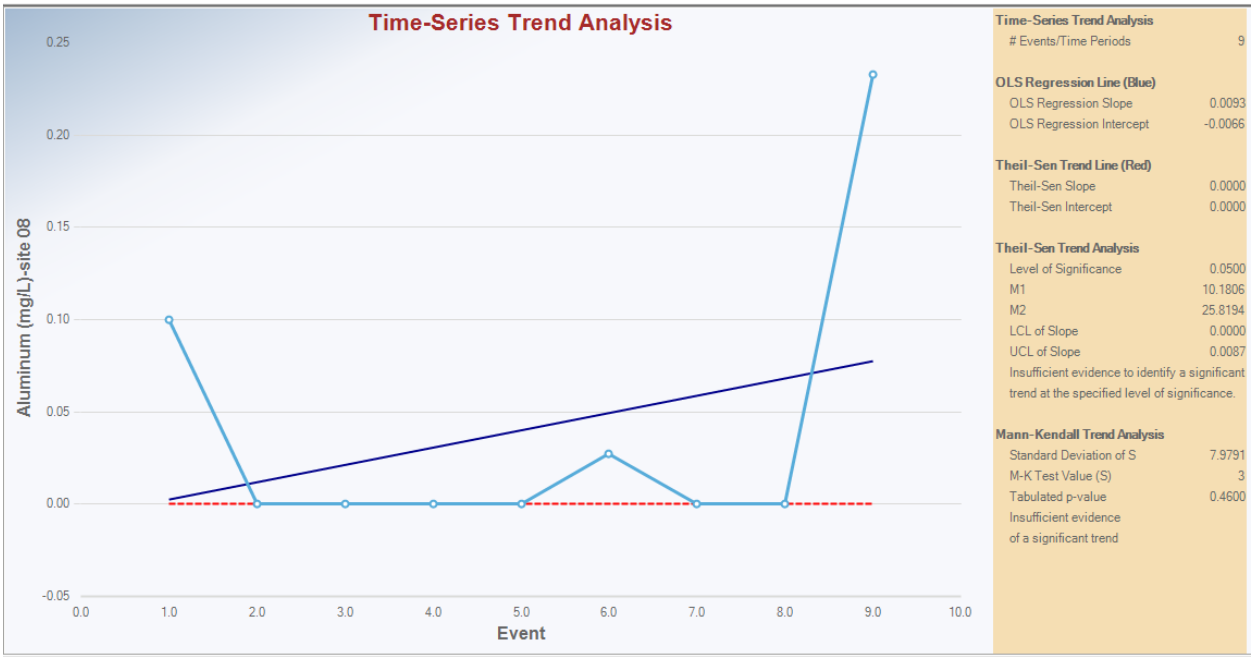
Site 6:


Time-Series Trend Analysis
Aluminum (mg/L)-site 06
Event
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0
Time-Series Trend Analysis
Events/Time Periods 17
OLS Regression Line (Blue)
OLS Regression Slope -0.0042
OLS Regression Intercept 0.0931
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0026
Theil-Sen Intercept 0.0616
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 44.5691
M2 91.4309
LCL of Slope -0.0087
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 23.9096
M-K Test Value (S) -41
Tabulated p-value 0.0540
Insufficient evidence of a significant trend

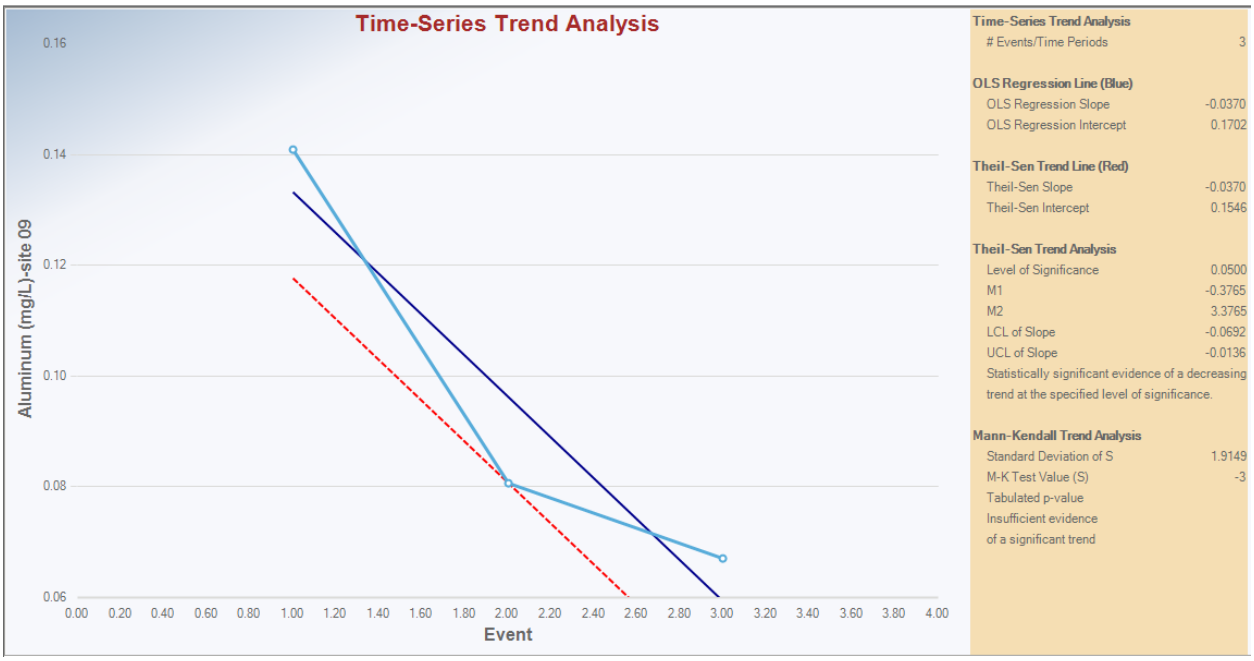
Site 7:


Time-Series Trend Analysis
Aluminum (mg/L)-site 07
Event
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0
Time-Series Trend Analysis
Events/Time Periods 17
OLS Regression Line (Blue)
OLS Regression Slope -0.0119
OLS Regression Intercept 0.2156
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0062
Theil-Sen Intercept 0.1186
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 44.4600
M2 91.5400
LCL of Slope -0.0167
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 24.0208
M-K Test Value (S) -45
Tabulated p-value 0.0380
Significant evidence of a decreasing trend

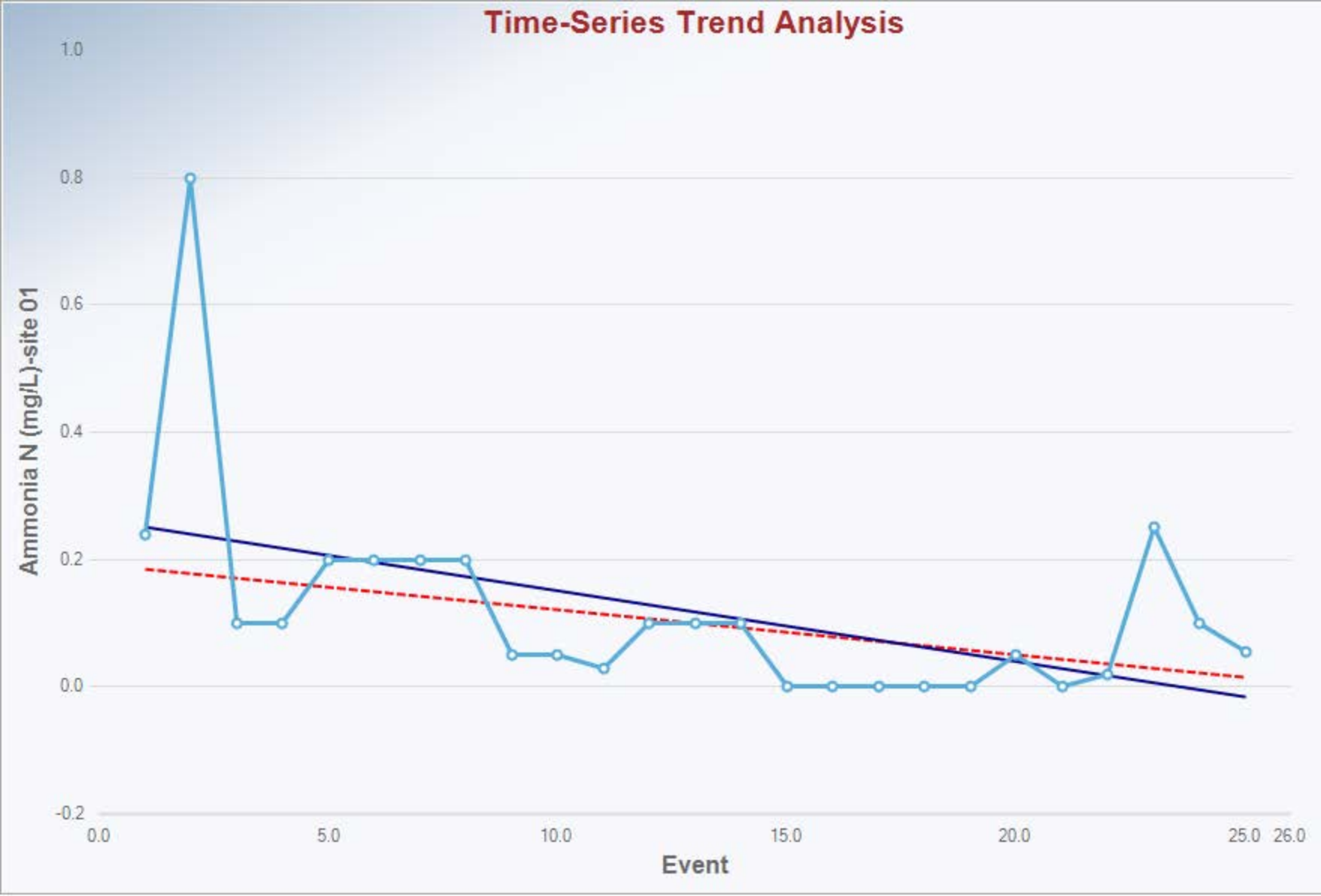
Site 8:


Time-Series Trend Analysis
Aluminum (mg/L)-site 08
Event
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Time-Series Trend Analysis
Events/Time Periods 9
OLS Regression Line (Blue)
OLS Regression Slope 0.0093
OLS Regression Intercept -0.0066
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0000
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 10.1806
M2 25.8194
LCL of Slope 0.0000
UCL of Slope 0.0087
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 7.9791
M-K Test Value (S) 3
Tabulated p-value 0.4600
Insufficient evidence of a significant trend

Site 9:


Time-Series Trend Analysis
Aluminum (mg/L)-site 09
Event
0.16
0.14
0.12
0.10
0.08
0.06
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.20 2.40 2.60 2.80 3.00 3.20 3.40 3.60 3.80 4.00
Time-Series Trend Analysis
Events/Time Periods 3
OLS Regression Line (Blue)
OLS Regression Slope -0.0370
OLS Regression Intercept 0.1702
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0370
Theil-Sen Intercept 0.1546
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 -0.3765
M2 3.3765
LCL of Slope -0.0692
UCL of Slope -0.0136
Statistically significant evidence of a decreasing trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 1.9149
M-K Test Value (S) -3
Tabulated p-value
Insufficient evidence of a significant trend

Ammonia Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0111
OLS Regression Intercept	0.2619

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0071
Theil-Sen Intercept	0.1929

Theil-Sen Trend Analysis

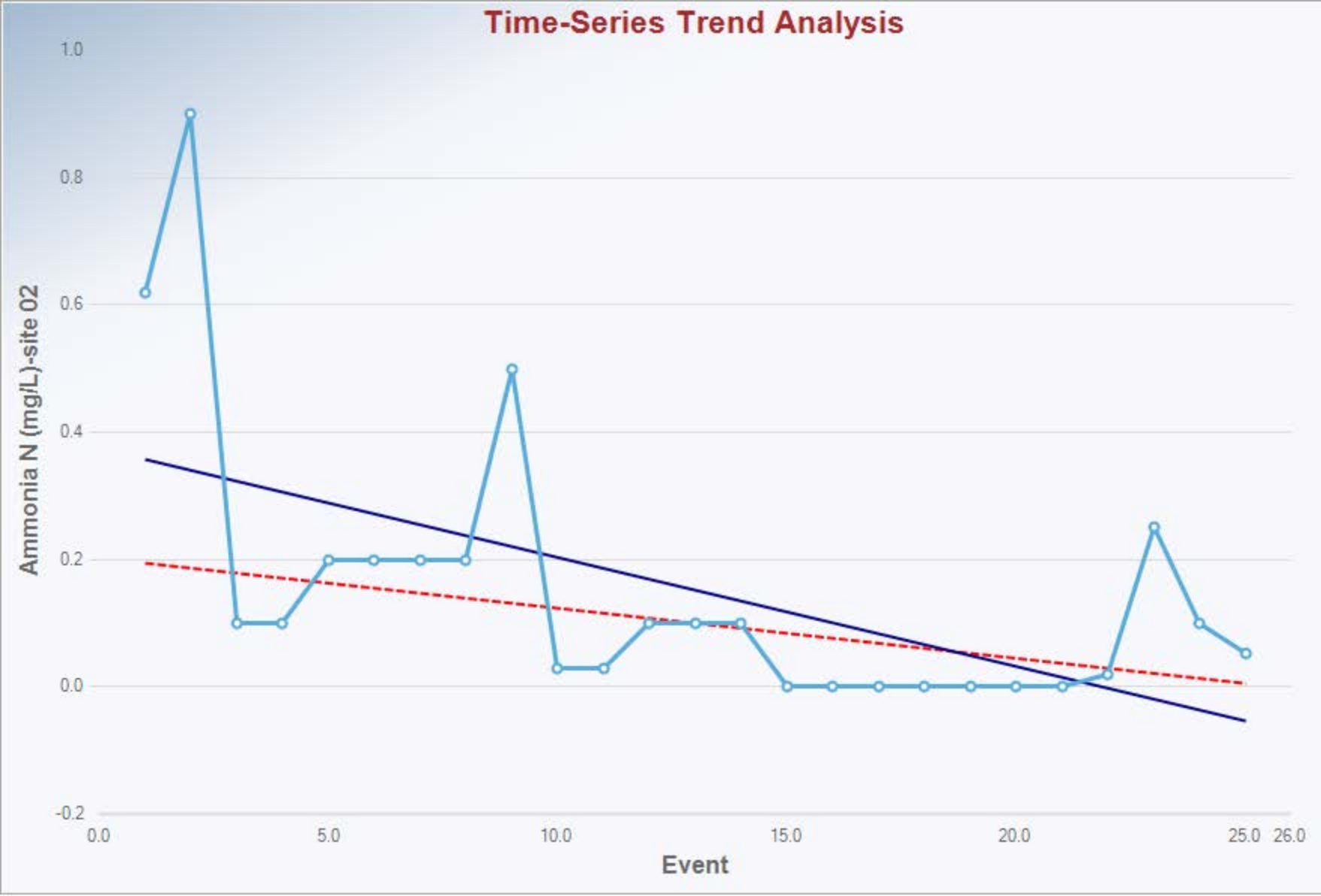
Level of Significance	0.0500
M1	108.8369
M2	191.1631
LCL of Slope	-0.0117
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.0040
M-K Standardized Val (S)	-2.7140
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0033

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0171
OLS Regression Intercept	0.3739

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0079
Theil-Sen Intercept	0.2023

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	108.9927
M2	191.0073
LCL of Slope	-0.0167
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8450
M-K Standardized Val (S)	-2.9155
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0018

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0072
OLS Regression Intercept	0.1894

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0050
Theil-Sen Intercept	0.1150

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	109.0357
M2	190.9643
LCL of Slope	-0.0100
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8011
M-K Standardized Val (S)	-2.5597
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0052

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0103
OLS Regression Intercept	0.2446

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0074
Theil-Sen Intercept	0.1962

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	108.9927
M2	191.0073
LCL of Slope	-0.0143
UCL of Slope	-0.0012

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8450
M-K Standardized Val (S)	-3.0589
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0011

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0060
OLS Regression Intercept	0.1654

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0049
Theil-Sen Intercept	0.1135

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	109.0357
M2	190.9643
LCL of Slope	-0.0105
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8011
M-K Standardized Val (S)	-2.7990
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0026

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0050
OLS Regression Intercept	0.1459

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0043
Theil-Sen Intercept	0.1057

Theil-Sen Trend Analysis

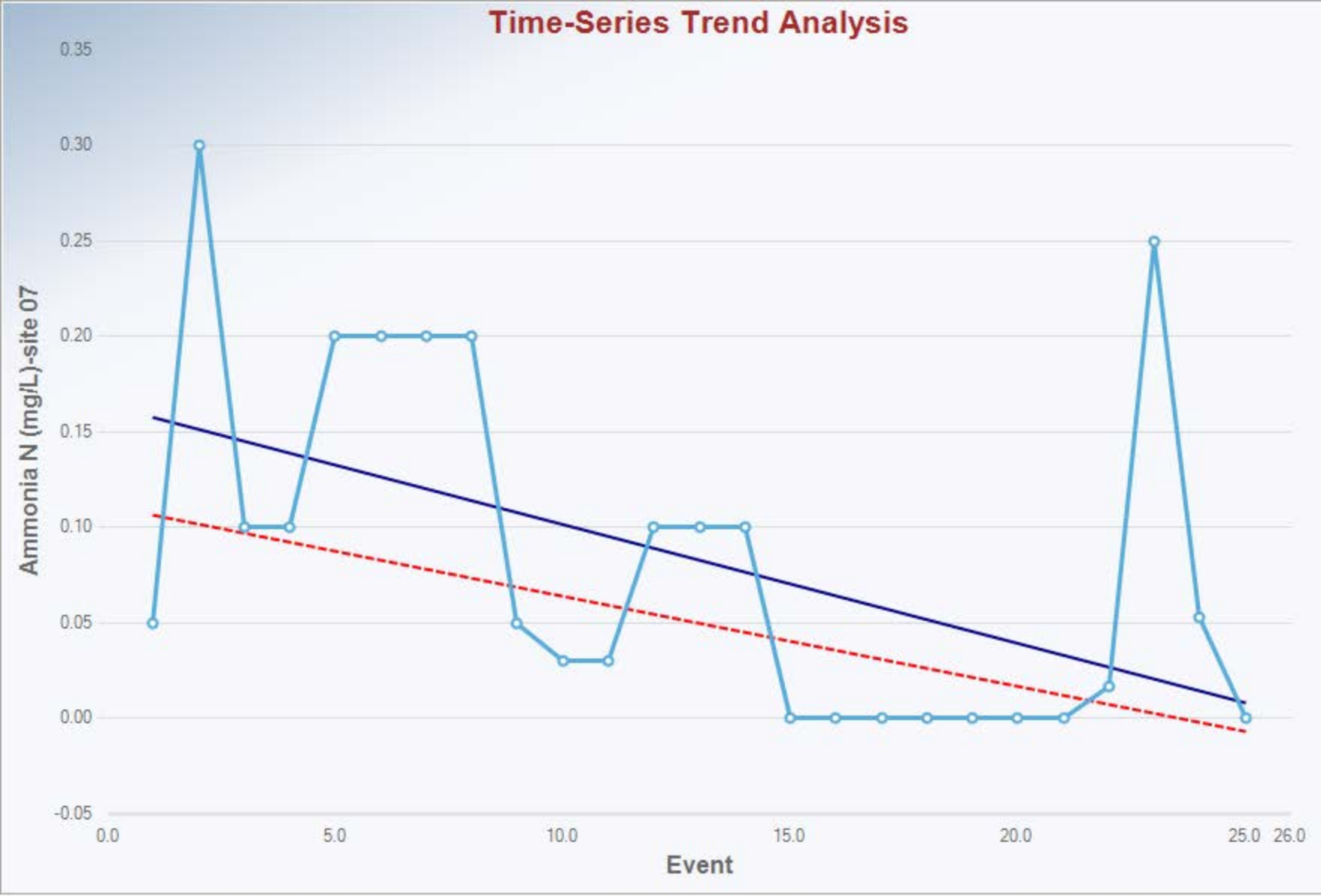
Level of Significance	0.0500
M1	109.3455
M2	190.6545
LCL of Slope	-0.0088
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.4849
M-K Standardized Val (S)	-2.6034
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0046

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0062
OLS Regression Intercept	0.1643

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0047
Theil-Sen Intercept	0.1115

Theil-Sen Trend Analysis

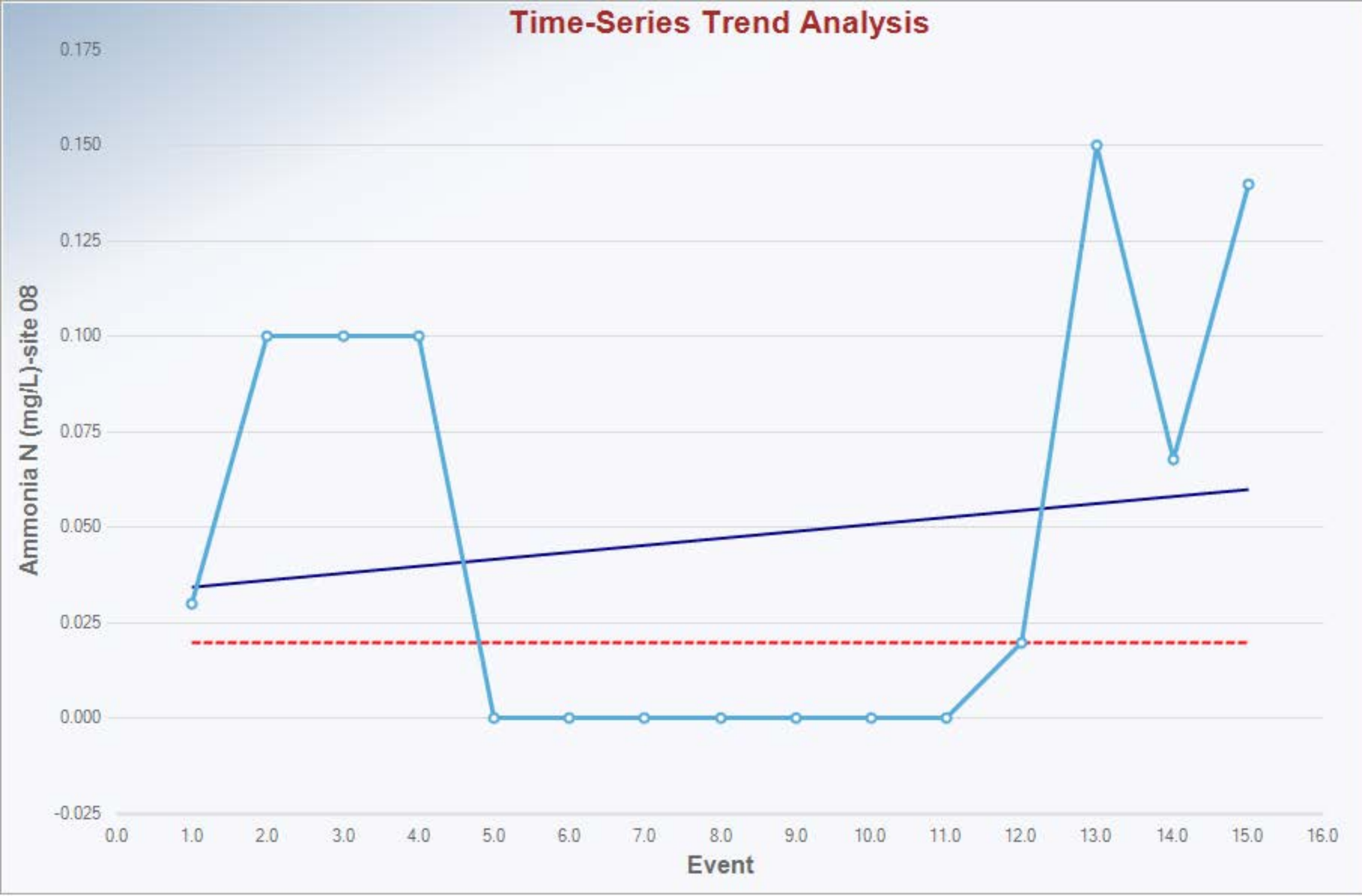
Level of Significance	0.0500
M1	109.1139
M2	190.8861
LCL of Slope	-0.0100
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.7213
M-K Standardized Val (S)	-2.8523
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0022

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	15

OLS Regression Line (Blue)

OLS Regression Slope	0.0018
OLS Regression Intercept	0.0327

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0200

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	33.8975
M2	71.1025
LCL of Slope	-0.0030
UCL of Slope	0.0051

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	18.9824
M-K Test Value (S)	7
Tabulated p-value	0.3850

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	9

OLS Regression Line (Blue)

OLS Regression Slope	0.0057
OLS Regression Intercept	0.0772

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0039
Theil-Sen Intercept	0.0804

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	8.6516
M2	27.3484
LCL of Slope	-0.0226
UCL of Slope	0.0256

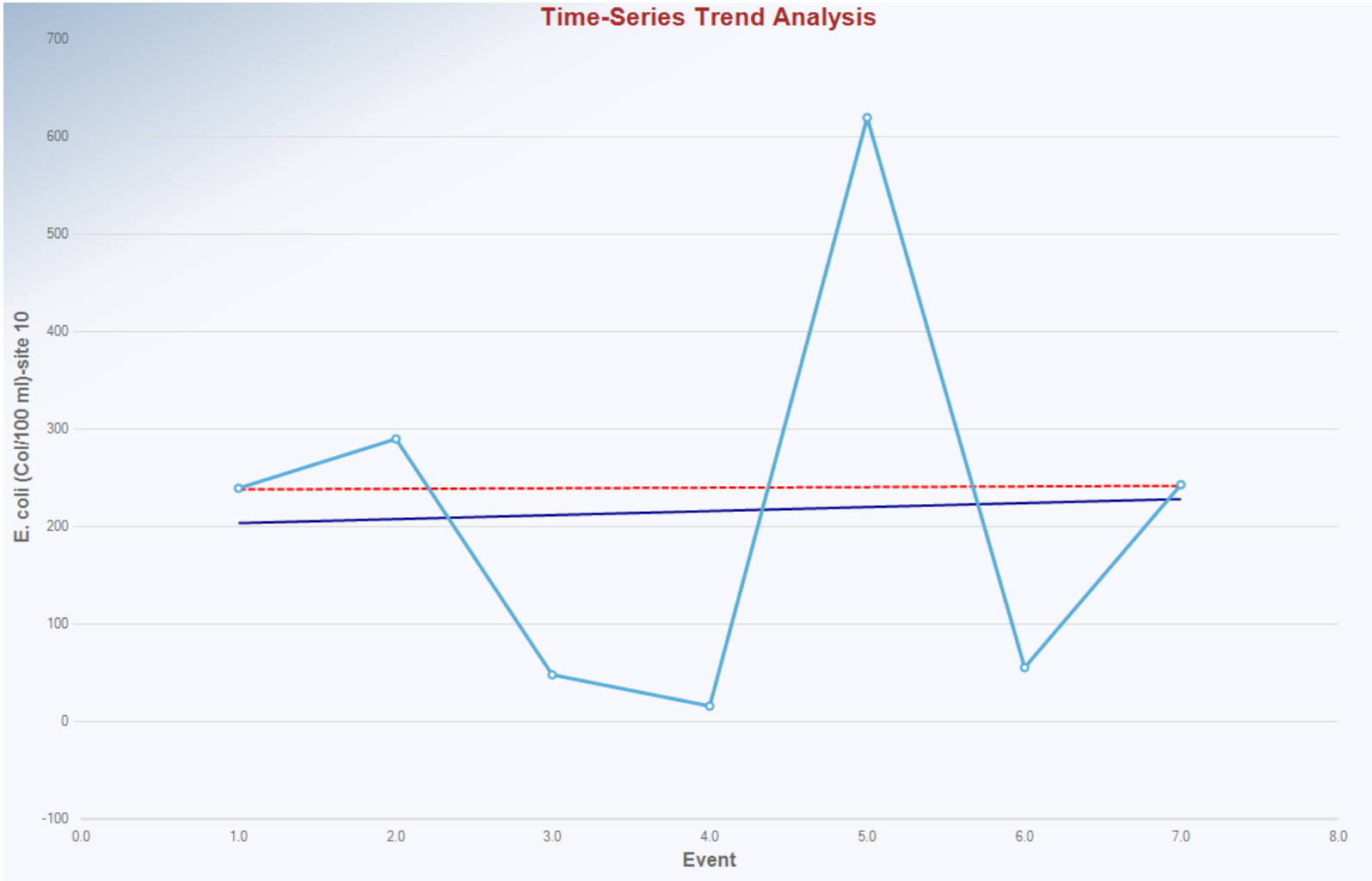
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	9.5394
M-K Test Value (S)	3
Tabulated p-value	0.4600

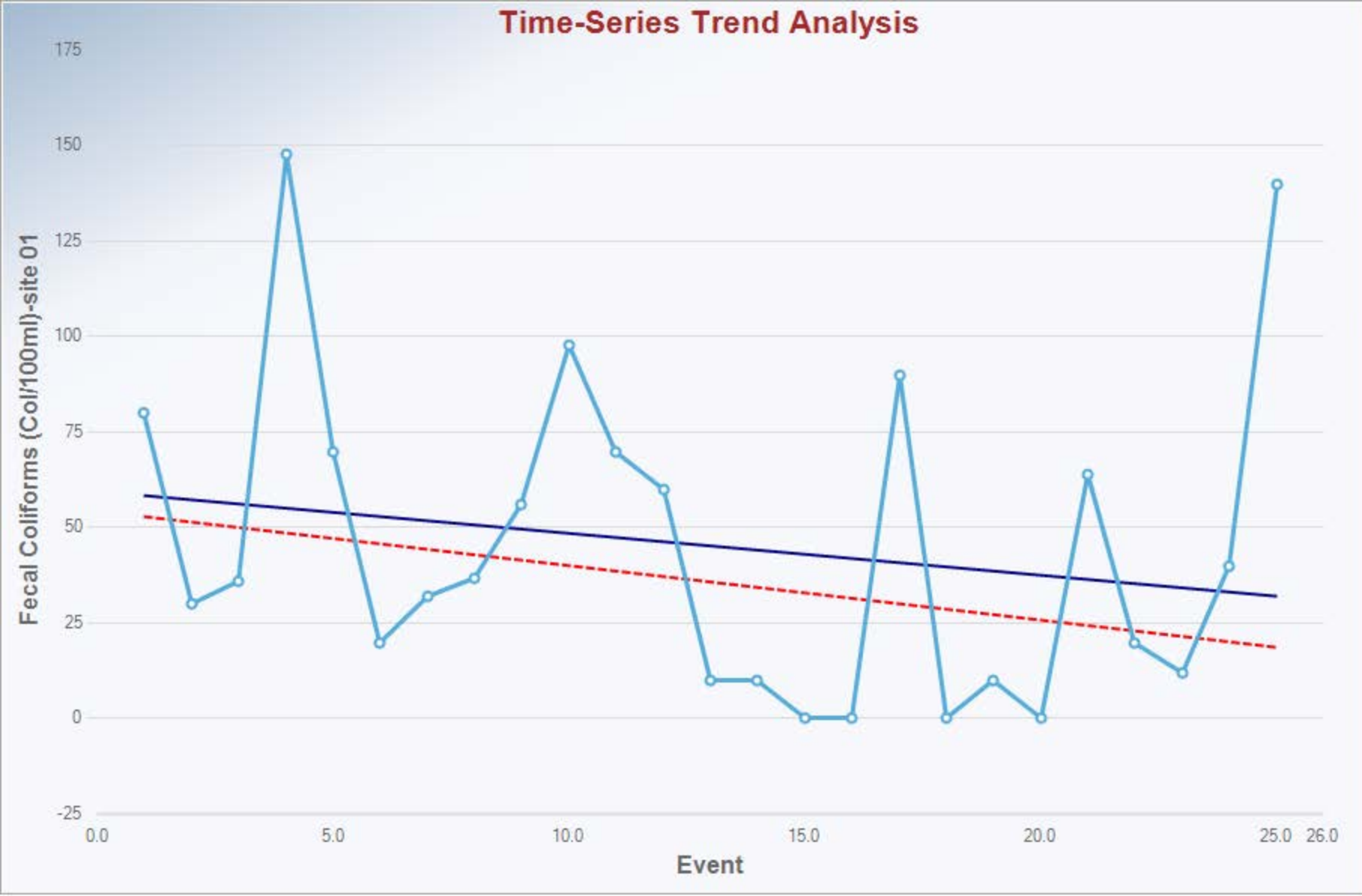
Insufficient evidence of a significant trend

Trend Graph – E. coli in Surface Water (2015-2024)
Station 10



Time-Series Trend Analysis	
# Events/Time Periods	7
OLS Regression Line (Blue)	
OLS Regression Slope	3.9643
OLS Regression Intercept	200.1143
Theil-Sen Trend Line (Red)	
Theil-Sen Slope	0.5000
Theil-Sen Intercept	238.0000
Theil-Sen Trend Analysis	
Level of Significance	0.0500
M1	3.9750
M2	17.0250
LCL of Slope	-138.3871
UCL of Slope	95.3756
Insufficient evidence to identify a significant trend at the specified level of significance.	
Mann-Kendall Trend Analysis	
Standard Deviation of S	6.6583
M-K Test Value (S)	1
Tabulated p-value	0.5000
Insufficient evidence of a significant trend	

Fecal Coliforms Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-1.0885
OLS Regression Intercept	59.4700

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-1.4286
Theil-Sen Intercept	54.5714

Theil-Sen Trend Analysis

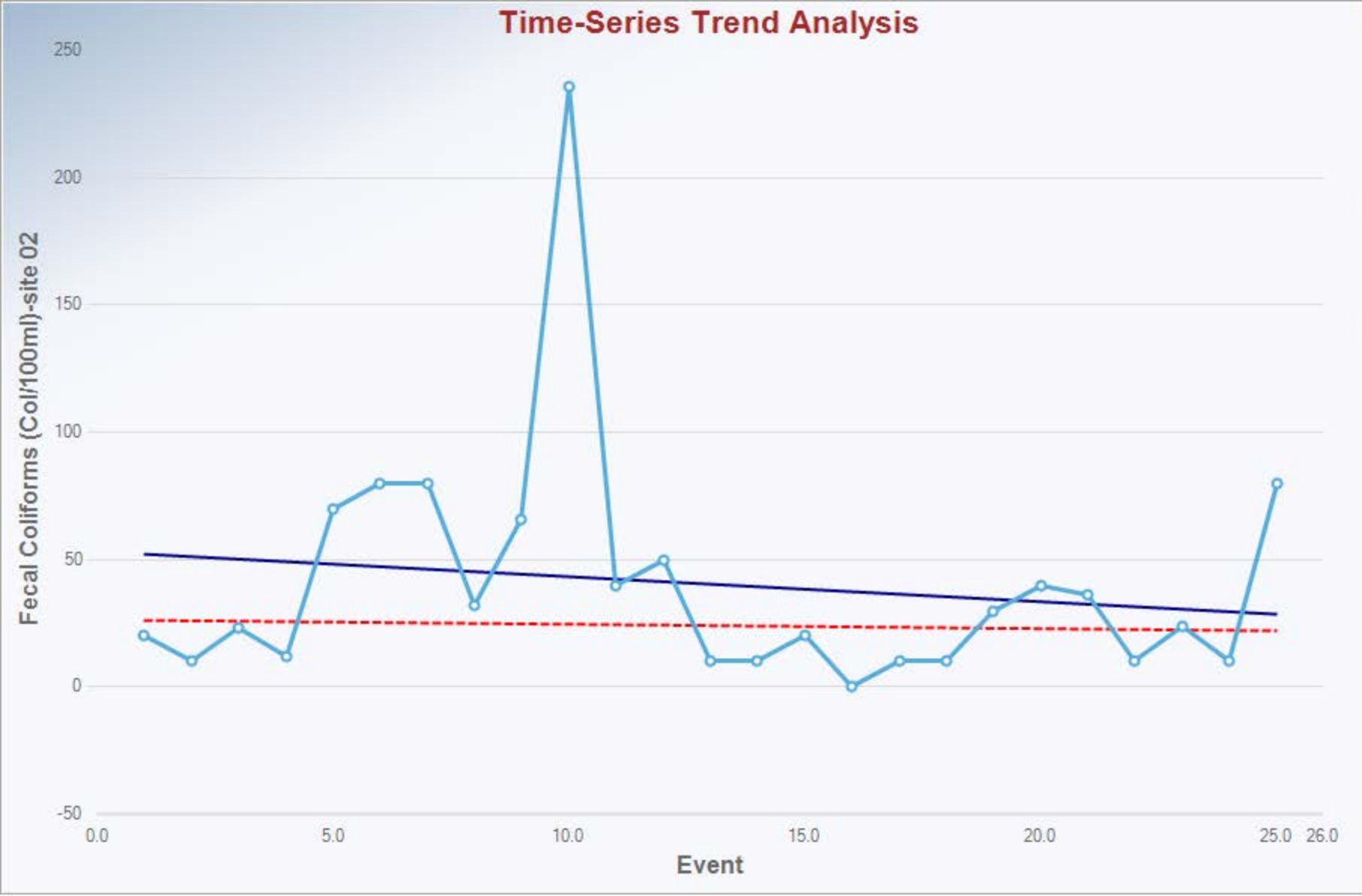
Level of Significance	0.0500
M1	108.2040
M2	191.7960
LCL of Slope	-3.1429
UCL of Slope	0.5995

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.6497
M-K Standardized Val (S)	-1.1723
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1205

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.9708
OLS Regression Intercept	52.9800

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1678
Theil-Sen Intercept	26.1818

Theil-Sen Trend Analysis

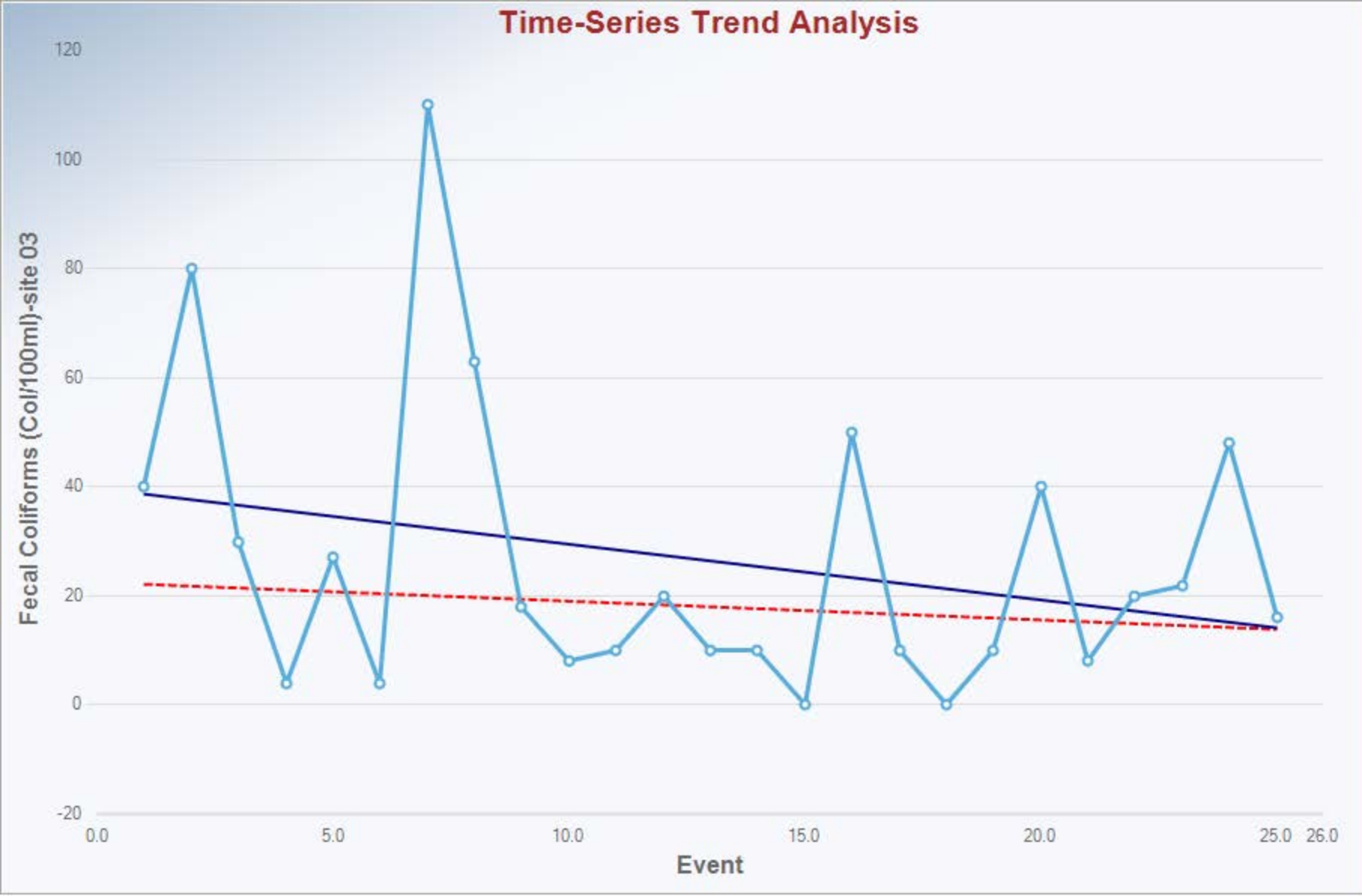
Level of Significance	0.0500
M1	108.6158
M2	191.3842
LCL of Slope	-2.5982
UCL of Slope	0.7242

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.2295
M-K Standardized Val (S)	-0.7814
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2173

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-1.0208
OLS Regression Intercept	39.5900

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.3485
Theil-Sen Intercept	22.5303

Theil-Sen Trend Analysis

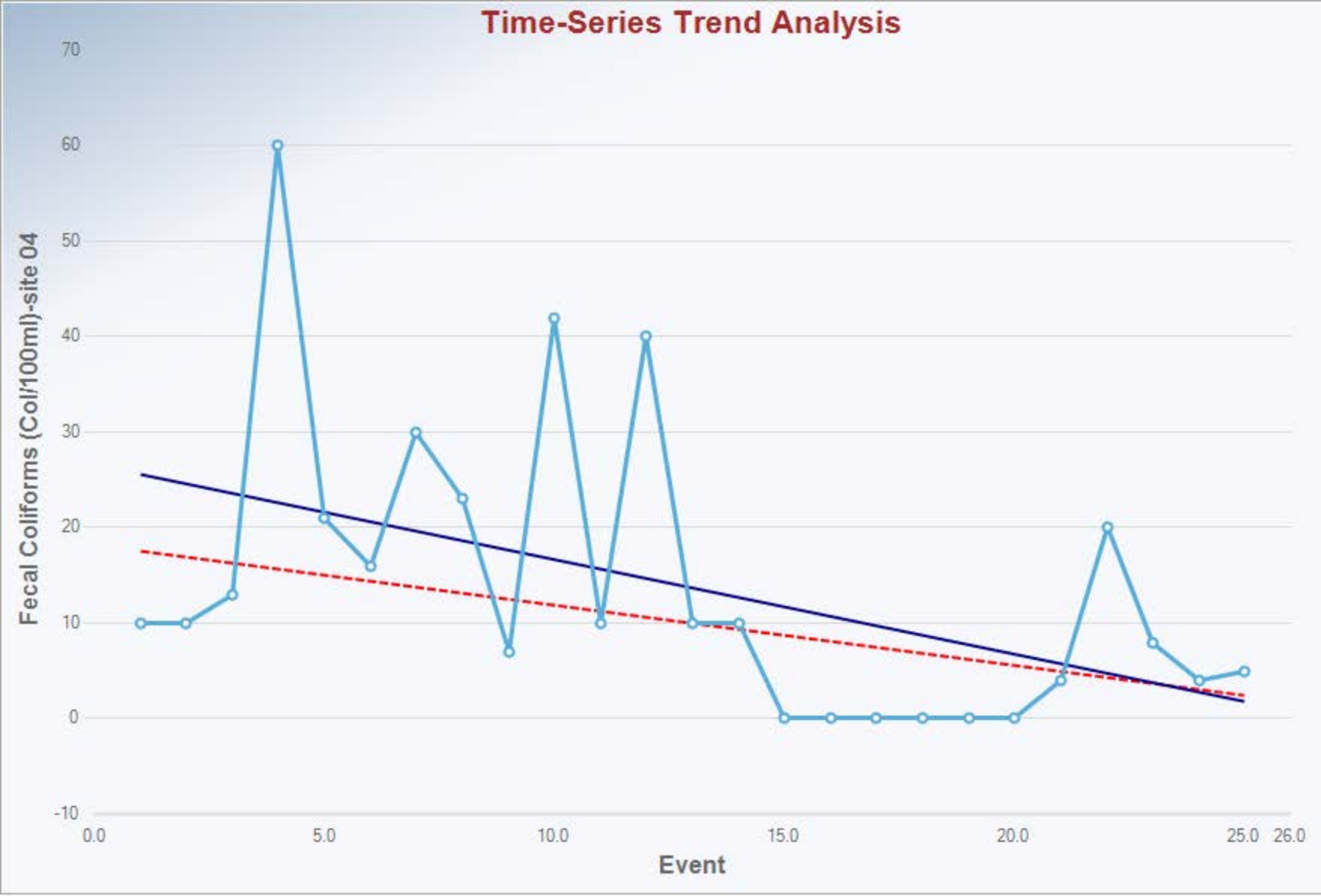
Level of Significance	0.0500
M1	108.2884
M2	191.7116
LCL of Slope	-2.0000
UCL of Slope	0.5639

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.5637
M-K Standardized Val (S)	-0.7518
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2261

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.9869
OLS Regression Intercept	26.5500

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.6250
Theil-Sen Intercept	18.1250

Theil-Sen Trend Analysis

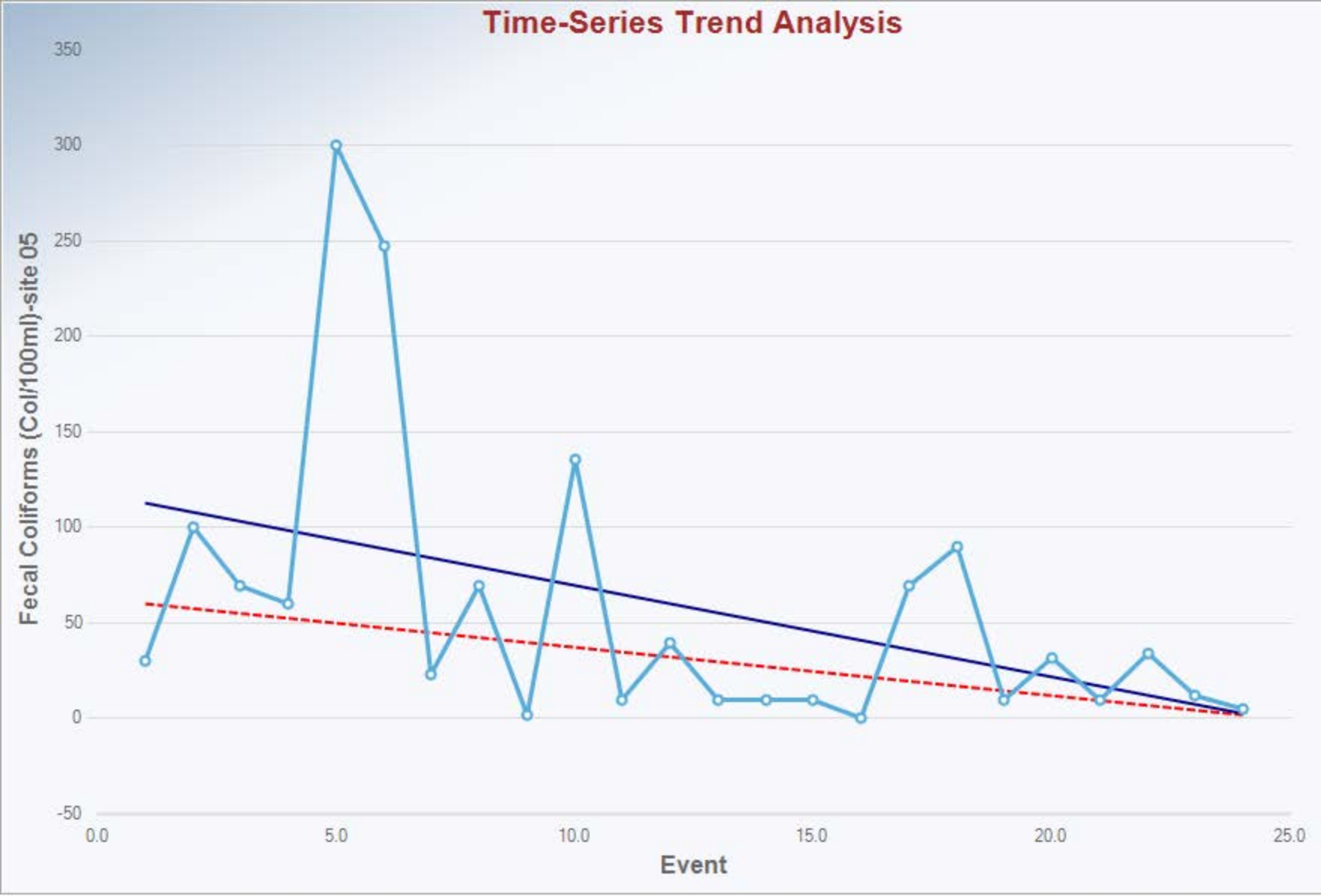
Level of Significance	0.0500
M1	108.5694
M2	191.4306
LCL of Slope	-1.3750
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.2769
M-K Standardized Val (S)	-2.4836
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0065

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	24

OLS Regression Line (Blue)

OLS Regression Slope	-4.7861
OLS Regression Intercept	117.4094

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-2.5132
Theil-Sen Intercept	62.4145

Theil-Sen Trend Analysis

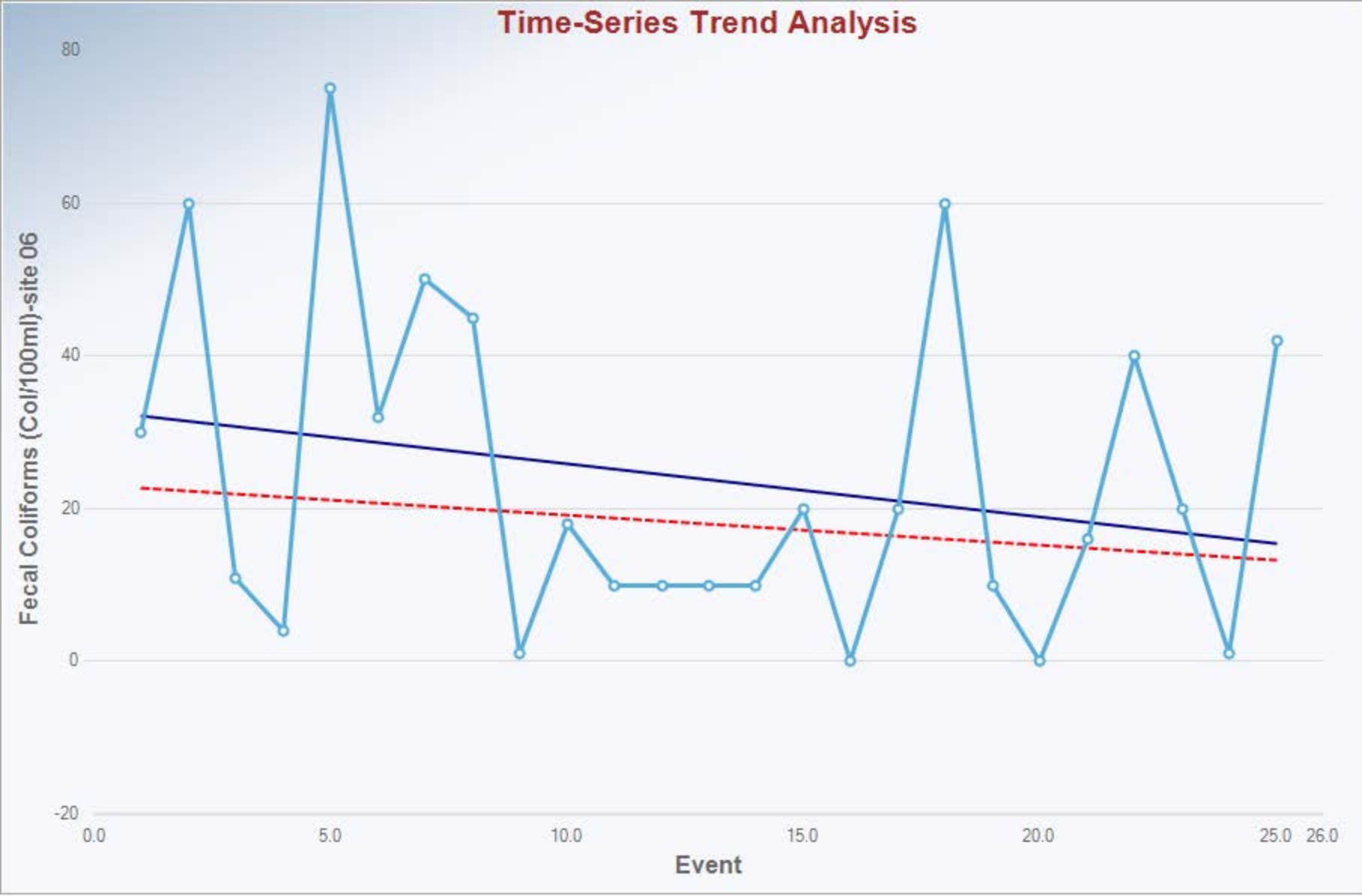
Level of Significance	0.0500
M1	98.8825
M2	177.1175
LCL of Slope	-6.0000
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	39.9166
M-K Standardized Val (S)	-2.1294
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0166

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.7000
OLS Regression Intercept	32.9000

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.4008
Theil-Sen Intercept	23.2103

Theil-Sen Trend Analysis

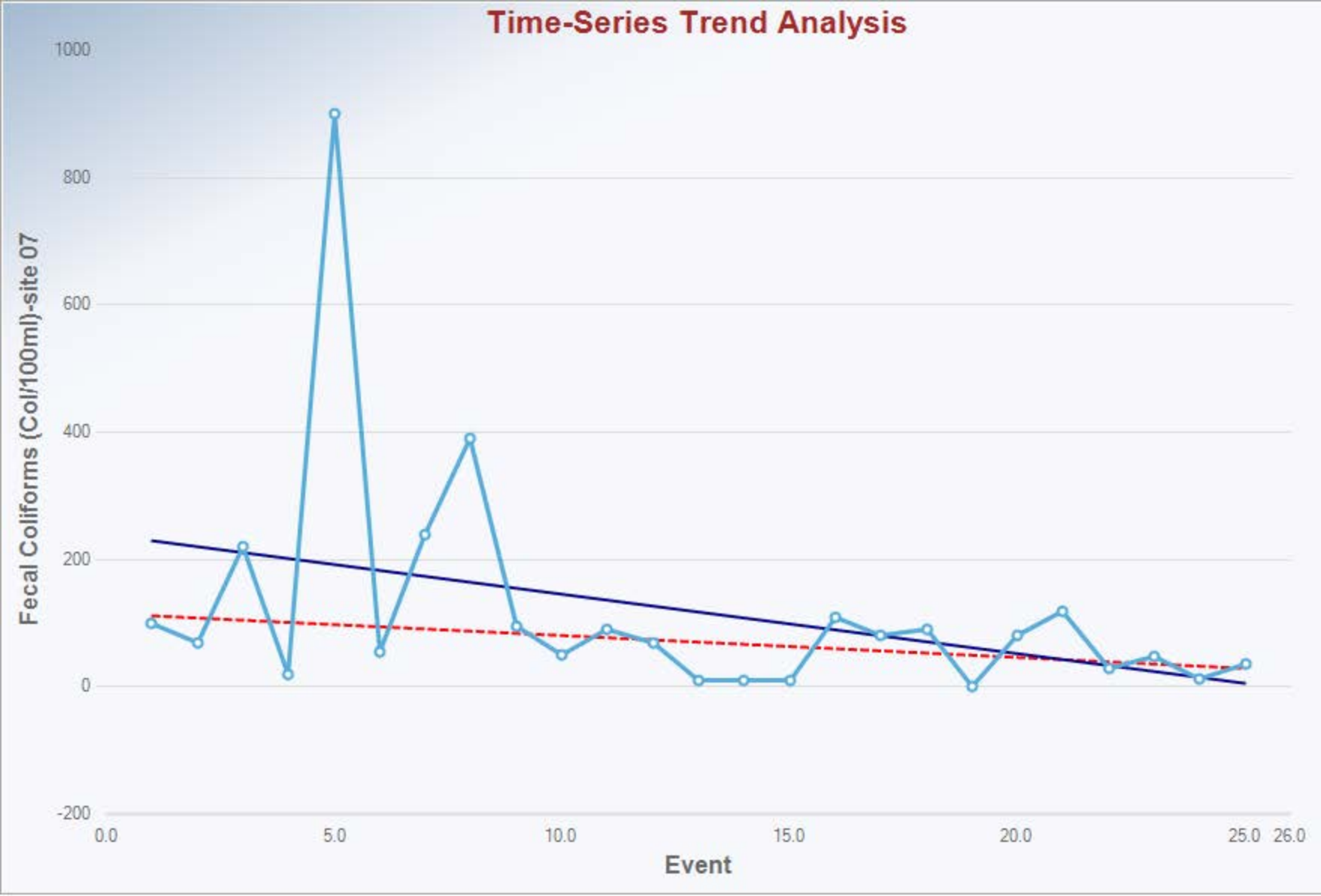
Level of Significance	0.0500
M1	108.3076
M2	191.6924
LCL of Slope	-1.8126
UCL of Slope	0.5182

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.5441
M-K Standardized Val (S)	-0.9637
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1676

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-9.3431
OLS Regression Intercept	239.0600

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-3.4643
Theil-Sen Intercept	115.0357

Theil-Sen Trend Analysis

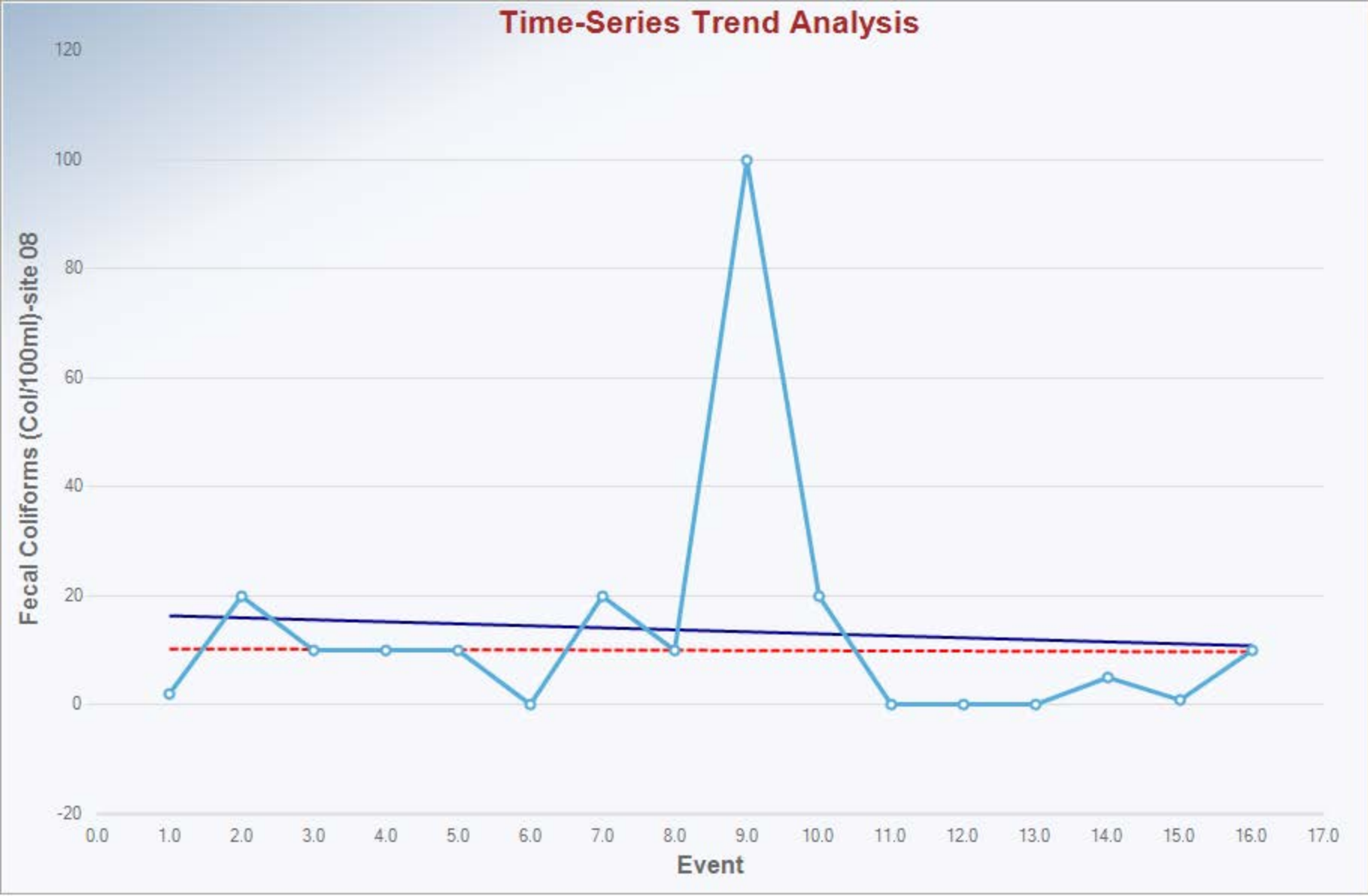
Level of Significance	0.0500
M1	108.1160
M2	191.8840
LCL of Slope	-8.6667
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.7395
M-K Standardized Val (S)	-1.9888
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0234

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	-0.3706
OLS Regression Intercept	16.7750

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0357
Theil-Sen Intercept	10.3036

Theil-Sen Trend Analysis

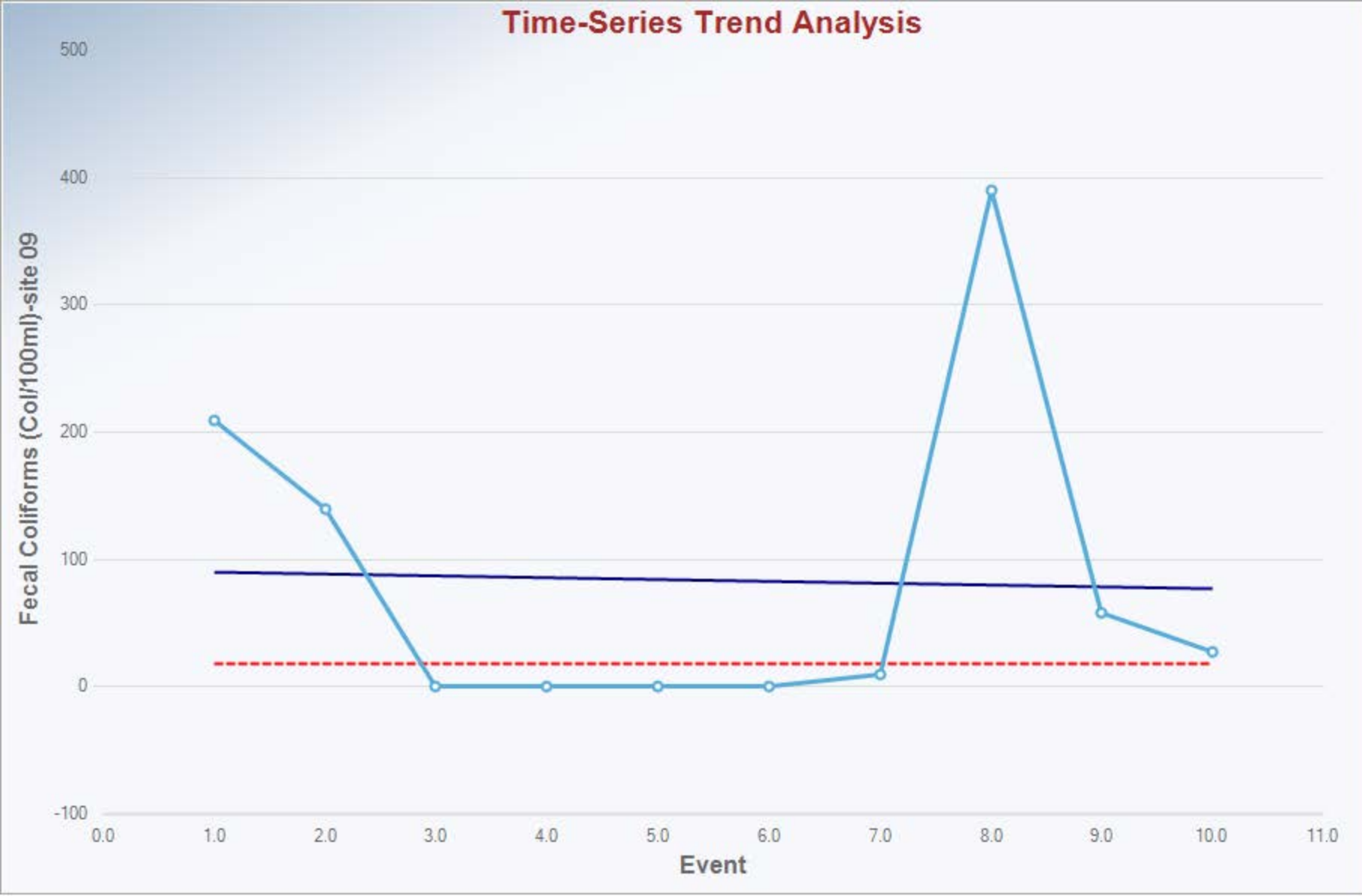
Level of Significance	0.0500
M1	38.8830
M2	81.1170
LCL of Slope	-1.3024
UCL of Slope	0.2330

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	21.5484
M-K Test Value (S)	-19
Tabulated p-value	0.2250

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	-1.4606
OLS Regression Intercept	91.5333

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	18.5000

Theil-Sen Trend Analysis

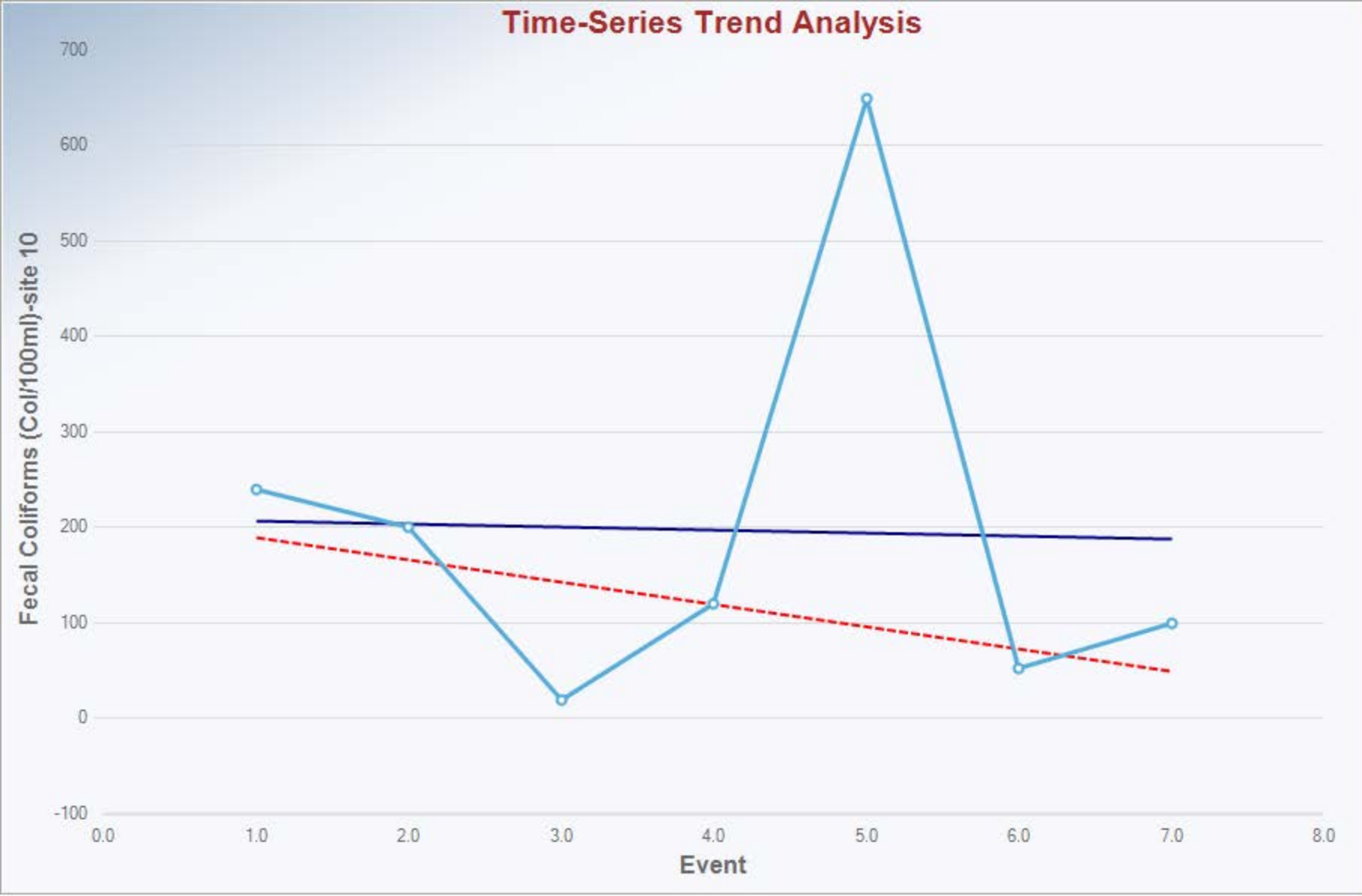
Level of Significance	0.0500
M1	11.9301
M2	33.0699
LCL of Slope	-33.4498
UCL of Slope	9.6900

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	10.7858
M-K Test Value (S)	3
Tabulated p-value	0.4310

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	7

OLS Regression Line (Blue)

OLS Regression Slope	-3.0714
OLS Regression Intercept	209.7143

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-23.3333
Theil-Sen Intercept	213.3333

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	3.9750
M2	17.0250
LCL of Slope	-111.7529
UCL of Slope	100.0626

Insufficient evidence to identify a significant trend at the specified level of significance.

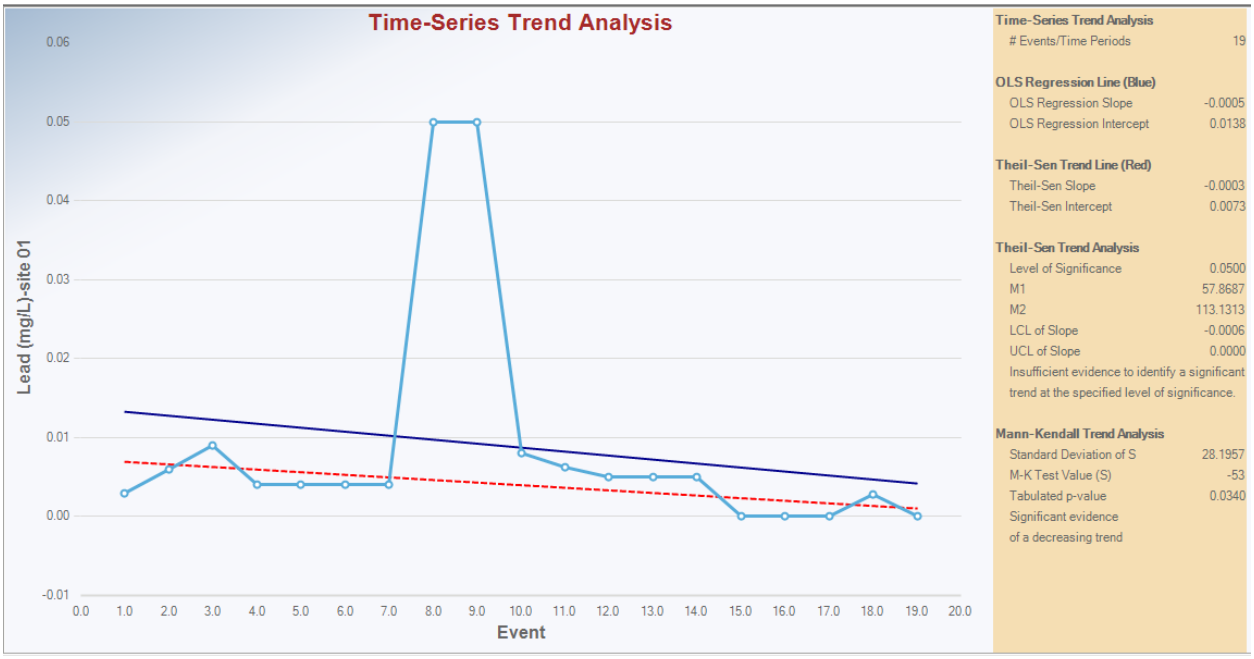
Mann-Kendall Trend Analysis

Standard Deviation of S	6.6583
M-K Test Value (S)	-5
Tabulated p-value	0.2810

Insufficient evidence of a significant trend

Lead graphs

Site 1:



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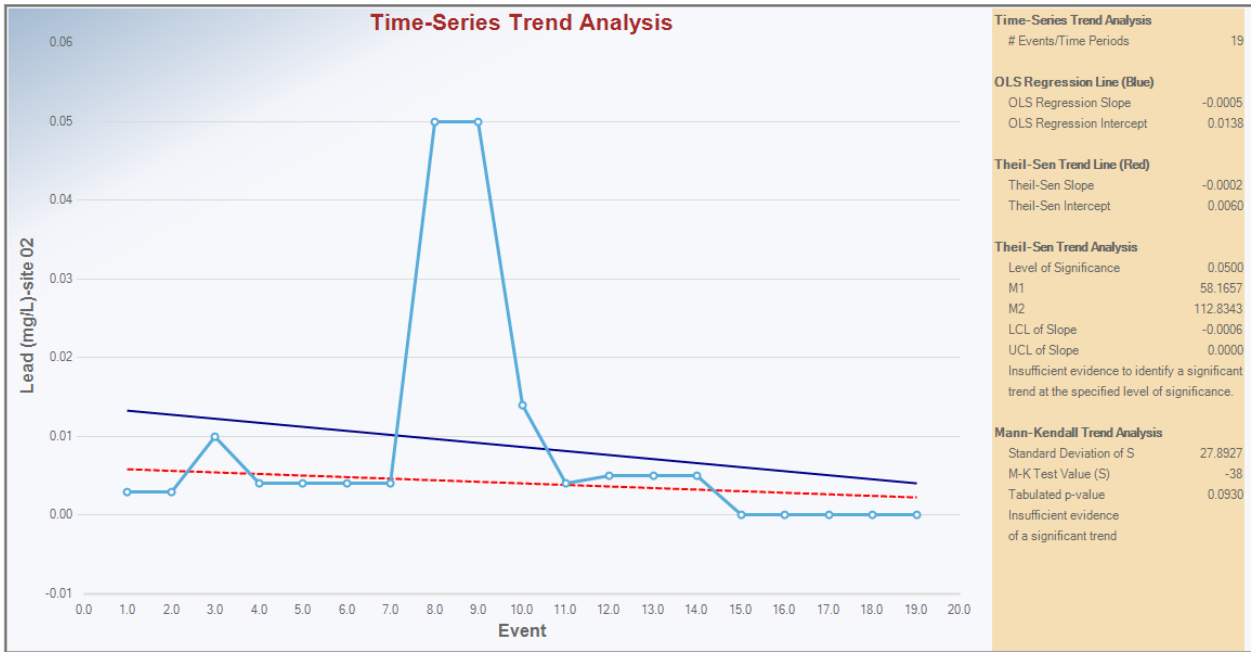

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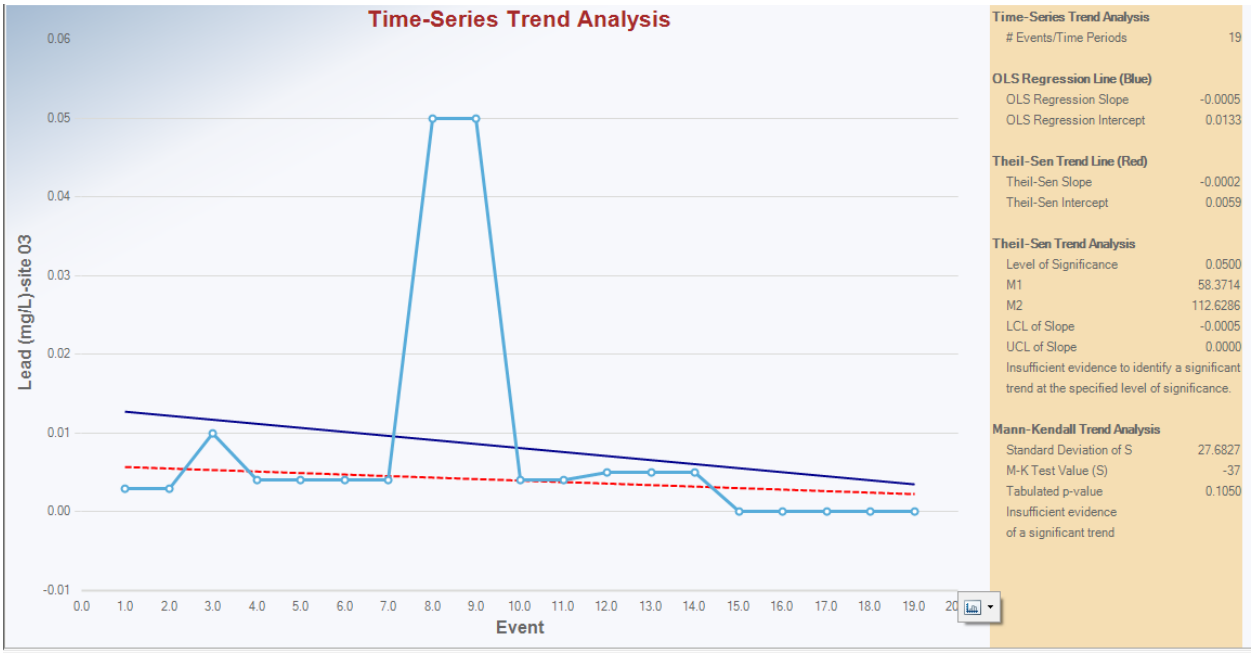
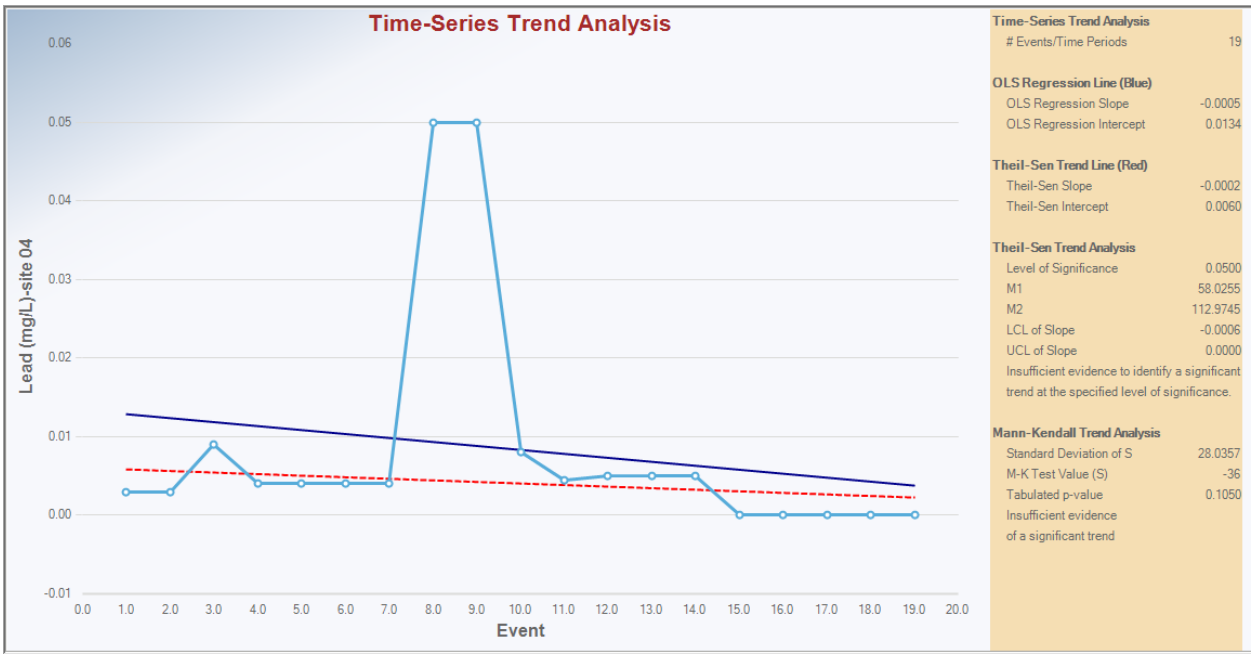
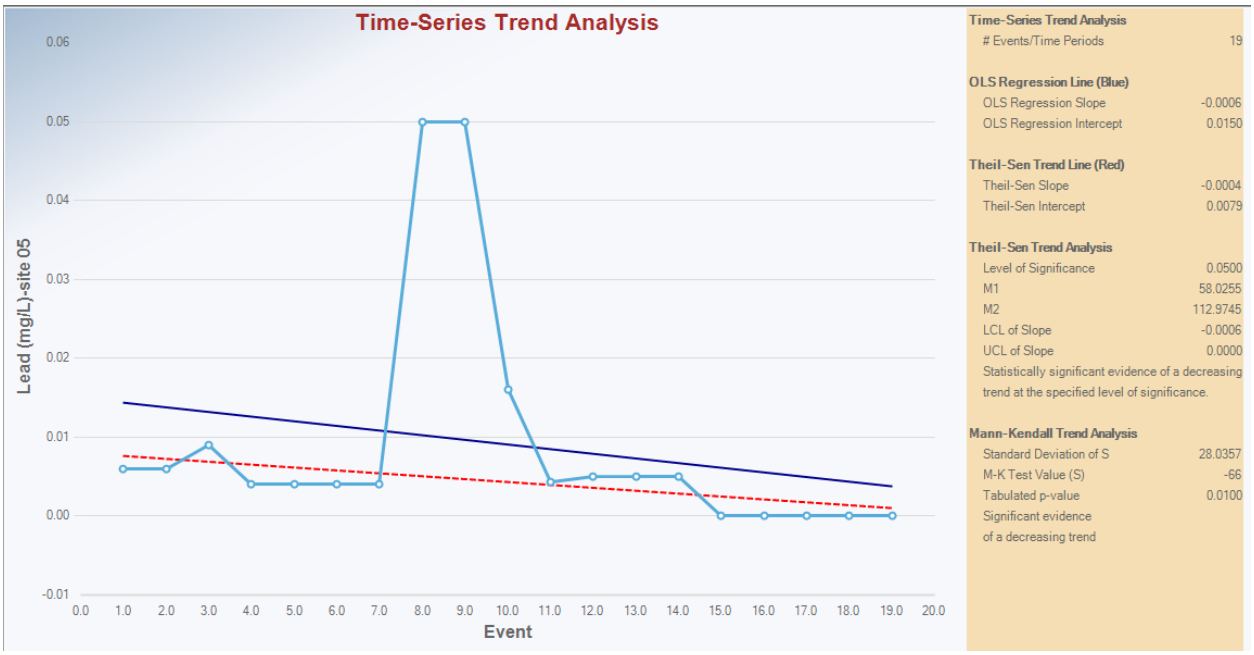

Time-Series Trend Analysis
Lead (mg/L)-site 03
Event
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20
Time-Series Trend Analysis
Events/Time Periods 19
OLS Regression Line (Blue)
OLS Regression Slope -0.0005
OLS Regression Intercept 0.0133
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0002
Theil-Sen Intercept 0.0059
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 58.3714
M2 112.6286
LCL of Slope -0.0005
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 27.6827
M-K Test Value (S) -37
Tabulated p-value 0.1050
Insufficient evidence of a significant trend

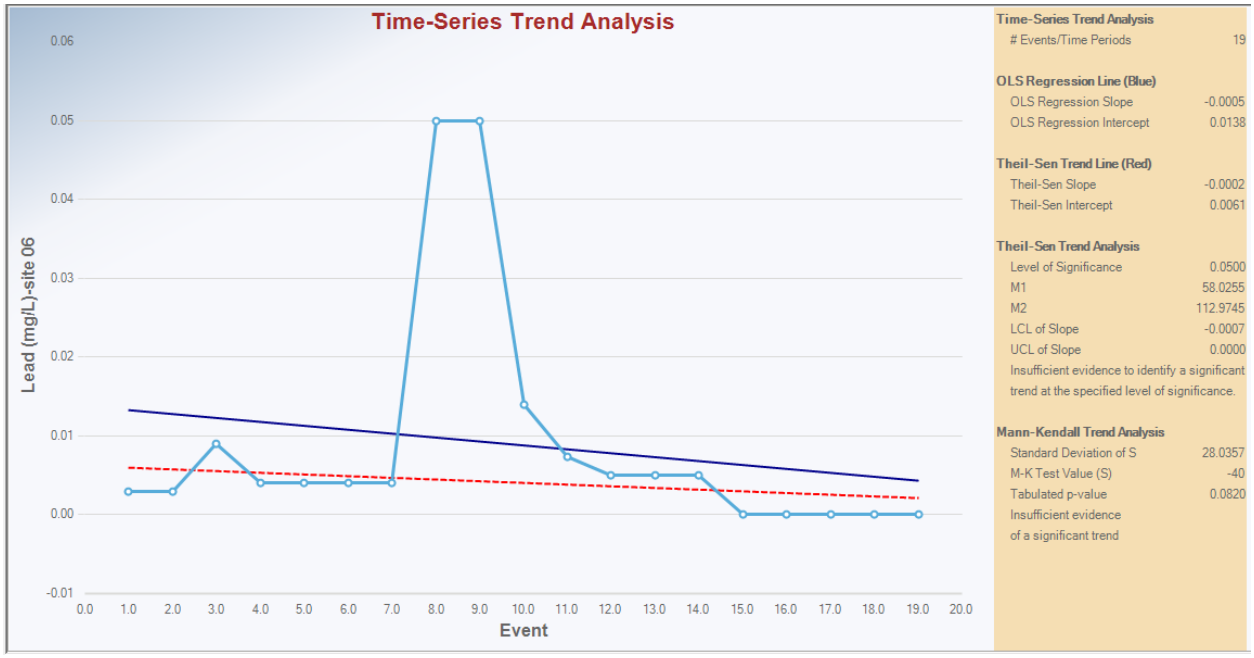
Site 4:


Time-Series Trend Analysis
Lead (mg/L)-site 04
Event
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0
Time-Series Trend Analysis
Events/Time Periods 19
OLS Regression Line (Blue)
OLS Regression Slope -0.0005
OLS Regression Intercept 0.0134
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0002
Theil-Sen Intercept 0.0060
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 58.0255
M2 112.9745
LCL of Slope -0.0006
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 28.0357
M-K Test Value (S) -36
Tabulated p-value 0.1050
Insufficient evidence of a significant trend

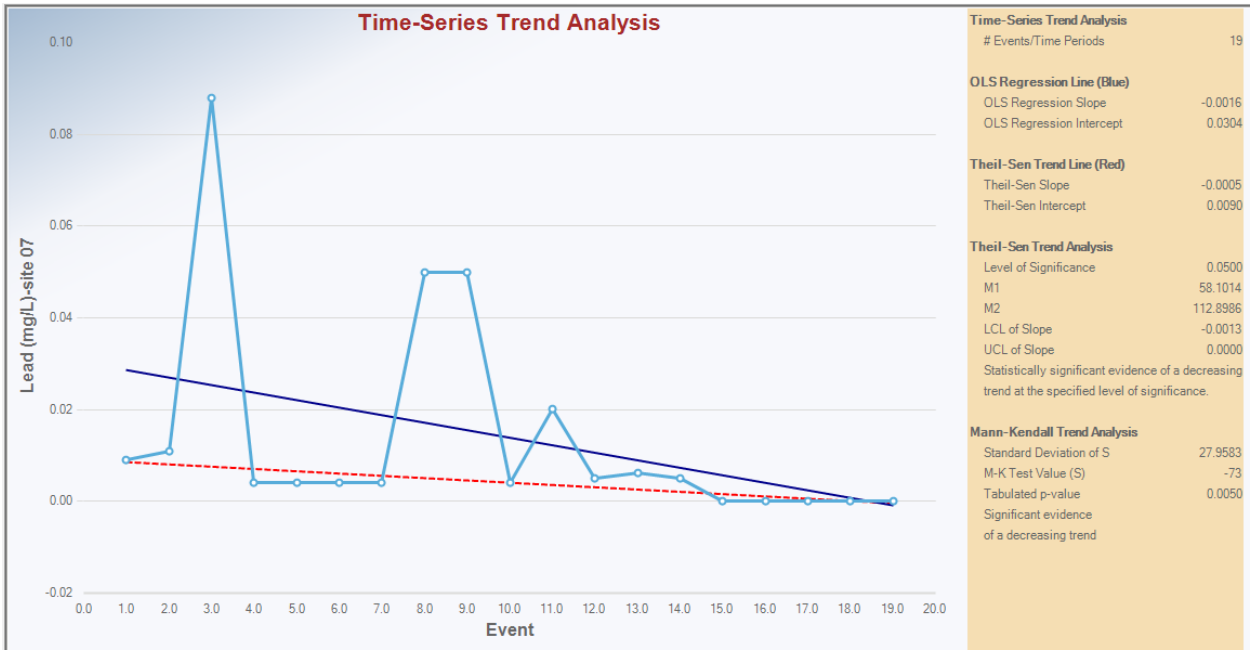
Site 5:


Time-Series Trend Analysis
Lead (mg/L)-site 05
Event
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0
Time-Series Trend Analysis
Events/Time Periods 19
OLS Regression Line (Blue)
OLS Regression Slope -0.0006
OLS Regression Intercept 0.0150
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0004
Theil-Sen Intercept 0.0079
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 58.0255
M2 112.9745
LCL of Slope -0.0006
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 28.0357
M-K Test Value (S) -66
Tabulated p-value 0.0100
Significant evidence of a decreasing trend

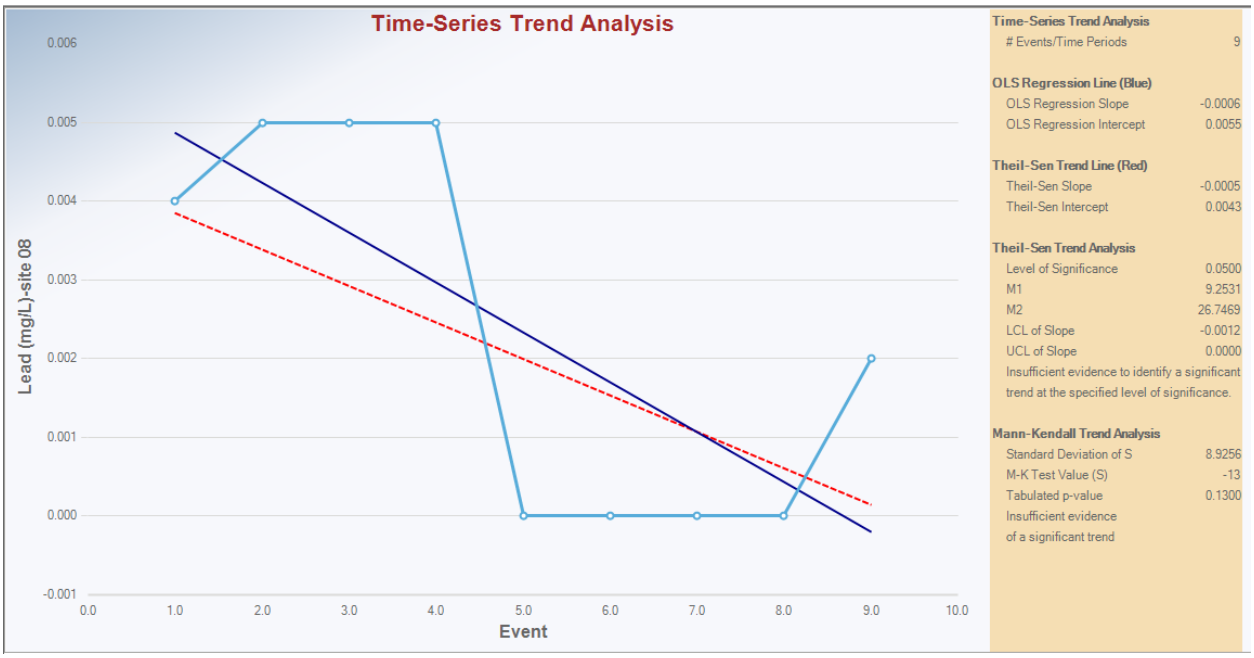
Site 6:


Time-Series Trend Analysis
Lead (mg/L)-site 06
Event
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0
Time-Series Trend Analysis
Events/Time Periods 19
OLS Regression Line (Blue)
OLS Regression Slope -0.0005
OLS Regression Intercept 0.0138
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0002
Theil-Sen Intercept 0.0061
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 58.0255
M2 112.9745
LCL of Slope -0.0007
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 28.0357
M-K Test Value (S) -40
Tabulated p-value 0.0820
Insufficient evidence of a significant trend

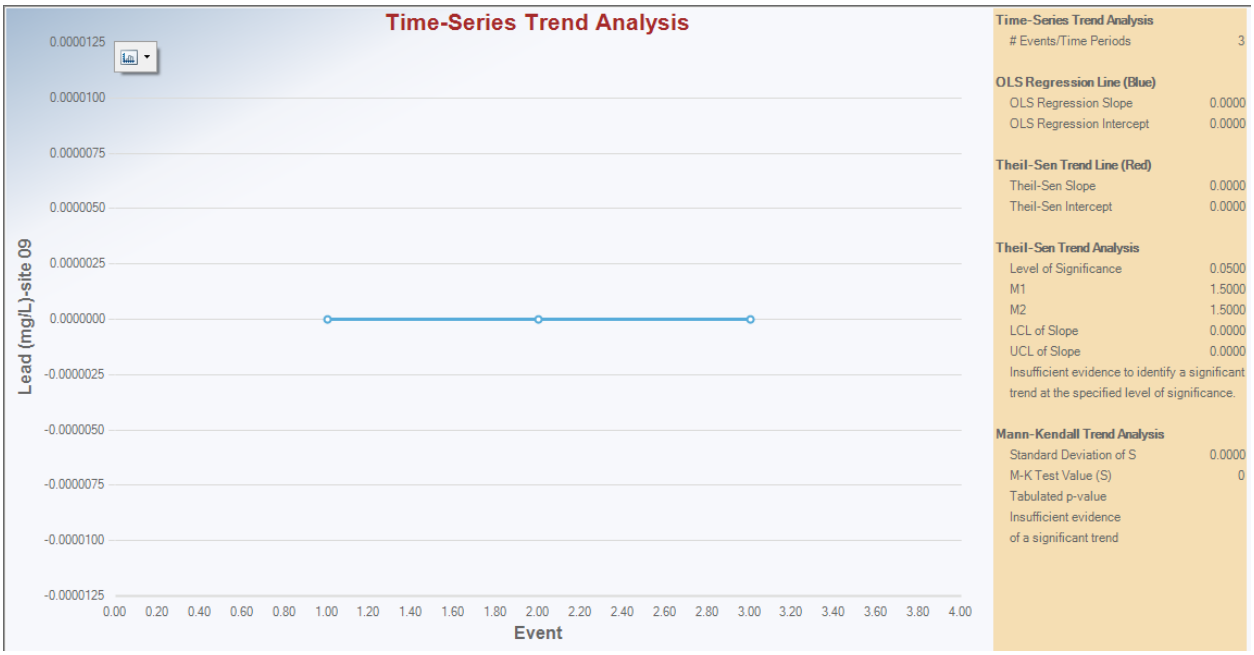
Site 7:


Time-Series Trend Analysis
Lead (mg/L)-site 07
Event
0.10
0.08
0.06
0.04
0.02
0.00
-0.02
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0
Time-Series Trend Analysis
Events/Time Periods 19
OLS Regression Line (Blue)
OLS Regression Slope -0.0016
OLS Regression Intercept 0.0304
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0005
Theil-Sen Intercept 0.0090
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 58.1014
M2 112.8986
LCL of Slope -0.0013
UCL of Slope 0.0000
Statistically significant evidence of a decreasing trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 27.9583
M-K Test Value (S) -73
Tabulated p-value 0.0050
Significant evidence of a decreasing trend

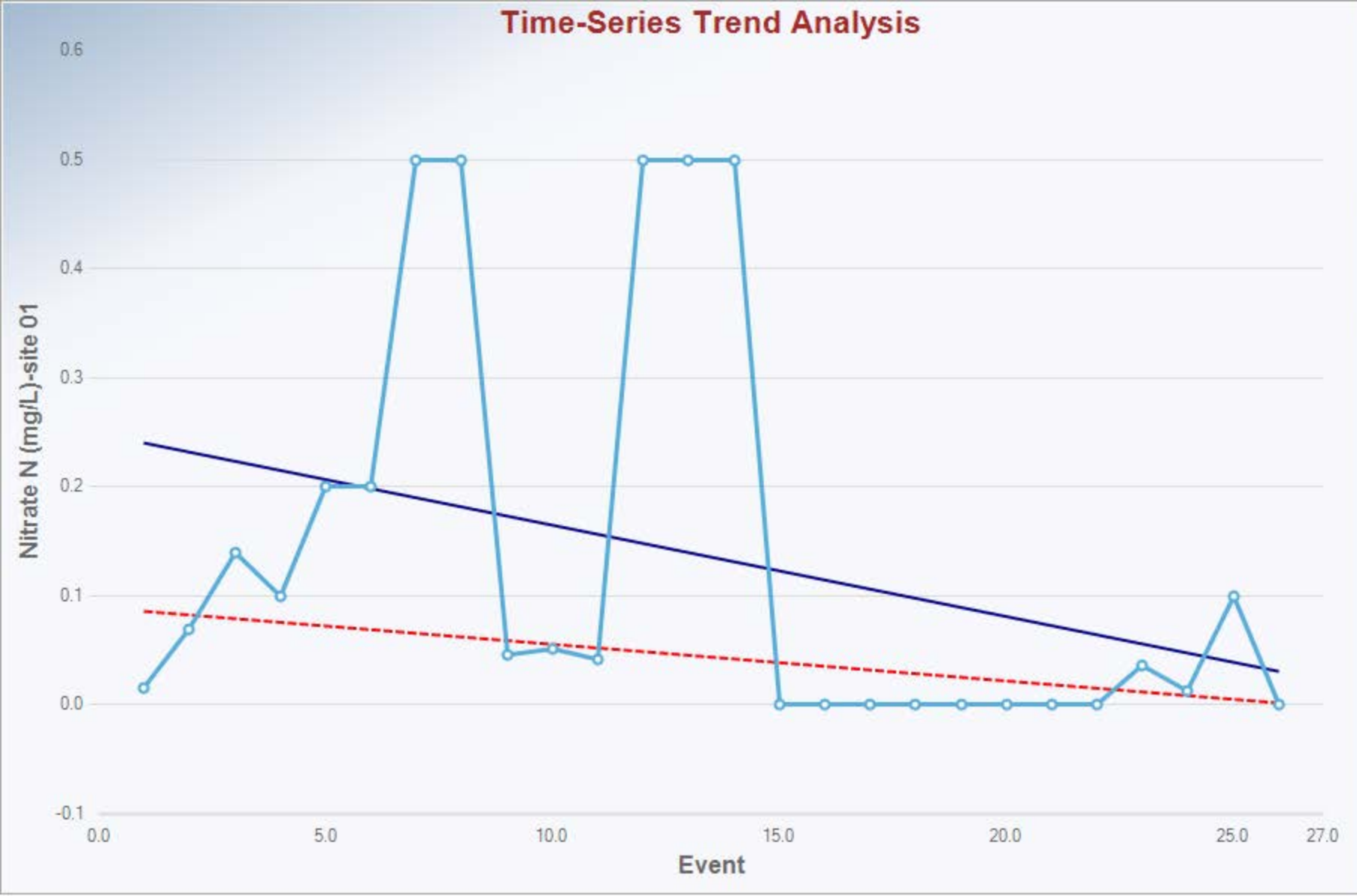
Site 8:


Time-Series Trend Analysis
Lead (mg/L)-site 08
Event
0.006
0.005
0.004
0.003
0.002
0.001
0.000
-0.001
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Time-Series Trend Analysis
Events/Time Periods 9
OLS Regression Line (Blue)
OLS Regression Slope -0.0006
OLS Regression Intercept 0.0055
Theil-Sen Trend Line (Red)
Theil-Sen Slope -0.0005
Theil-Sen Intercept 0.0043
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 9.2531
M2 26.7469
LCL of Slope -0.0012
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 8.9256
M-K Test Value (S) -13
Tabulated p-value 0.1300
Insufficient evidence of a significant trend

Site 9:


Time-Series Trend Analysis
Lead (mg/L)-site 09
Event
0.0000125
0.0000100
0.0000075
0.0000050
0.0000025
0.0000000
-0.0000025
-0.0000050
-0.0000075
-0.0000100
-0.0000125
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.20 2.40 2.60 2.80 3.00 3.20 3.40 3.60 3.80 4.00
Time-Series Trend Analysis
Events/Time Periods 3
OLS Regression Line (Blue)
OLS Regression Slope 0.0000
OLS Regression Intercept 0.0000
Theil-Sen Trend Line (Red)
Theil-Sen Slope 0.0000
Theil-Sen Intercept 0.0000
Theil-Sen Trend Analysis
Level of Significance 0.0500
M1 1.5000
M2 1.5000
LCL of Slope 0.0000
UCL of Slope 0.0000
Insufficient evidence to identify a significant trend at the specified level of significance.
Mann-Kendall Trend Analysis
Standard Deviation of S 0.0000
M-K Test Value (S) 0
Tabulated p-value
Insufficient evidence of a significant trend

Nitrate - Nitrogen Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0084
OLS Regression Intercept	0.2482

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0034
Theil-Sen Intercept	0.0895

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	119.2511
M2	205.7489
LCL of Slope	-0.0077
UCL of Slope	0.0000

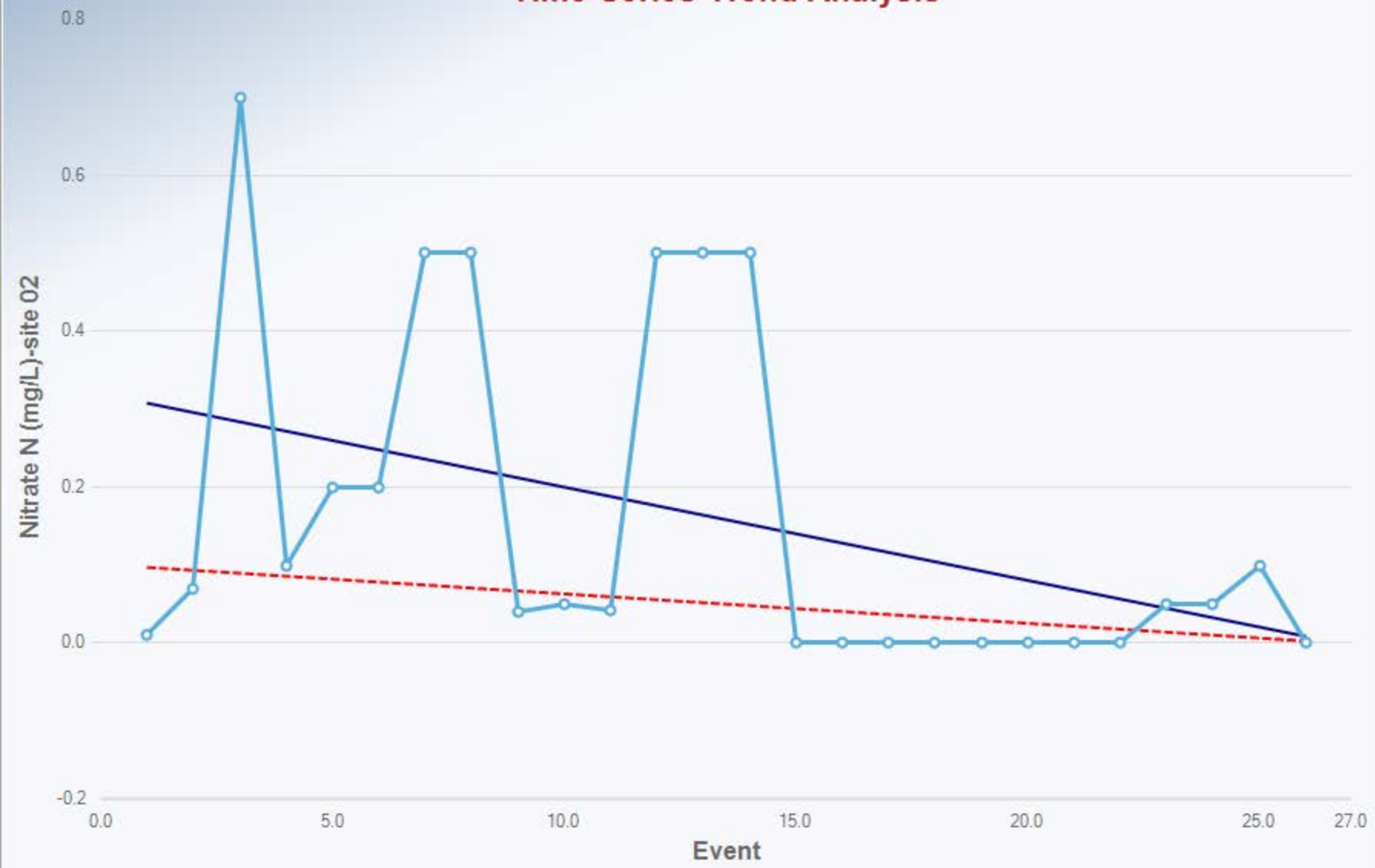
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.1324
M-K Standardized Val (S)	-2.2659
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0117

Significant evidence of a decreasing trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0120
OLS Regression Intercept	0.3196

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0038
Theil-Sen Intercept	0.1015

Theil-Sen Trend Analysis

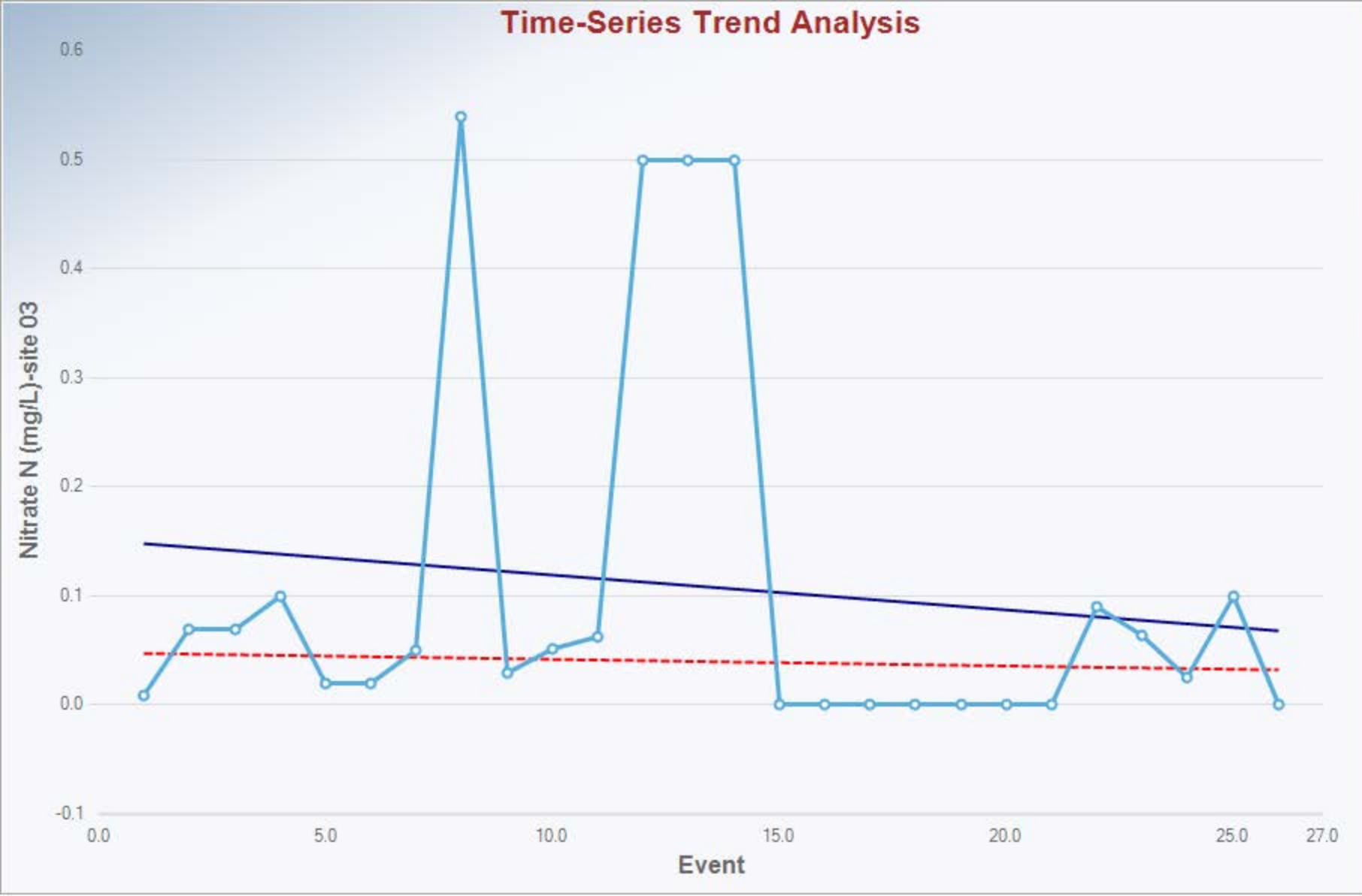
Level of Significance	0.0500
M1	119.2918
M2	205.7082
LCL of Slope	-0.0094
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.0908
M-K Standardized Val (S)	-2.2454
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0124

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0032
OLS Regression Intercept	0.1507

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0006
Theil-Sen Intercept	0.0476

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.8239
M2	206.1761
LCL of Slope	-0.0039
UCL of Slope	0.0001

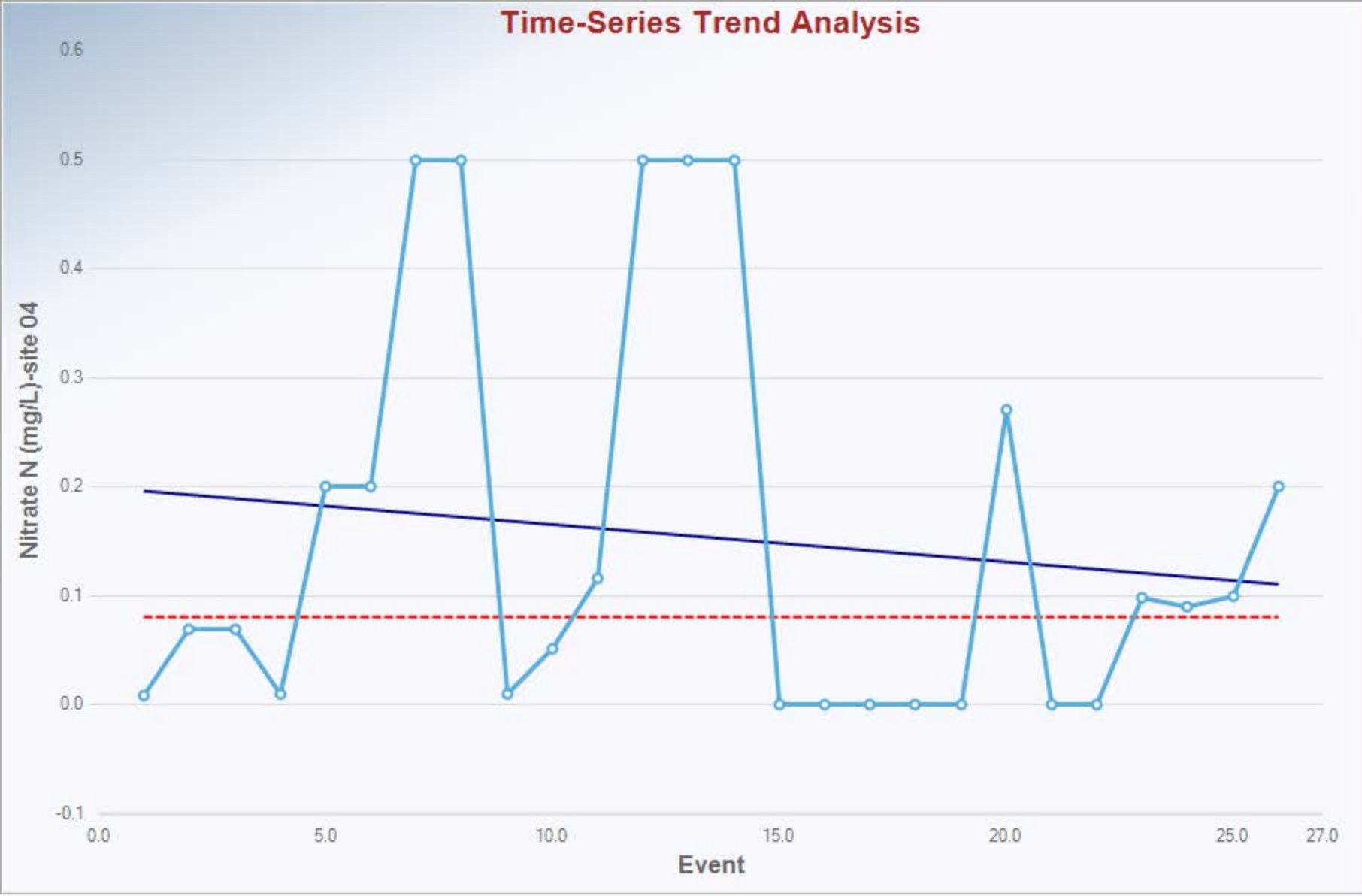
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.5683
M-K Standardized Val (S)	-1.1219
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1310

Insufficient evidence of a significant trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0034
OLS Regression Intercept	0.1992

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0800

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.7653
M2	206.2347
LCL of Slope	-0.0050
UCL of Slope	0.0036

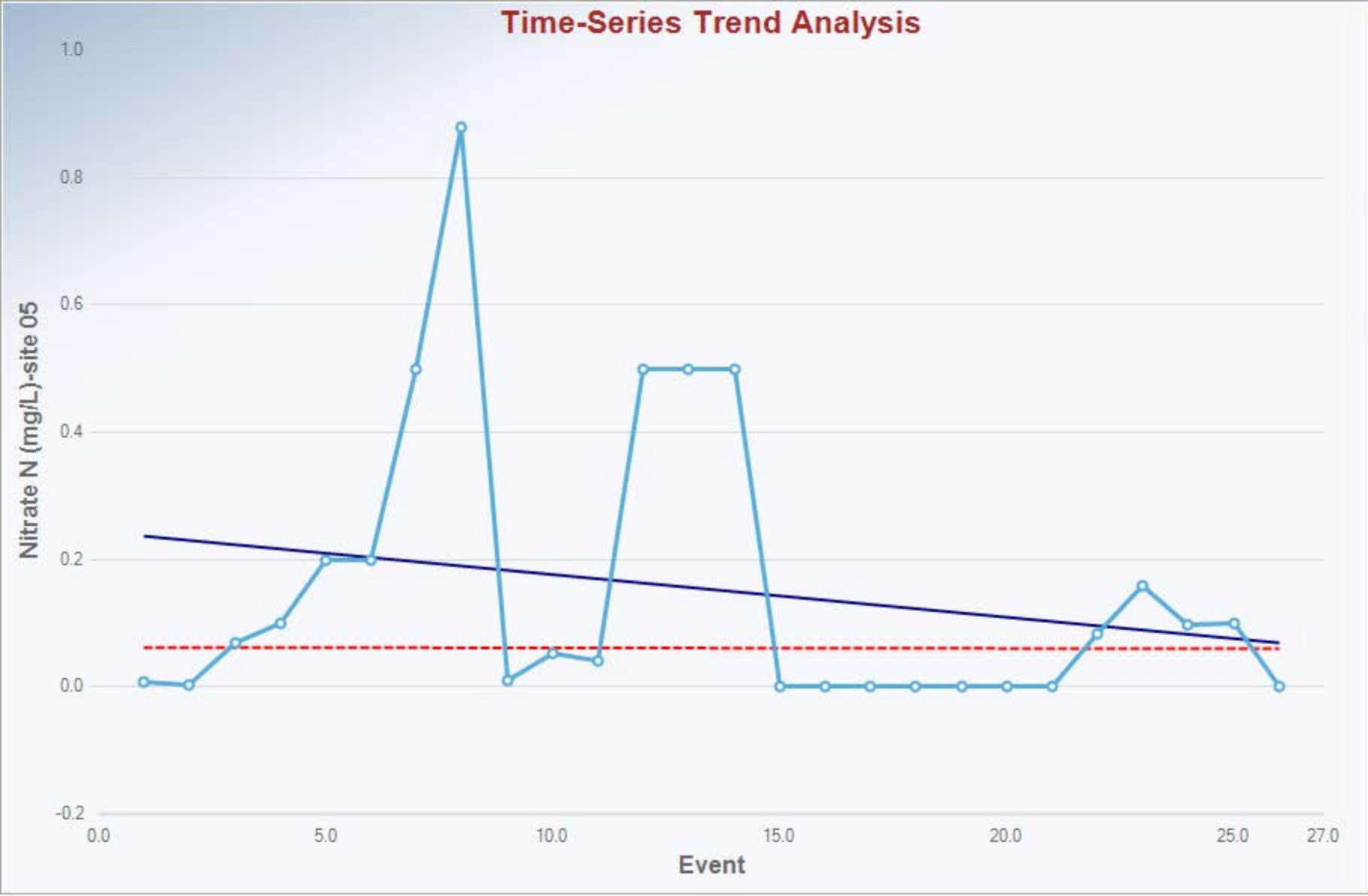
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.6281
M-K Standardized Val (S)	-0.5378
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2954

Insufficient evidence of a significant trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0067
OLS Regression Intercept	0.2444

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0002
Theil-Sen Intercept	0.0631

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.8679
M2	206.1321
LCL of Slope	-0.0060
UCL of Slope	0.0000

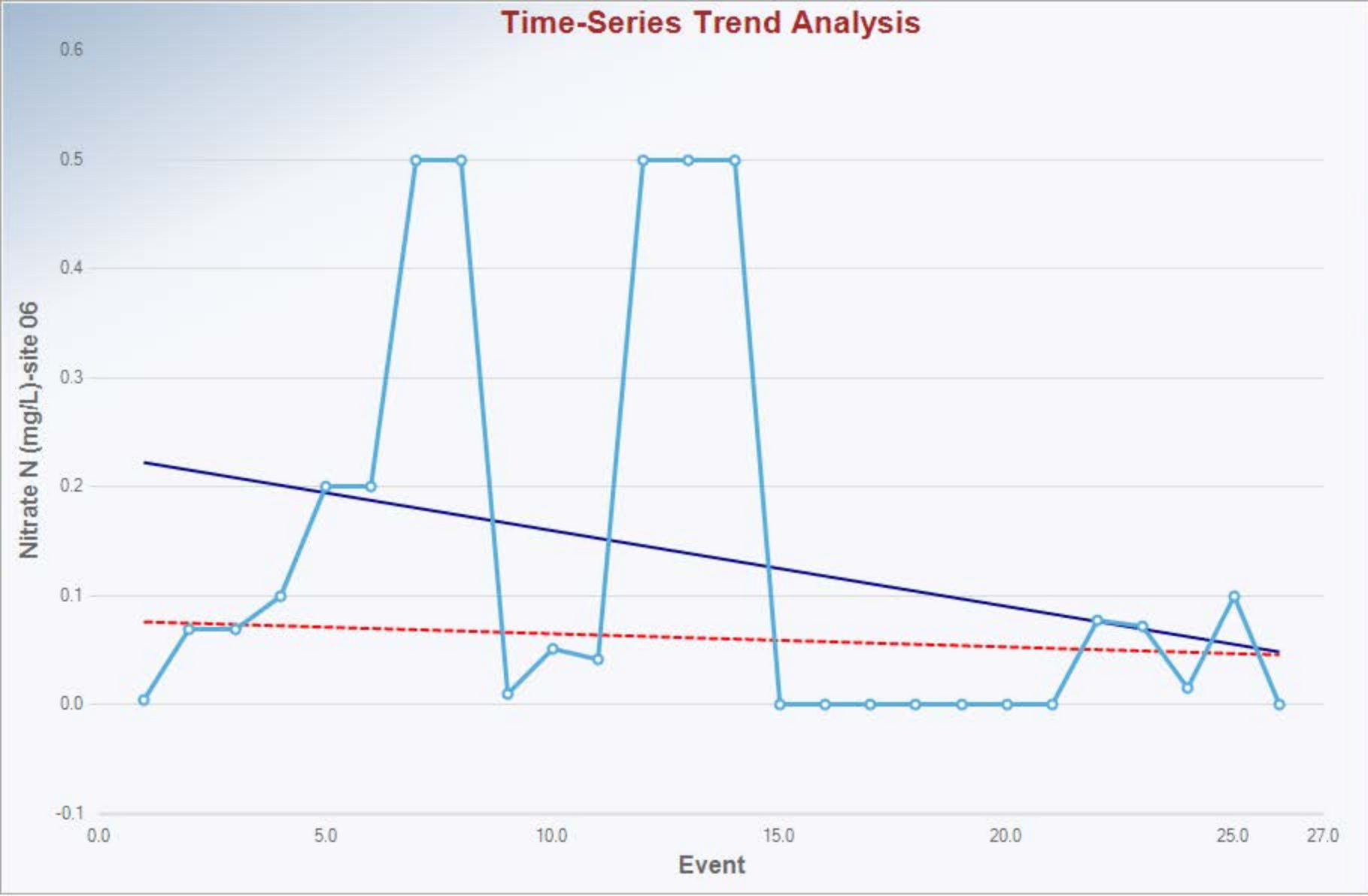
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.5234
M-K Standardized Val (S)	-1.1679
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1214

Insufficient evidence of a significant trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0070
OLS Regression Intercept	0.2291

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0013
Theil-Sen Intercept	0.0779

Theil-Sen Trend Analysis

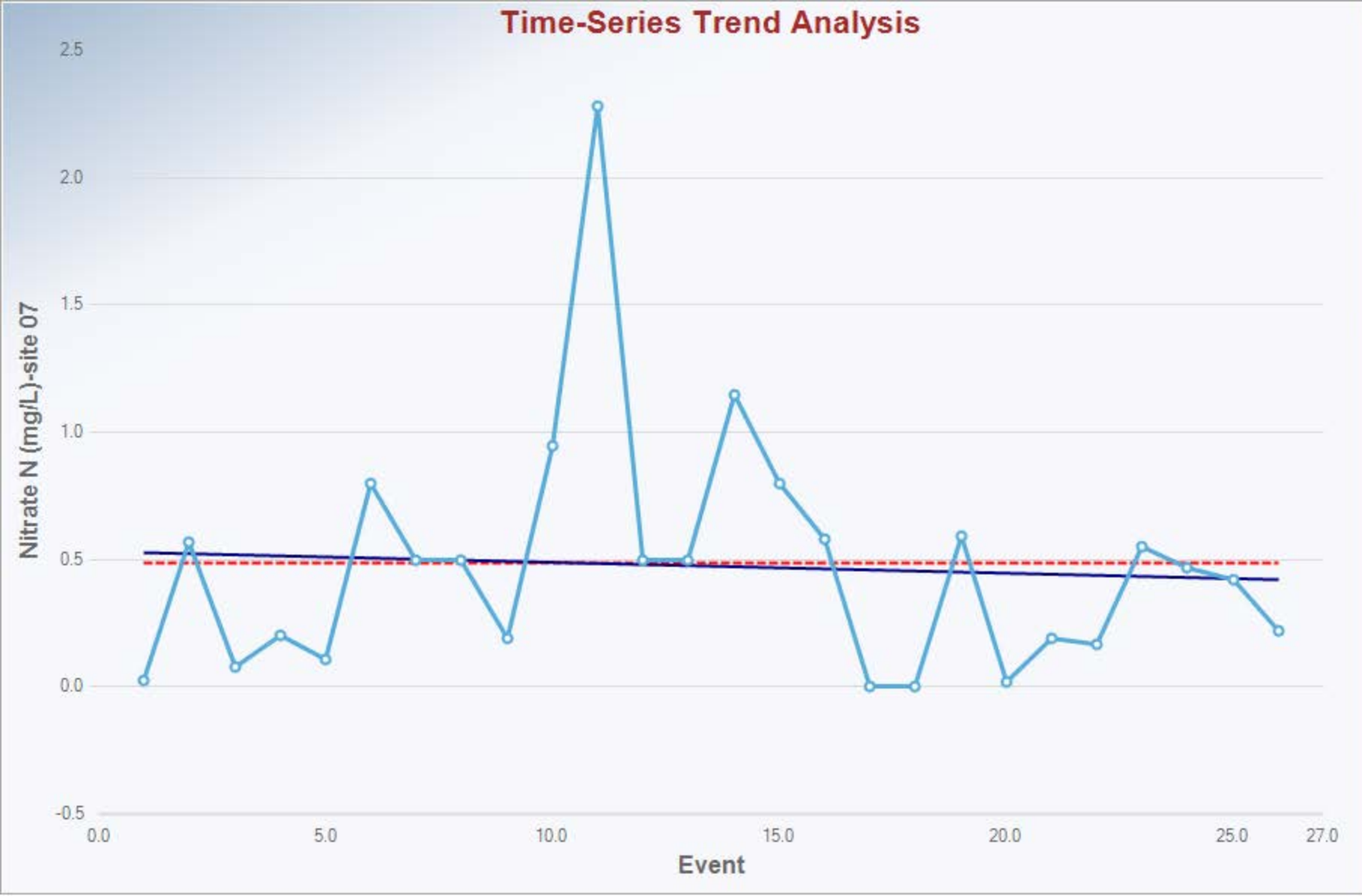
Level of Significance	0.0500
M1	118.9670
M2	206.0330
LCL of Slope	-0.0063
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.4222
M-K Standardized Val (S)	-1.5083
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0657

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0043
OLS Regression Intercept	0.5334

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0001
Theil-Sen Intercept	0.4861

Theil-Sen Trend Analysis

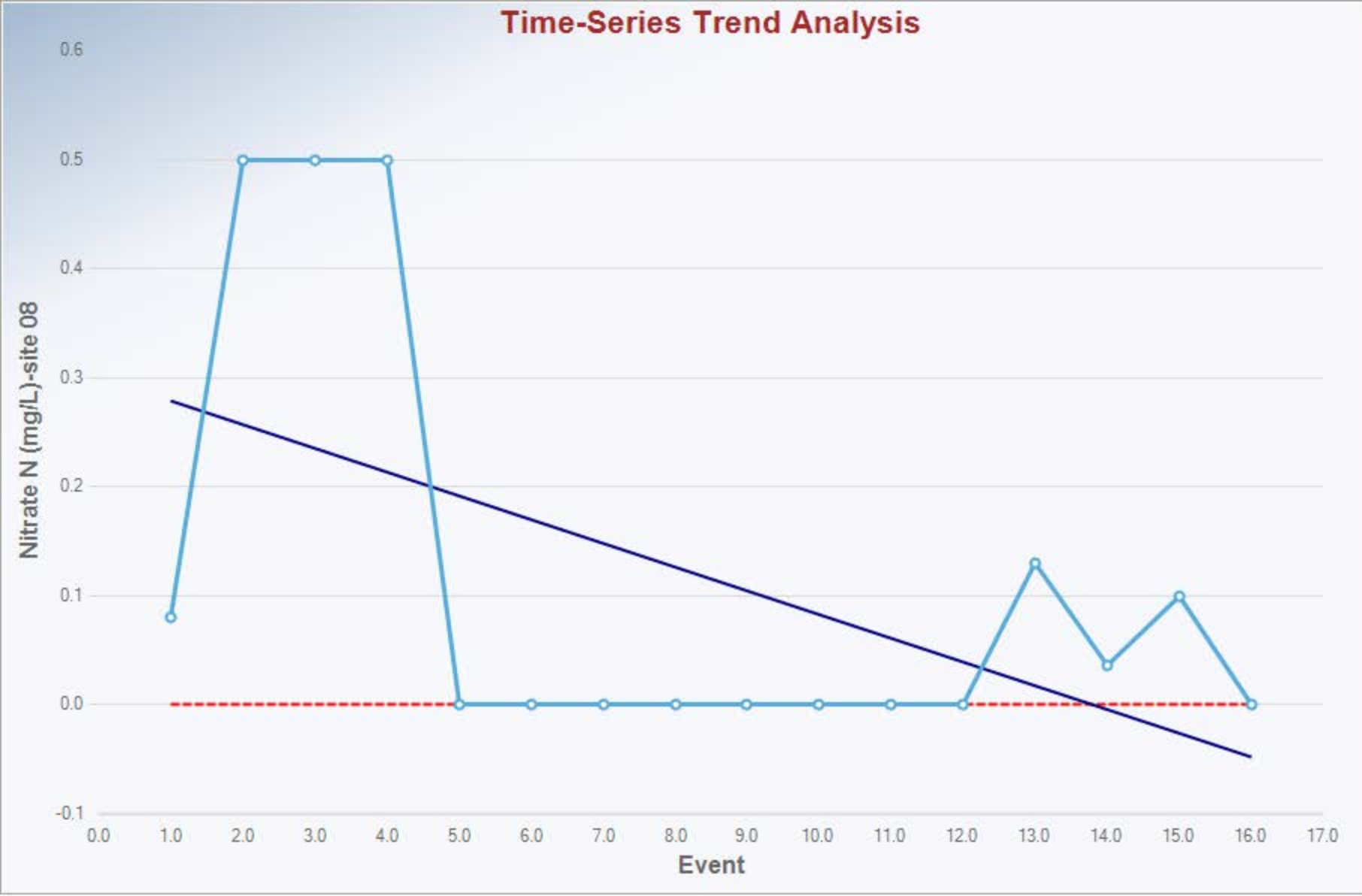
Level of Significance	0.0500
M1	118.1547
M2	206.8453
LCL of Slope	-0.0200
UCL of Slope	0.0175

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.2512
M-K Standardized Val (S)	-0.1768
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.4298

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	-0.0218
OLS Regression Intercept	0.3007

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0000

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	40.4576
M2	79.5424
LCL of Slope	-0.0193
UCL of Slope	0.0000

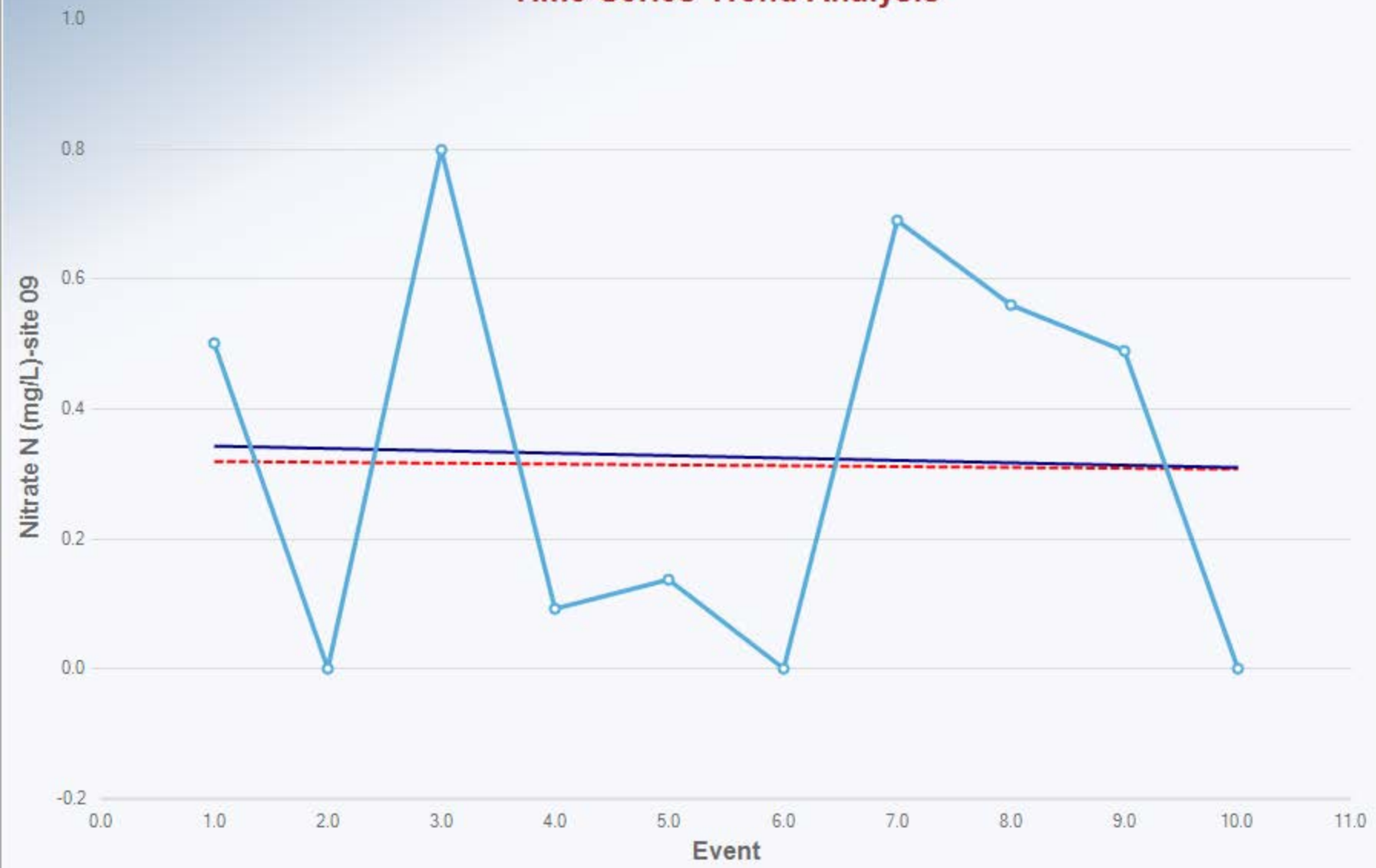
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	19.9416
M-K Test Value (S)	-21
Tabulated p-value	0.1990

Insufficient evidence of a significant trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	-0.0037
OLS Regression Intercept	0.3476

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0014
Theil-Sen Intercept	0.3216

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	11.7054
M2	33.2946
LCL of Slope	-0.1043
UCL of Slope	0.0821

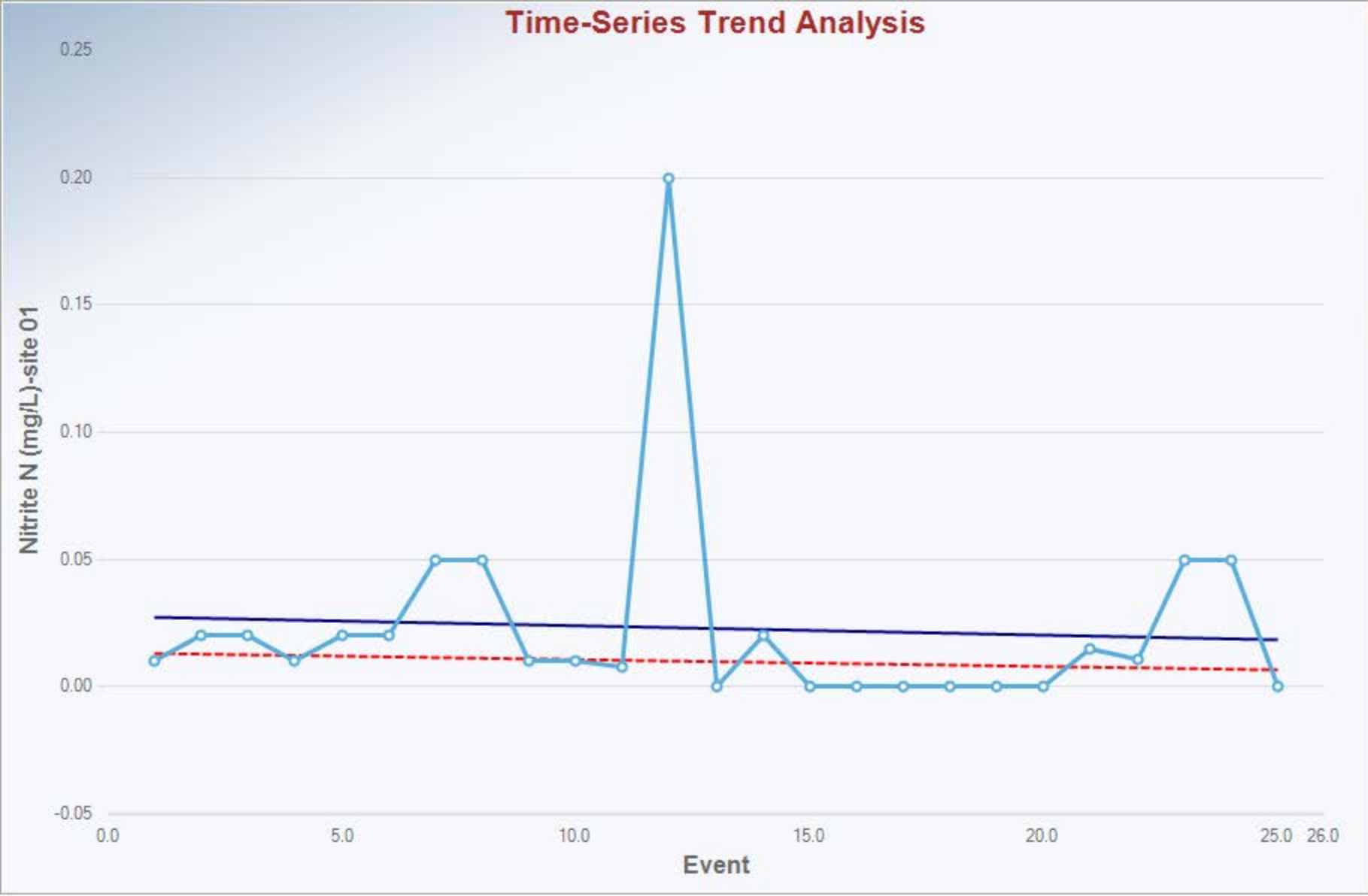
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	11.0151
M-K Test Value (S)	-4
Tabulated p-value	0.3640

Insufficient evidence of a significant trend

Nitrite - Nitrogen Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0004
OLS Regression Intercept	0.0277

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0003
Theil-Sen Intercept	0.0137

Theil-Sen Trend Analysis

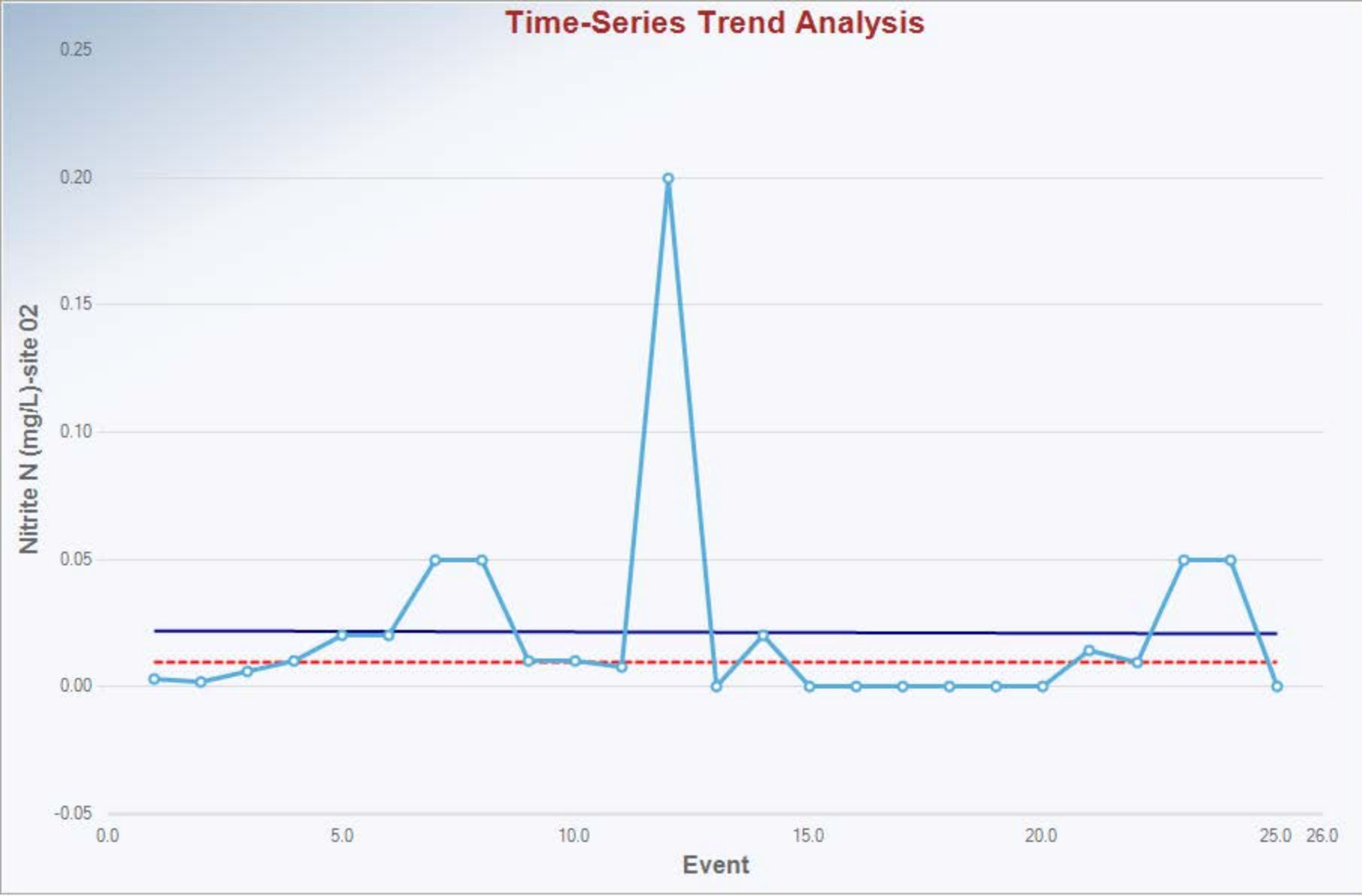
Level of Significance	0.0500
M1	109.1923
M2	190.8077
LCL of Slope	-0.0011
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.6413
M-K Standardized Val (S)	-1.3208
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0933

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0001
OLS Regression Intercept	0.0220

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0099

Theil-Sen Trend Analysis

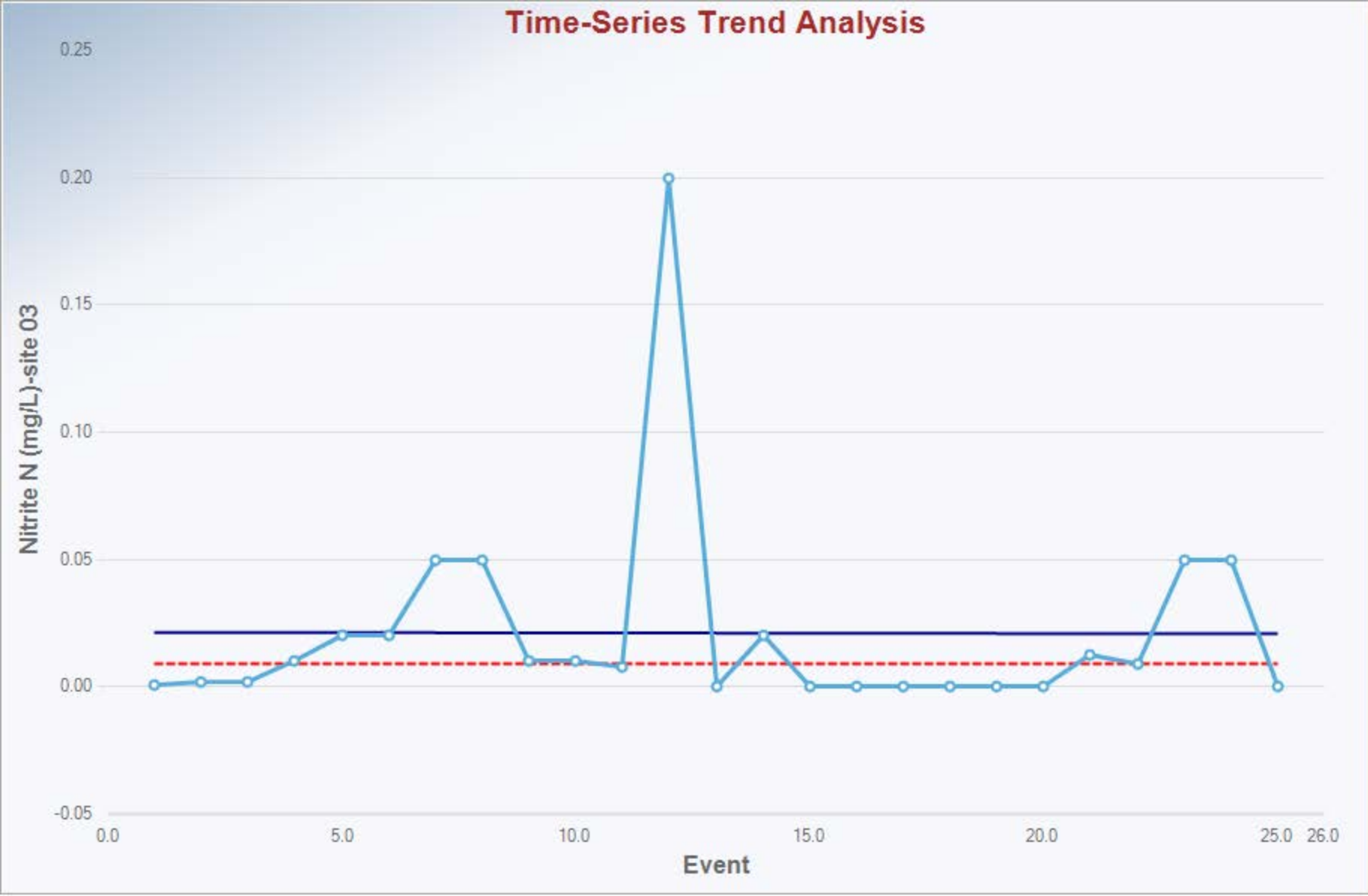
Level of Significance	0.0500
M1	108.9810
M2	191.0190
LCL of Slope	-0.0006
UCL of Slope	0.0004

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8569
M-K Standardized Val (S)	-0.6451
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2594

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0000
OLS Regression Intercept	0.0212

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0093

Theil-Sen Trend Analysis

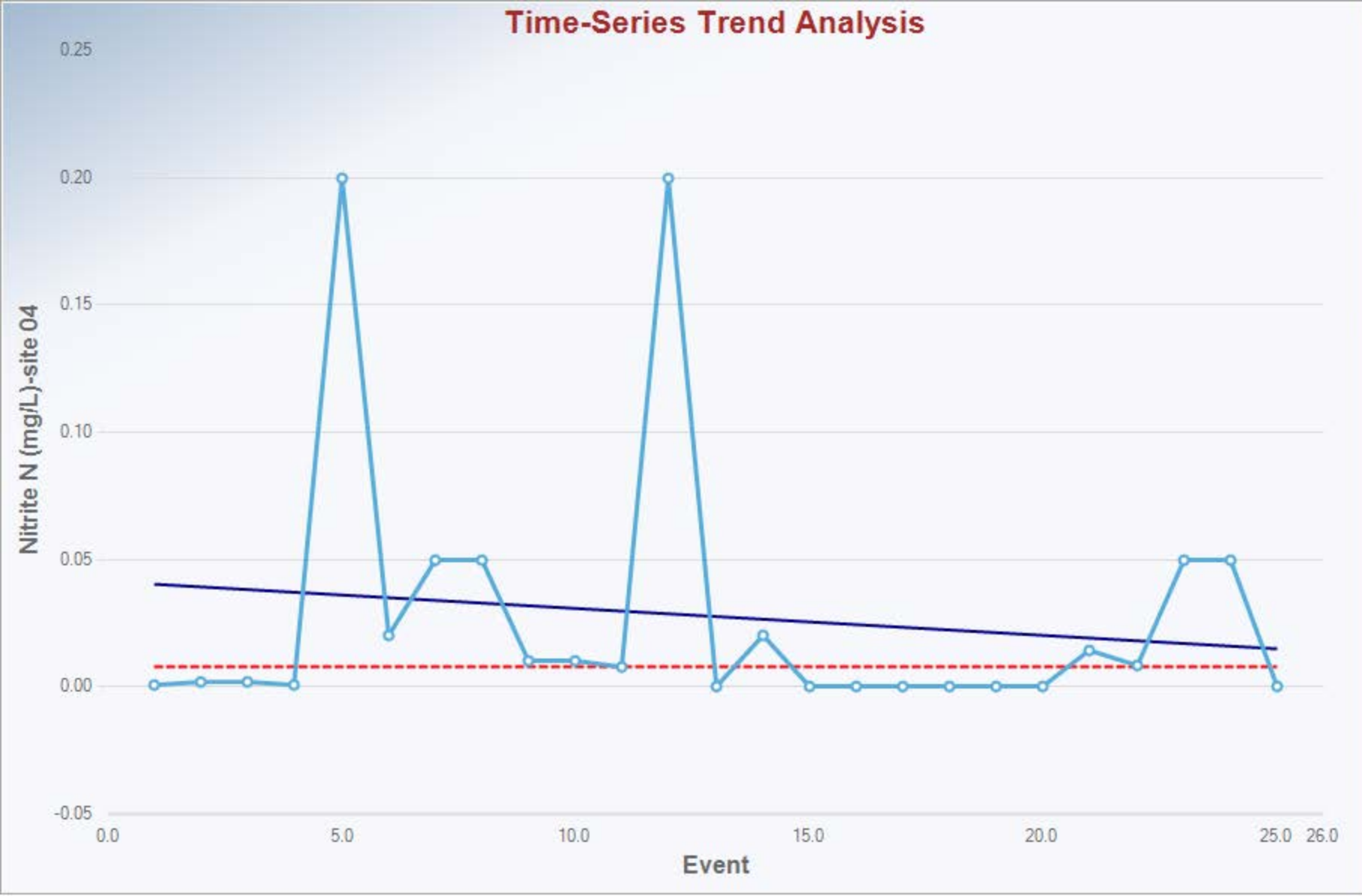
Level of Significance	0.0500
M1	108.9927
M2	191.0073
LCL of Slope	-0.0006
UCL of Slope	0.0004

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8450
M-K Standardized Val (S)	-0.6213
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2672

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0011
OLS Regression Intercept	0.0416

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0080

Theil-Sen Trend Analysis

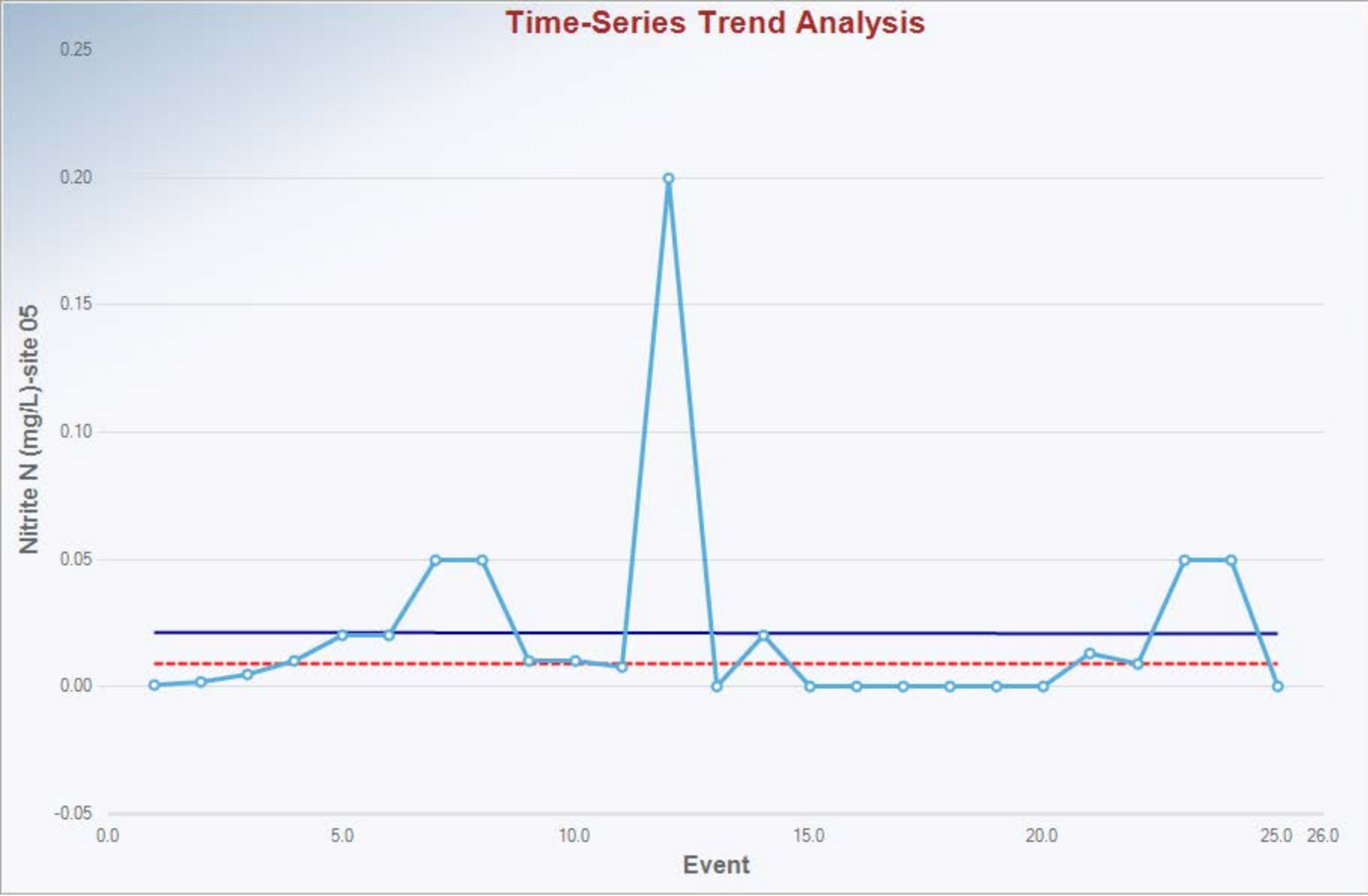
Level of Significance	0.0500
M1	108.9537
M2	191.0463
LCL of Slope	-0.0008
UCL of Slope	0.0003

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8848
M-K Standardized Val (S)	-0.8595
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1950

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0000
OLS Regression Intercept	0.0217

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0091

Theil-Sen Trend Analysis

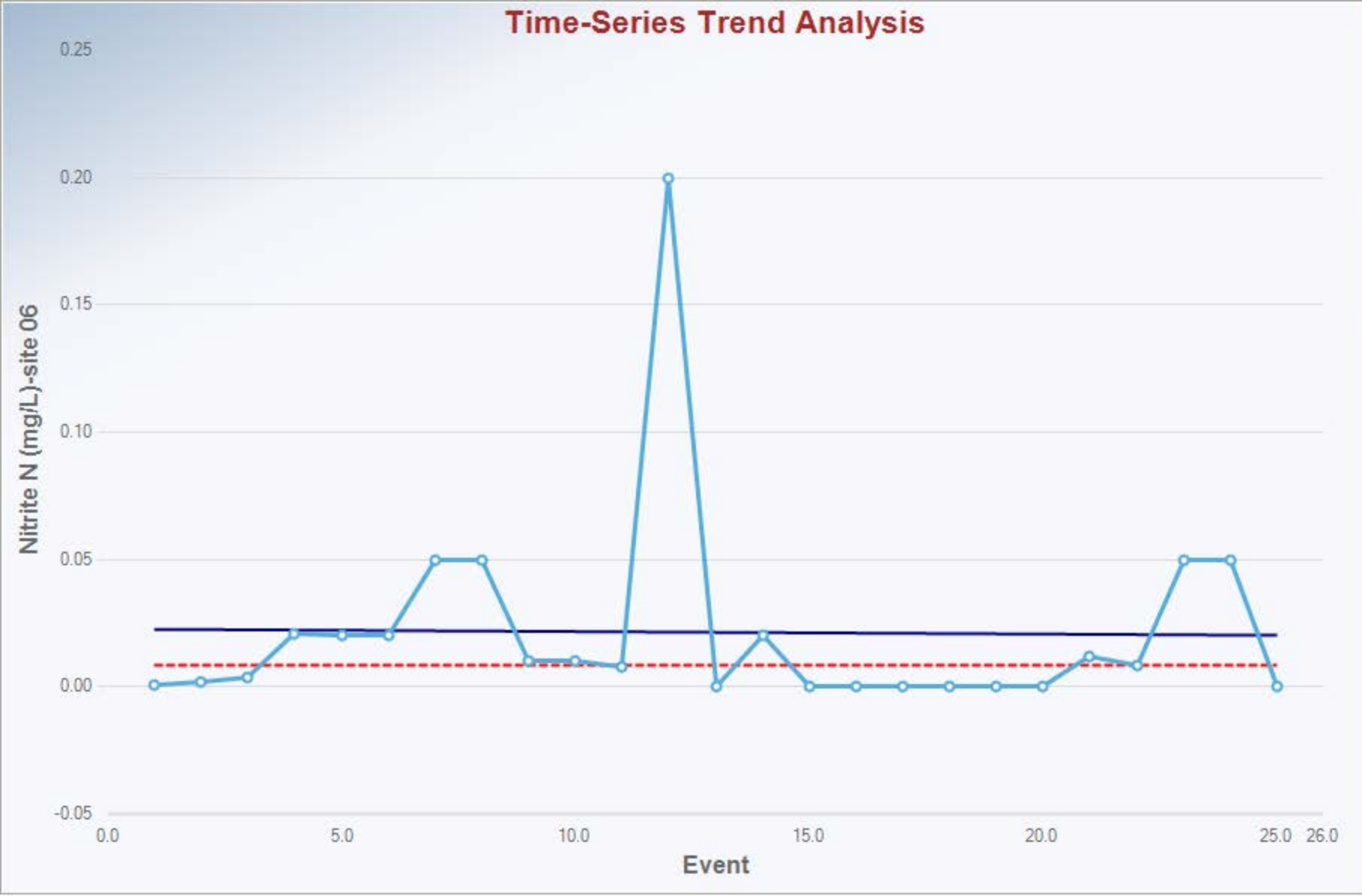
Level of Significance	0.0500
M1	108.9810
M2	191.0190
LCL of Slope	-0.0006
UCL of Slope	0.0004

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8569
M-K Standardized Val (S)	-0.5973
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2752

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0001
OLS Regression Intercept	0.0230

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0082

Theil-Sen Trend Analysis

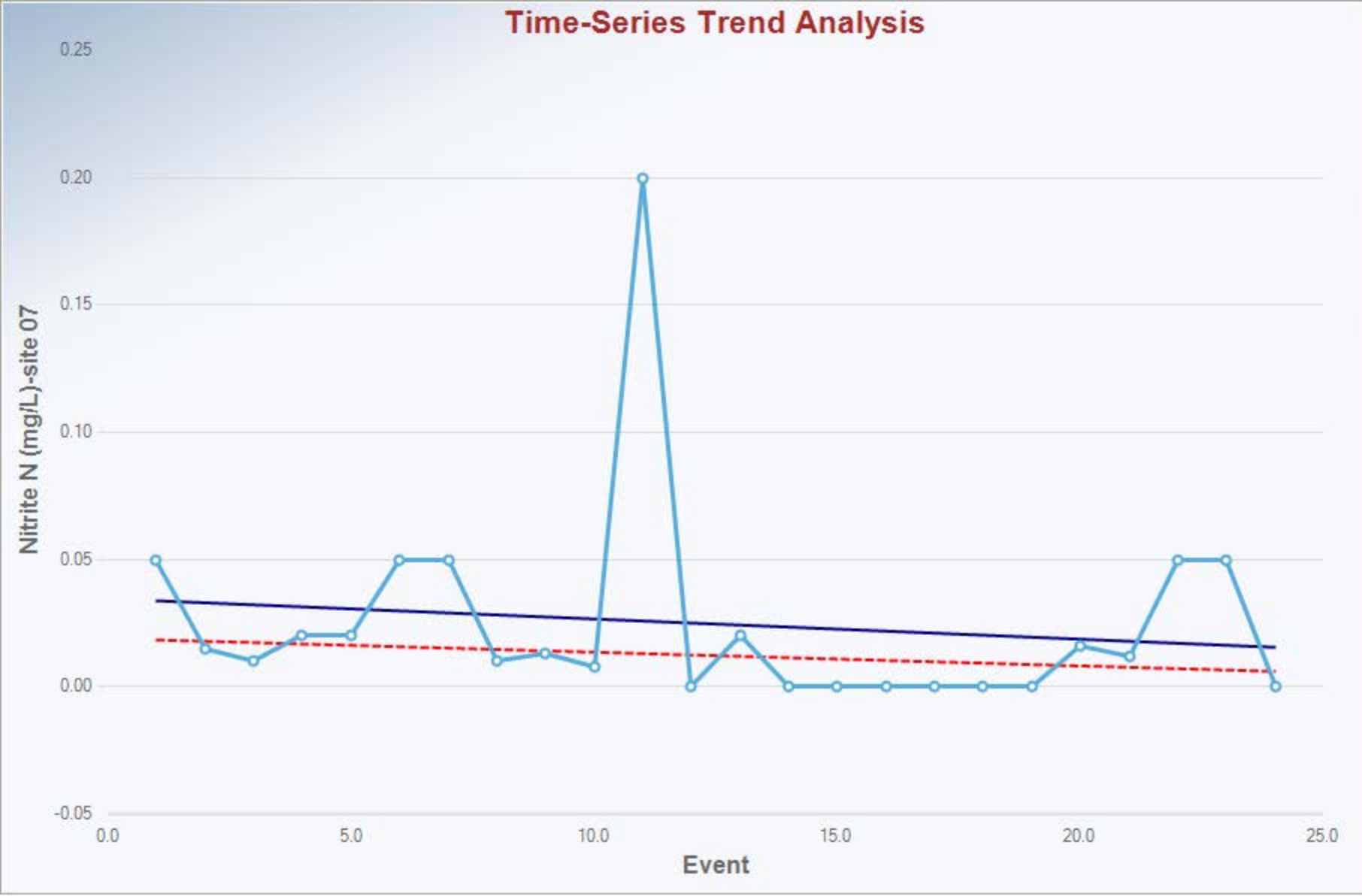
Level of Significance	0.0500
M1	108.9498
M2	191.0502
LCL of Slope	-0.0010
UCL of Slope	0.0002

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8887
M-K Standardized Val (S)	-0.8355
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2017

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	24

OLS Regression Line (Blue)

OLS Regression Slope	-0.0008
OLS Regression Intercept	0.0348

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0005
Theil-Sen Intercept	0.0193

Theil-Sen Trend Analysis

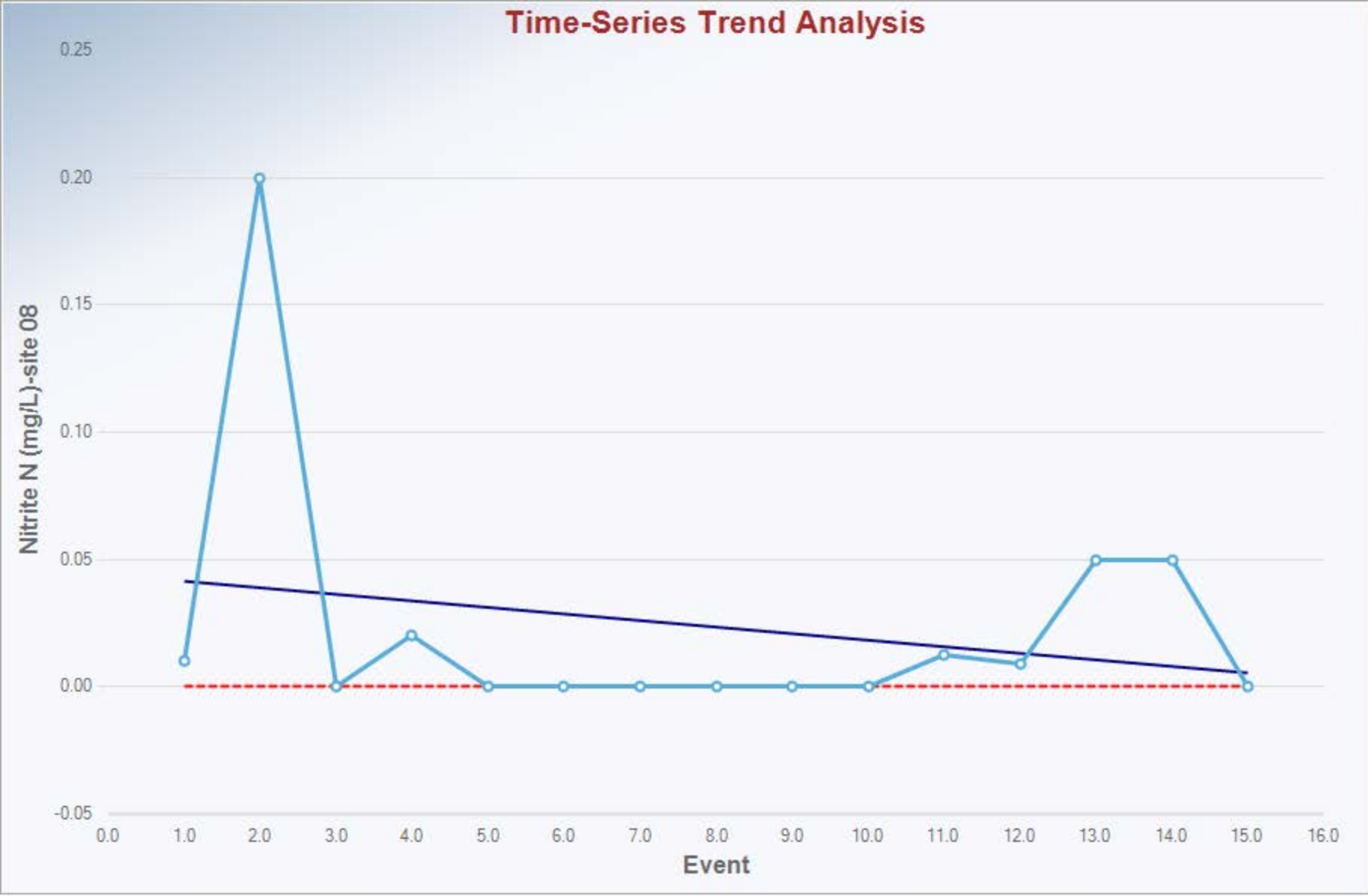
Level of Significance	0.0500
M1	99.5594
M2	176.4406
LCL of Slope	-0.0015
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	39.2258
M-K Standardized Val (S)	-1.5551
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0600

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	15

OLS Regression Line (Blue)

OLS Regression Slope	-0.0026
OLS Regression Intercept	0.0442

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0000

Theil-Sen Trend Analysis

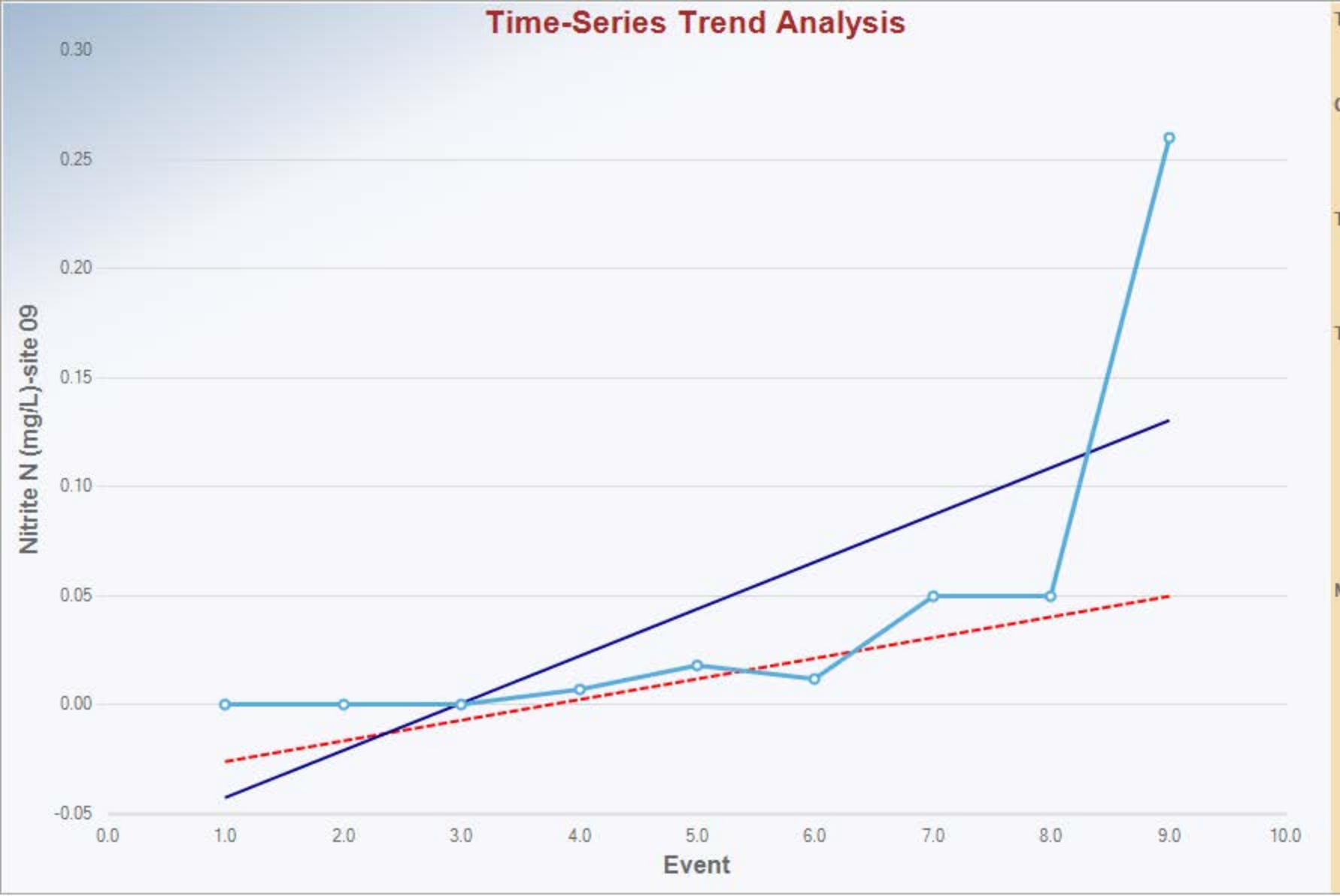
Level of Significance	0.0500
M1	34.3770
M2	70.6230
LCL of Slope	-0.0009
UCL of Slope	0.0017

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	18.4932
M-K Test Value (S)	4
Tabulated p-value	0.4230

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	9

OLS Regression Line (Blue)

OLS Regression Slope	0.0216
OLS Regression Intercept	-0.0637

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0095
Theil-Sen Intercept	-0.0356

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	8.8418
M2	27.1582
LCL of Slope	0.0029
UCL of Slope	0.0211

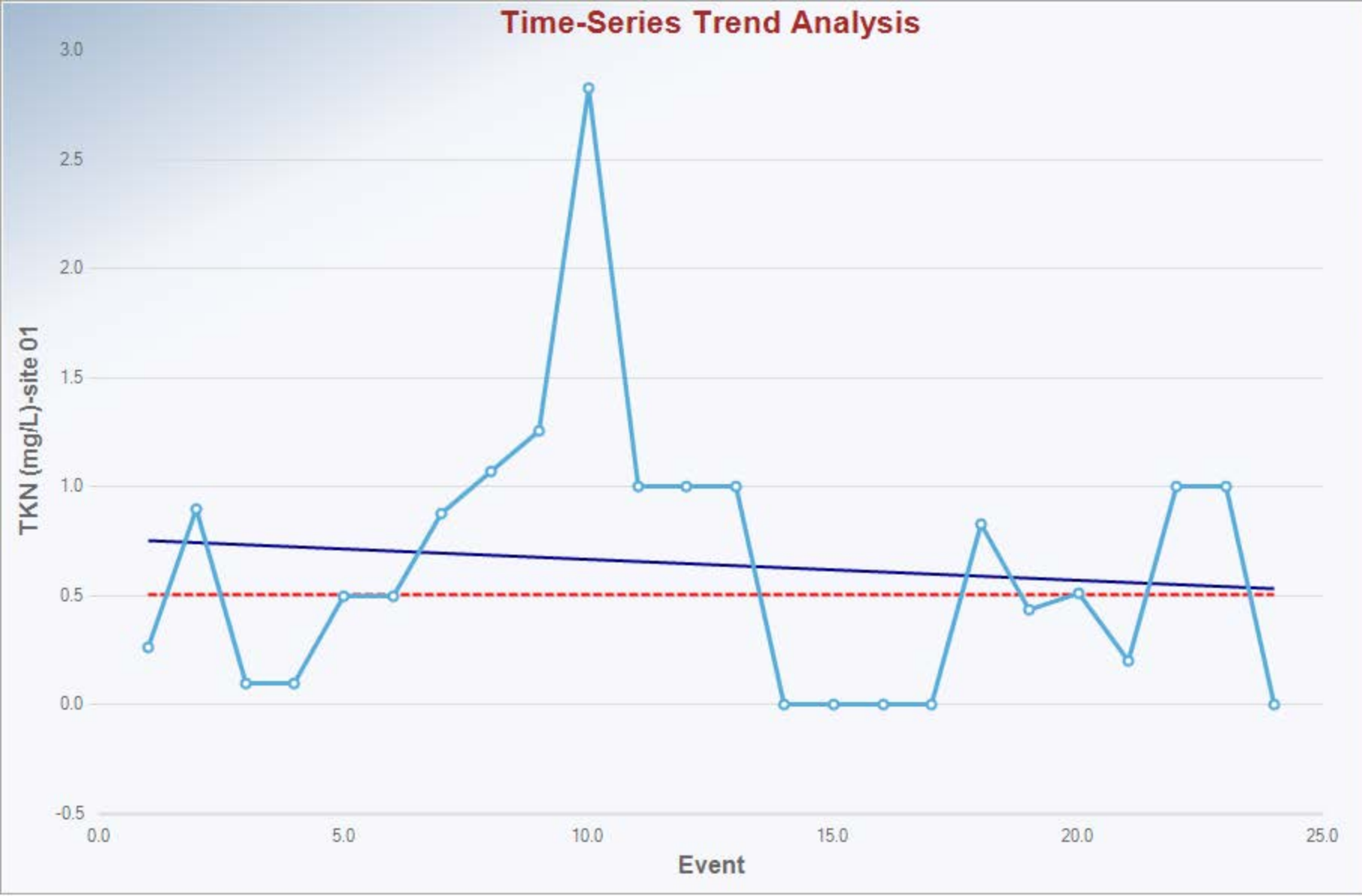
Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	9.3452
M-K Test Value (S)	30
Tabulated p-value	0.0000

Significant evidence of an increasing trend

Total Kjeldahl Nitrogen (TKN) Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	24

OLS Regression Line (Blue)

OLS Regression Slope	-0.0095
OLS Regression Intercept	0.7603

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.5050

Theil-Sen Trend Analysis

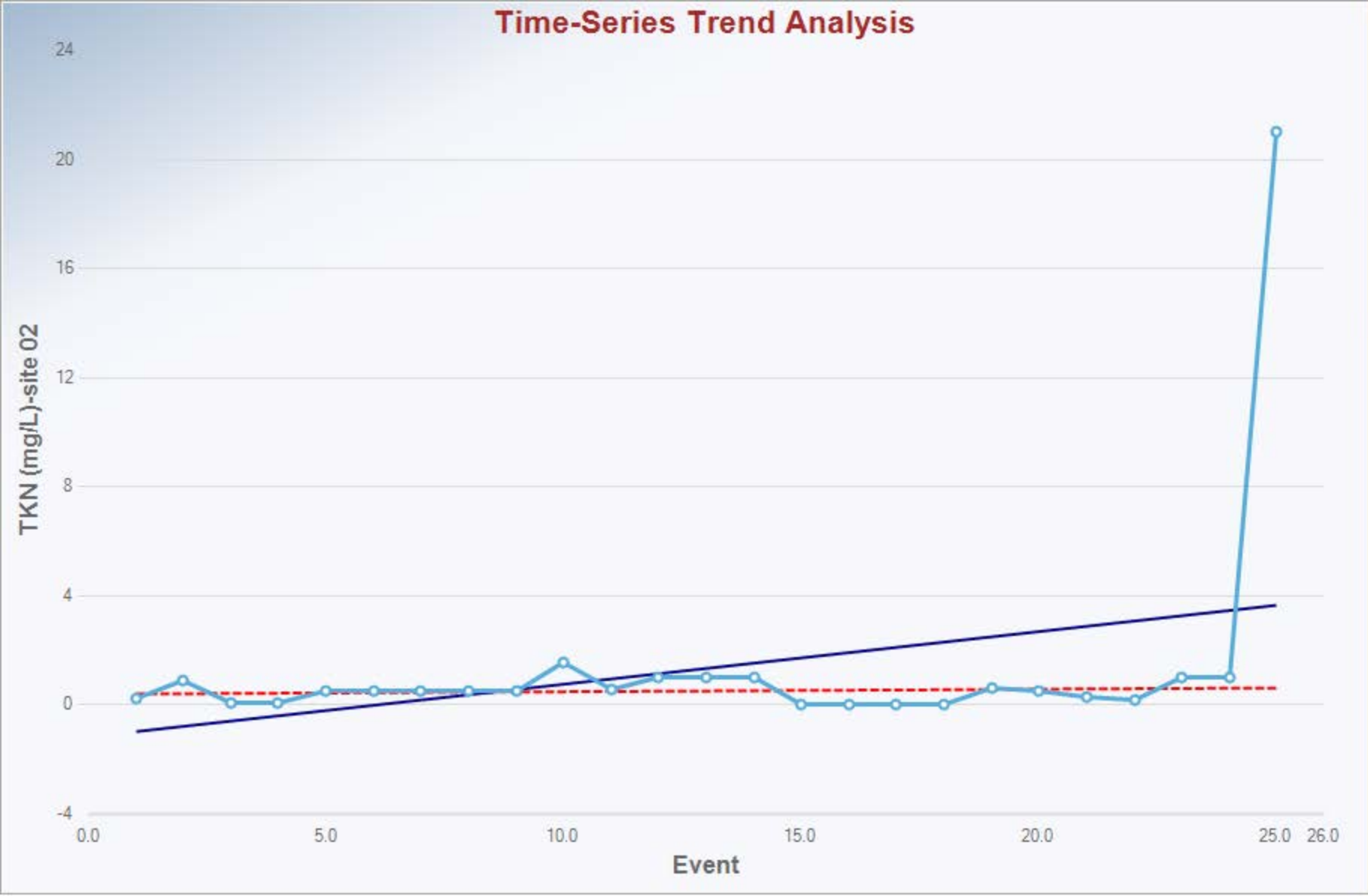
Level of Significance	0.0500
M1	98.9234
M2	177.0766
LCL of Slope	-0.0283
UCL of Slope	0.0258

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	39.8748
M-K Standardized Val (S)	-0.3762
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.3534

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.1915
OLS Regression Intercept	-1.1417

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0088
Theil-Sen Intercept	0.3859

Theil-Sen Trend Analysis

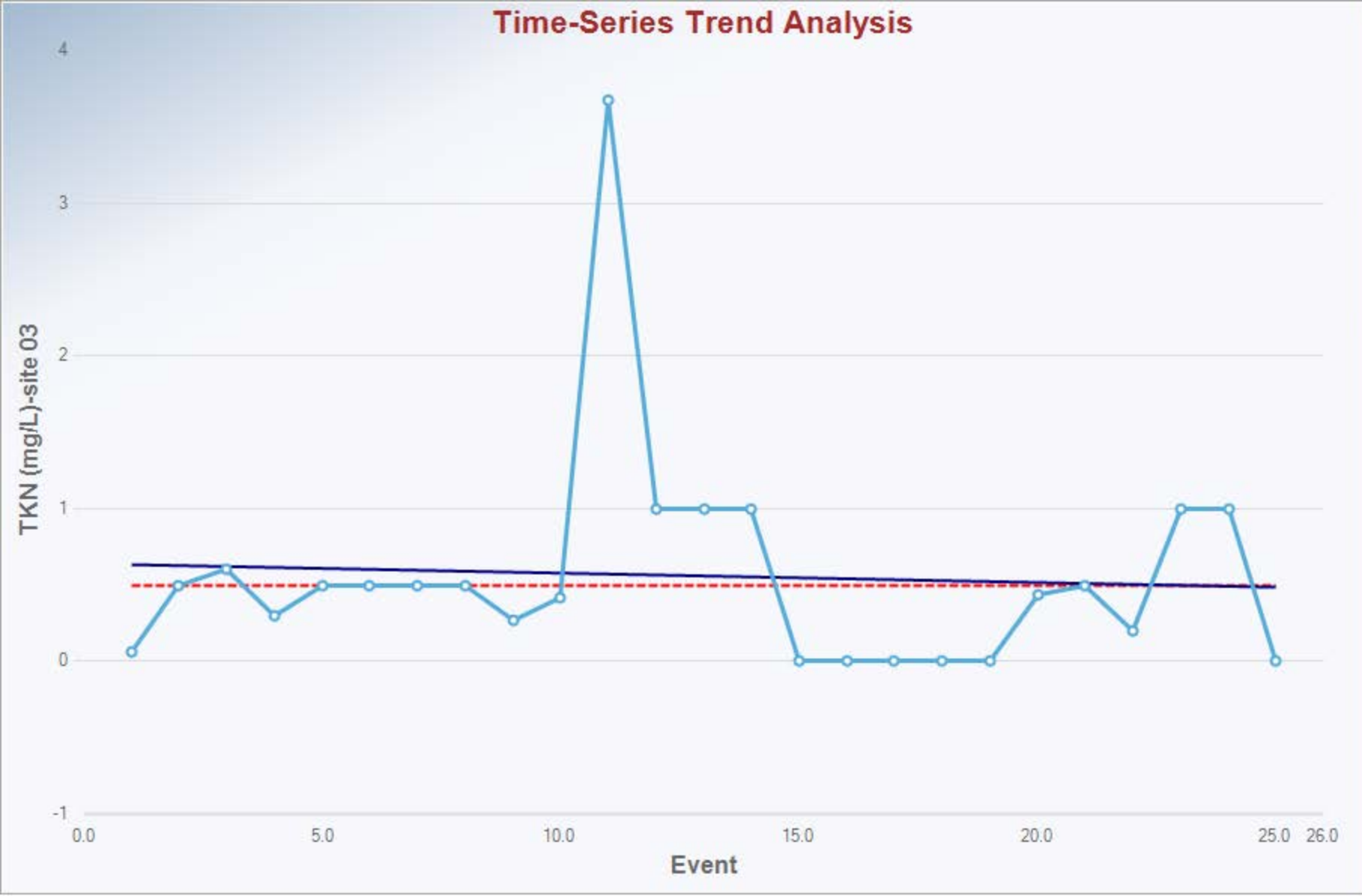
Level of Significance	0.0500
M1	108.4537
M2	191.5463
LCL of Slope	-0.0071
UCL of Slope	0.0400

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.3950
M-K Standardized Val (S)	1.2030
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.1145

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0060
OLS Regression Intercept	0.6362

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.5000

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	108.8874
M2	191.1126
LCL of Slope	-0.0250
UCL of Slope	0.0193

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.9524
M-K Standardized Val (S)	-0.5959
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2756

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0050
OLS Regression Intercept	0.4738

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.4000

Theil-Sen Trend Analysis

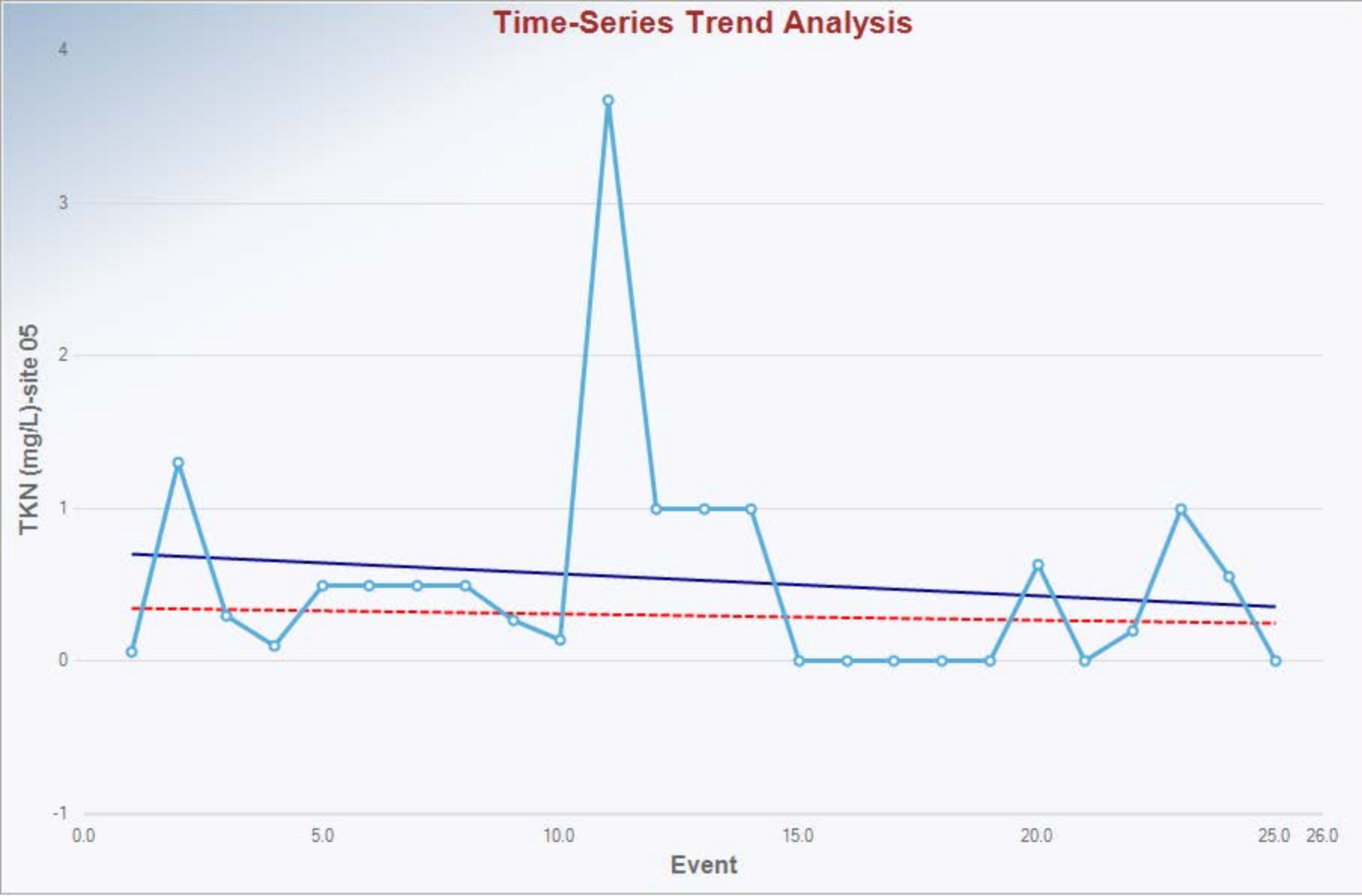
Level of Significance	0.0500
M1	108.9498
M2	191.0502
LCL of Slope	-0.0201
UCL of Slope	0.0067

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8887
M-K Standardized Val (S)	-0.6923
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2444

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0142
OLS Regression Intercept	0.7137

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0039
Theil-Sen Intercept	0.3504

Theil-Sen Trend Analysis

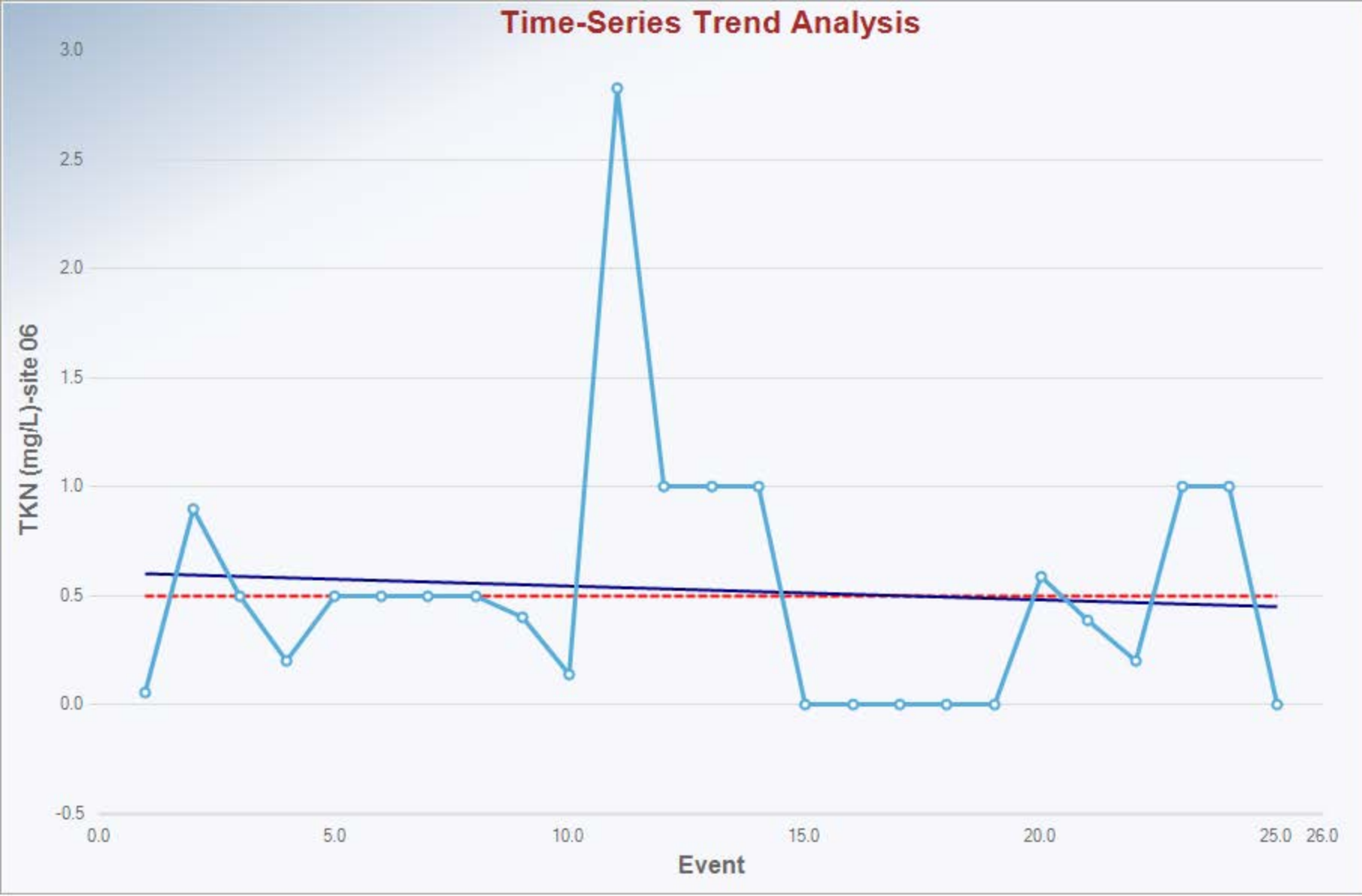
Level of Significance	0.0500
M1	108.7514
M2	191.2486
LCL of Slope	-0.0296
UCL of Slope	0.0036

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.0912
M-K Standardized Val (S)	-0.9978
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1592

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0062
OLS Regression Intercept	0.6089

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.5000

Theil-Sen Trend Analysis

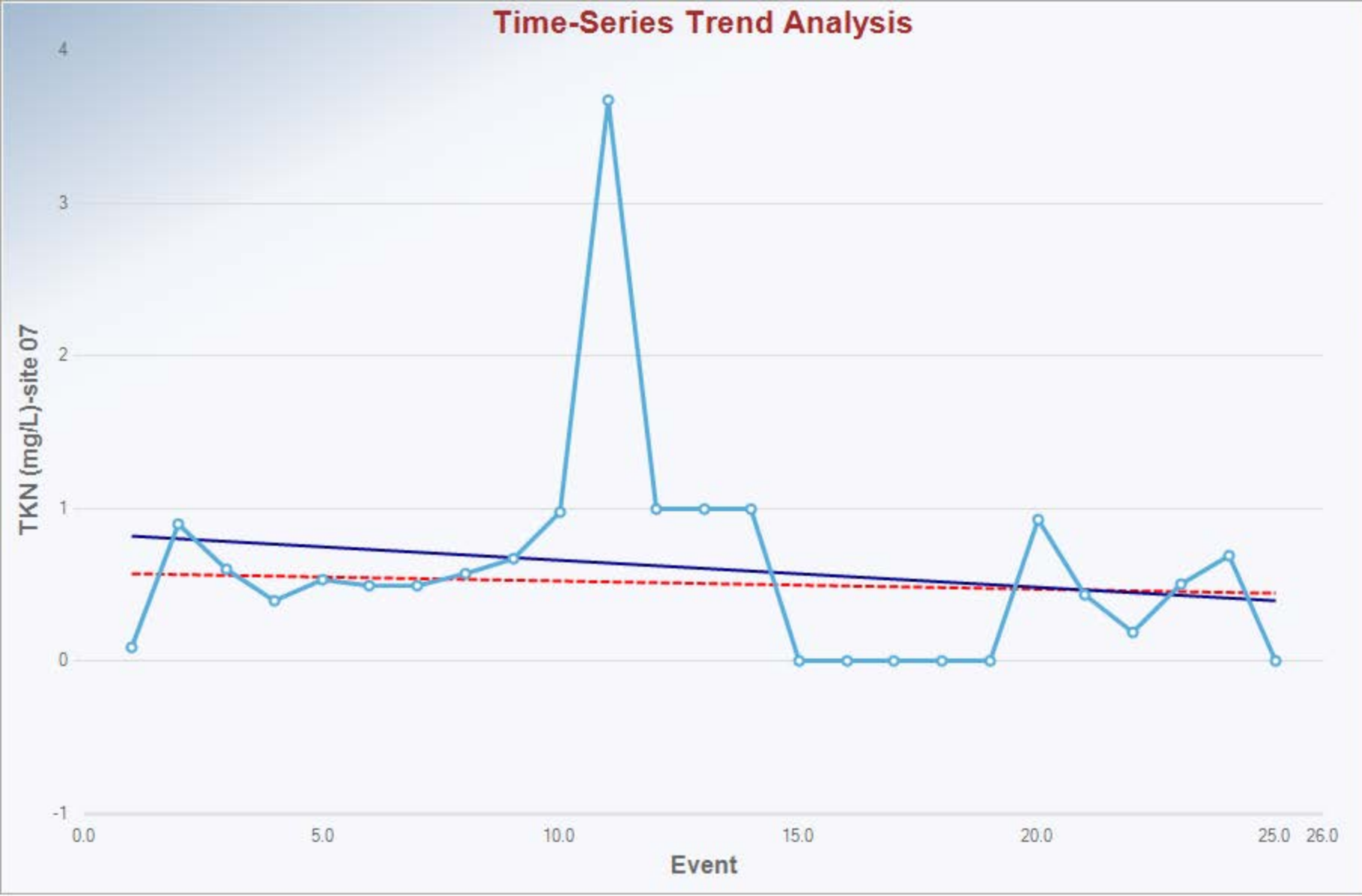
Level of Significance	0.0500
M1	108.7631
M2	191.2369
LCL of Slope	-0.0264
UCL of Slope	0.0085

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.0793
M-K Standardized Val (S)	-0.5941
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2762

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0175
OLS Regression Intercept	0.8356

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0050
Theil-Sen Intercept	0.5750

Theil-Sen Trend Analysis

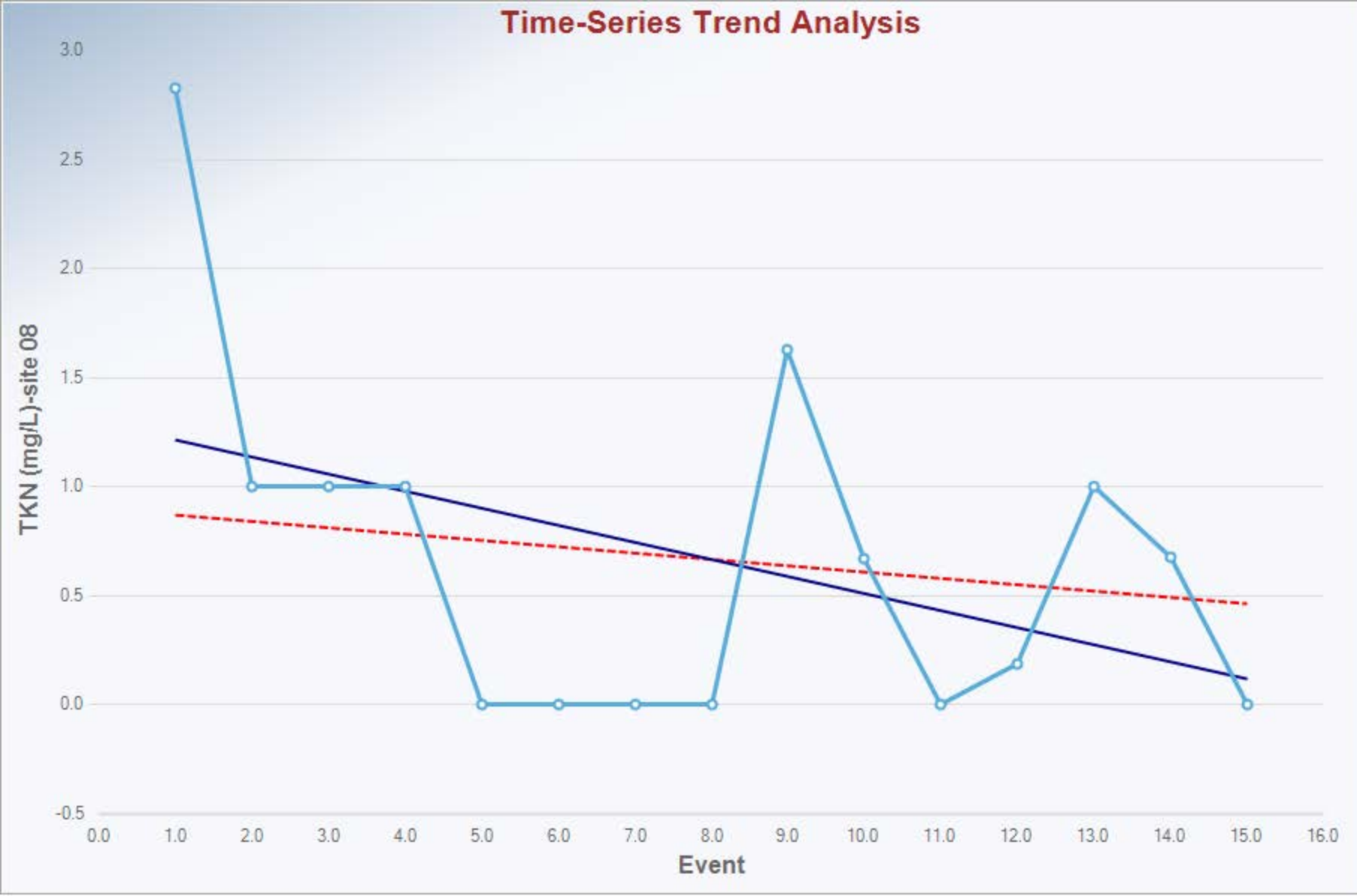
Level of Significance	0.0500
M1	108.4190
M2	191.5810
LCL of Slope	-0.0347
UCL of Slope	0.0100

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.4303
M-K Standardized Val (S)	-0.7542
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2254

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	15

OLS Regression Line (Blue)

OLS Regression Slope	-0.0786
OLS Regression Intercept	1.2952

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0291
Theil-Sen Intercept	0.9027

Theil-Sen Trend Analysis

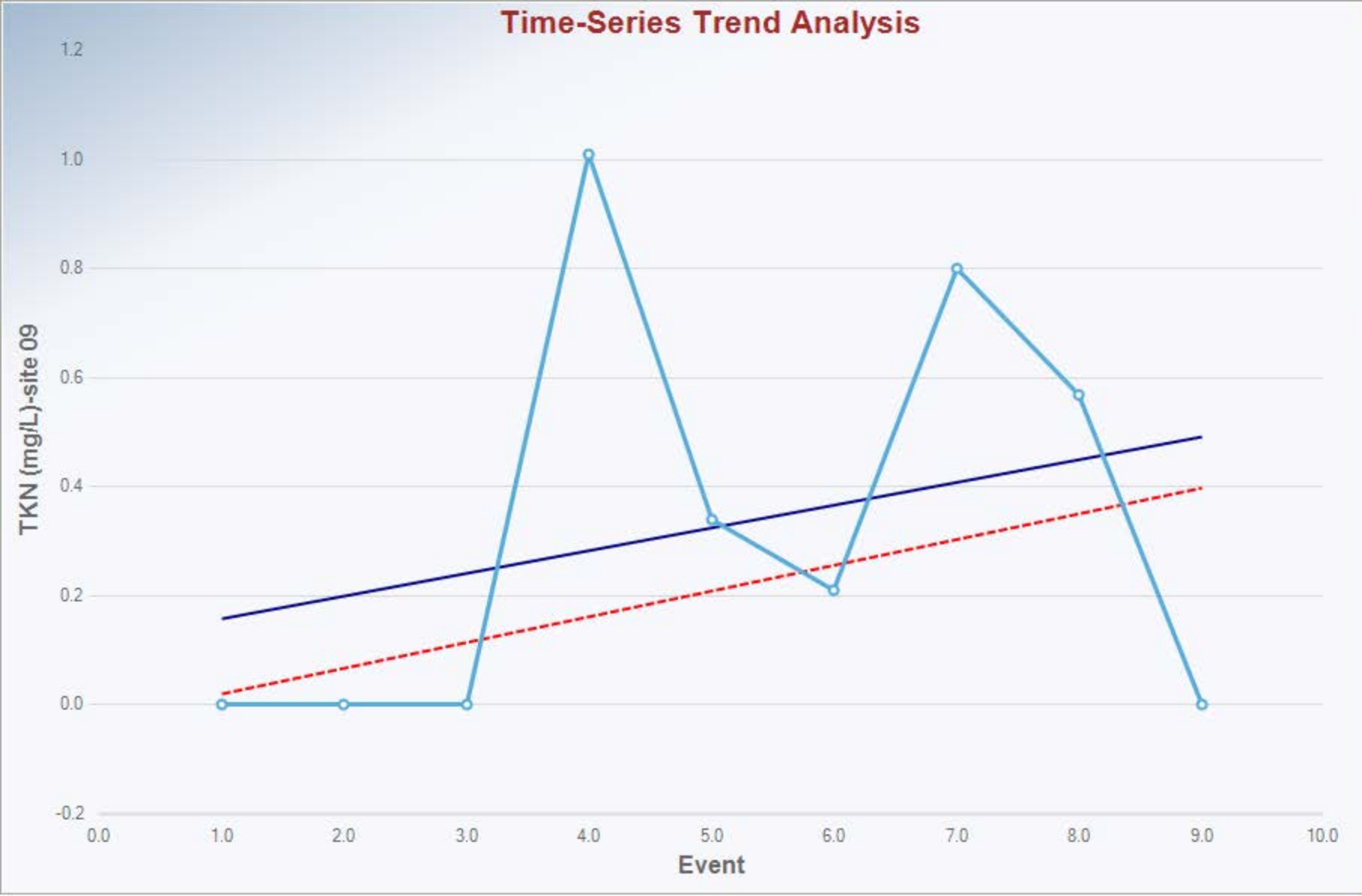
Level of Significance	0.0500
M1	33.6157
M2	71.3843
LCL of Slope	-0.1659
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	19.2700
M-K Test Value (S)	-24
Tabulated p-value	0.1200

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	9

OLS Regression Line (Blue)

OLS Regression Slope	0.0418
OLS Regression Intercept	0.1164

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0473
Theil-Sen Intercept	-0.0263

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	9.0540
M2	26.9460
LCL of Slope	-0.0842
UCL of Slope	0.1323

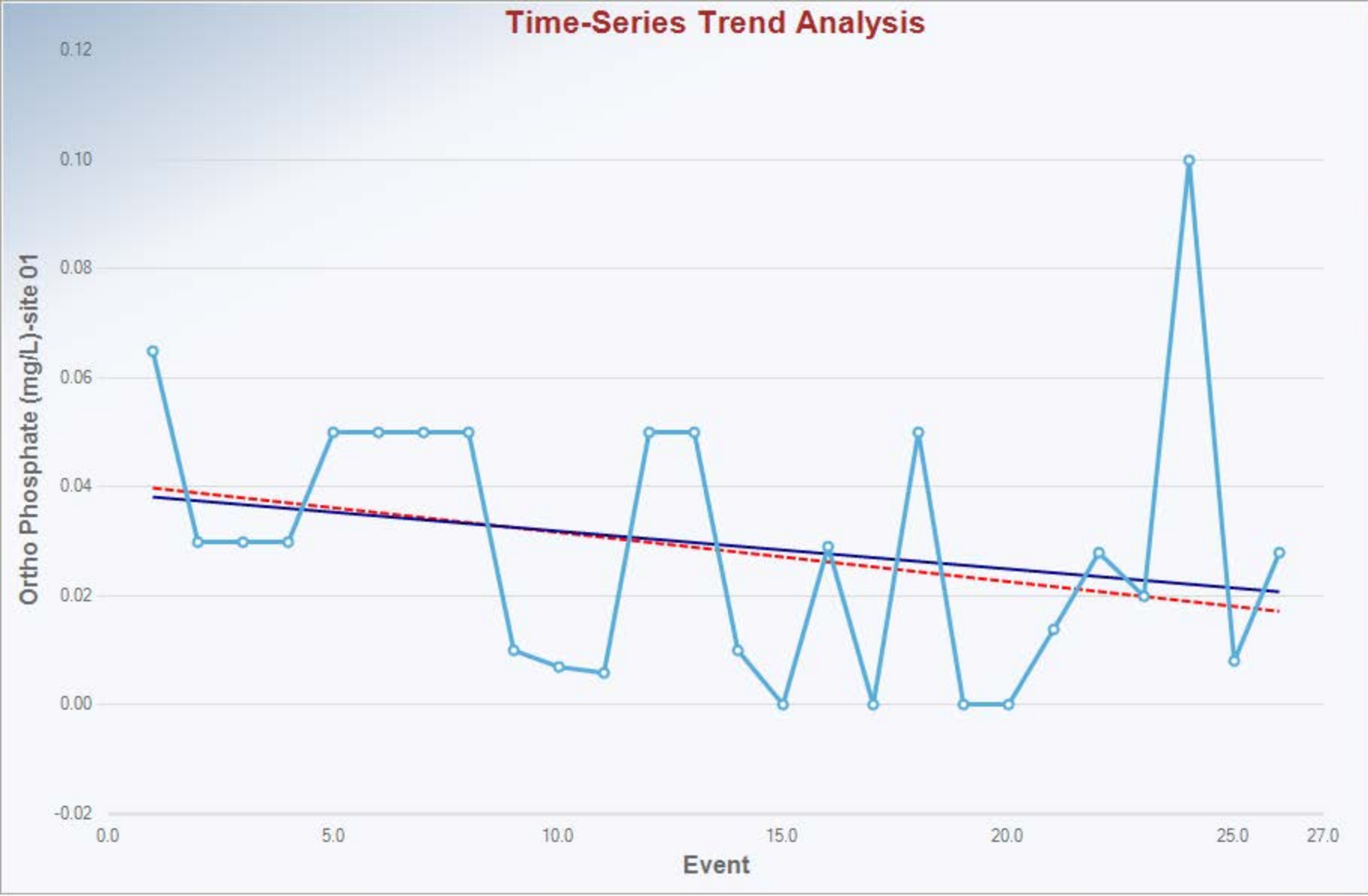
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	9.1287
M-K Test Value (S)	8
Tabulated p-value	0.2380

Insufficient evidence of a significant trend

Ortho Phosphate Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0007
OLS Regression Intercept	0.0388

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0009
Theil-Sen Intercept	0.0408

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.6775
M2	206.3225
LCL of Slope	-0.0020
UCL of Slope	0.0000

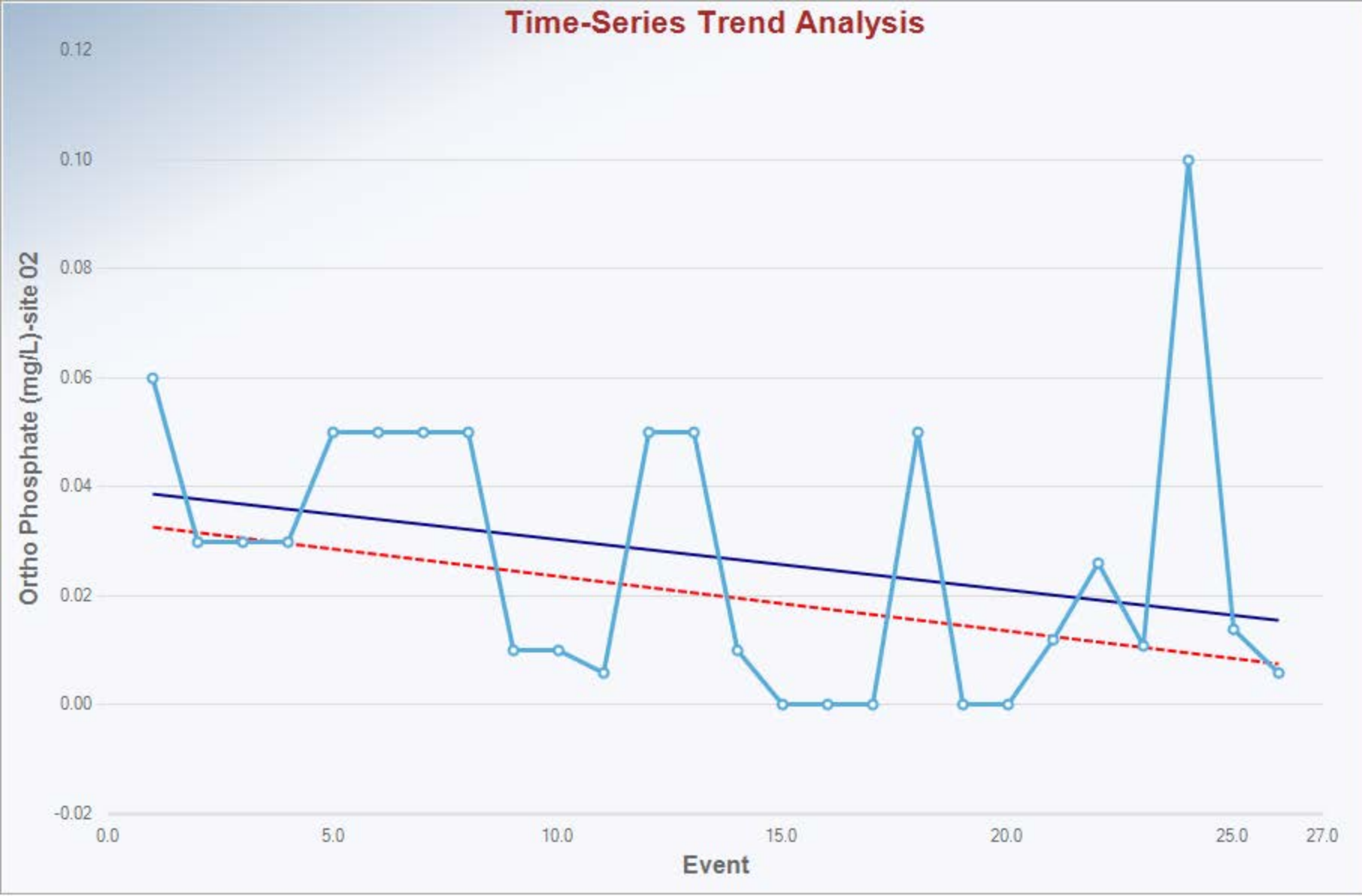
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.7176
M-K Standardized Val (S)	-1.7443
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0406

Significant evidence of a decreasing trend

Time-Series Trend Analysis



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0009
OLS Regression Intercept	0.0397

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0010
Theil-Sen Intercept	0.0335

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.7946
M2	206.2054
LCL of Slope	-0.0021
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.5982
M-K Standardized Val (S)	-1.8386
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0330

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0003
OLS Regression Intercept	0.0292

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0005
Theil-Sen Intercept	0.0271

Theil-Sen Trend Analysis

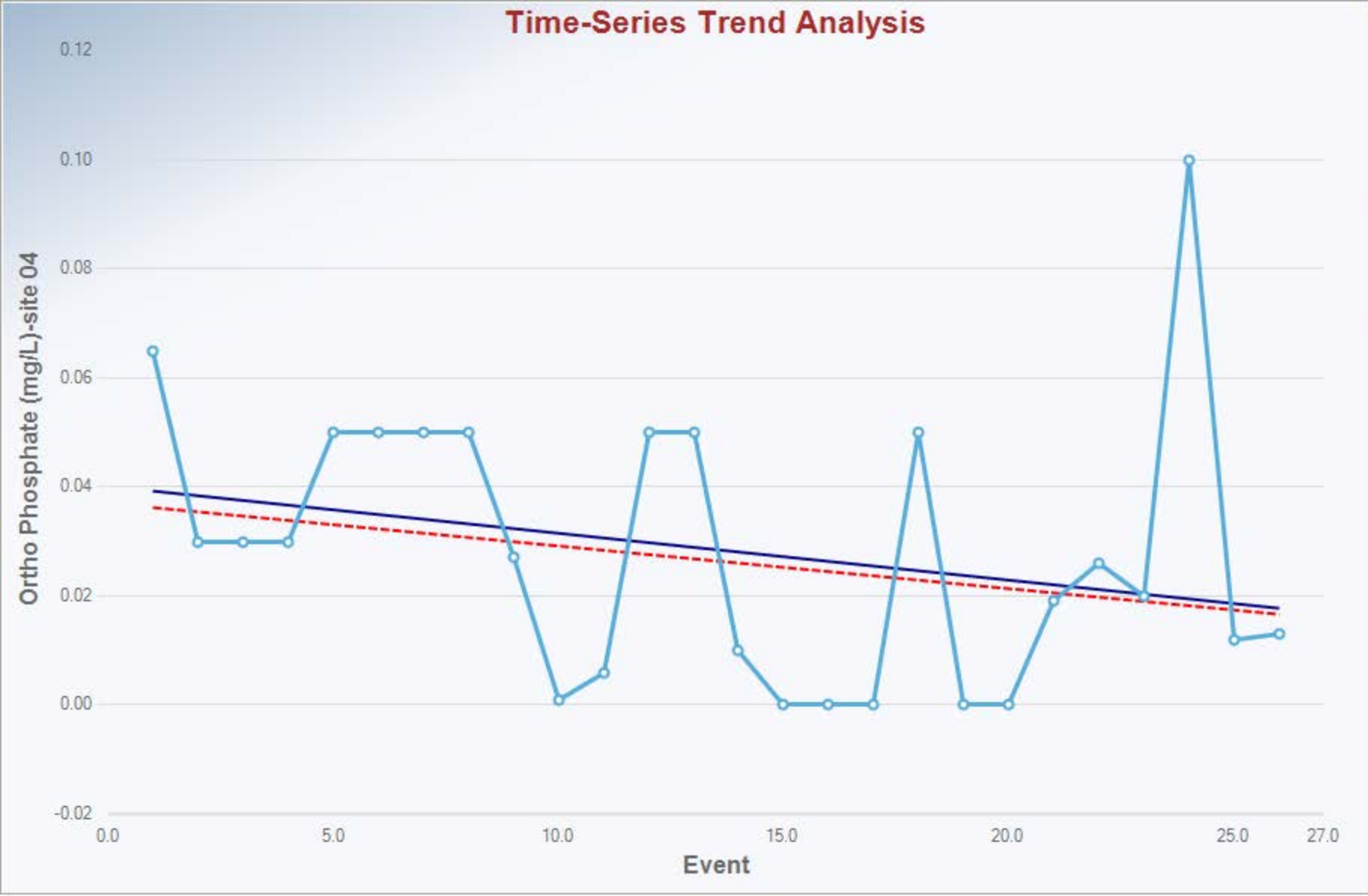
Level of Significance	0.0500
M1	118.6228
M2	206.3772
LCL of Slope	-0.0019
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.7735
M-K Standardized Val (S)	-1.3177
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0938

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0009
OLS Regression Intercept	0.0401

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0008
Theil-Sen Intercept	0.0371

Theil-Sen Trend Analysis

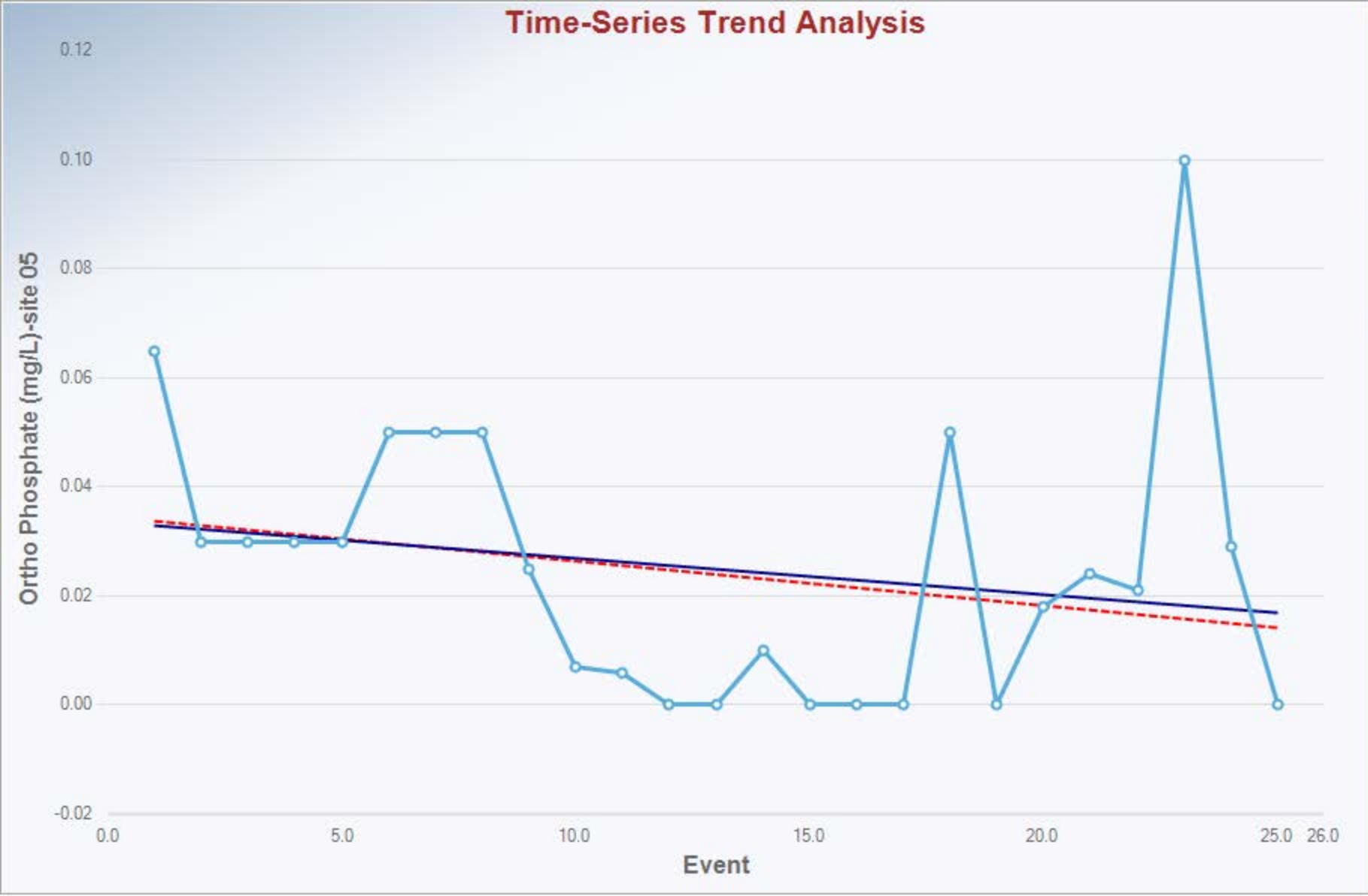
Level of Significance	0.0500
M1	118.7433
M2	206.2567
LCL of Slope	-0.0021
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.6505
M-K Standardized Val (S)	-1.8813
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0300

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0007
OLS Regression Intercept	0.0337

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0008
Theil-Sen Intercept	0.0346

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	108.7514
M2	191.2486
LCL of Slope	-0.0022
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.0912
M-K Standardized Val (S)	-1.9006
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0287

Significant evidence of a decreasing trend

Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0007
OLS Regression Intercept	0.0334

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0009
Theil-Sen Intercept	0.0273

Theil-Sen Trend Analysis

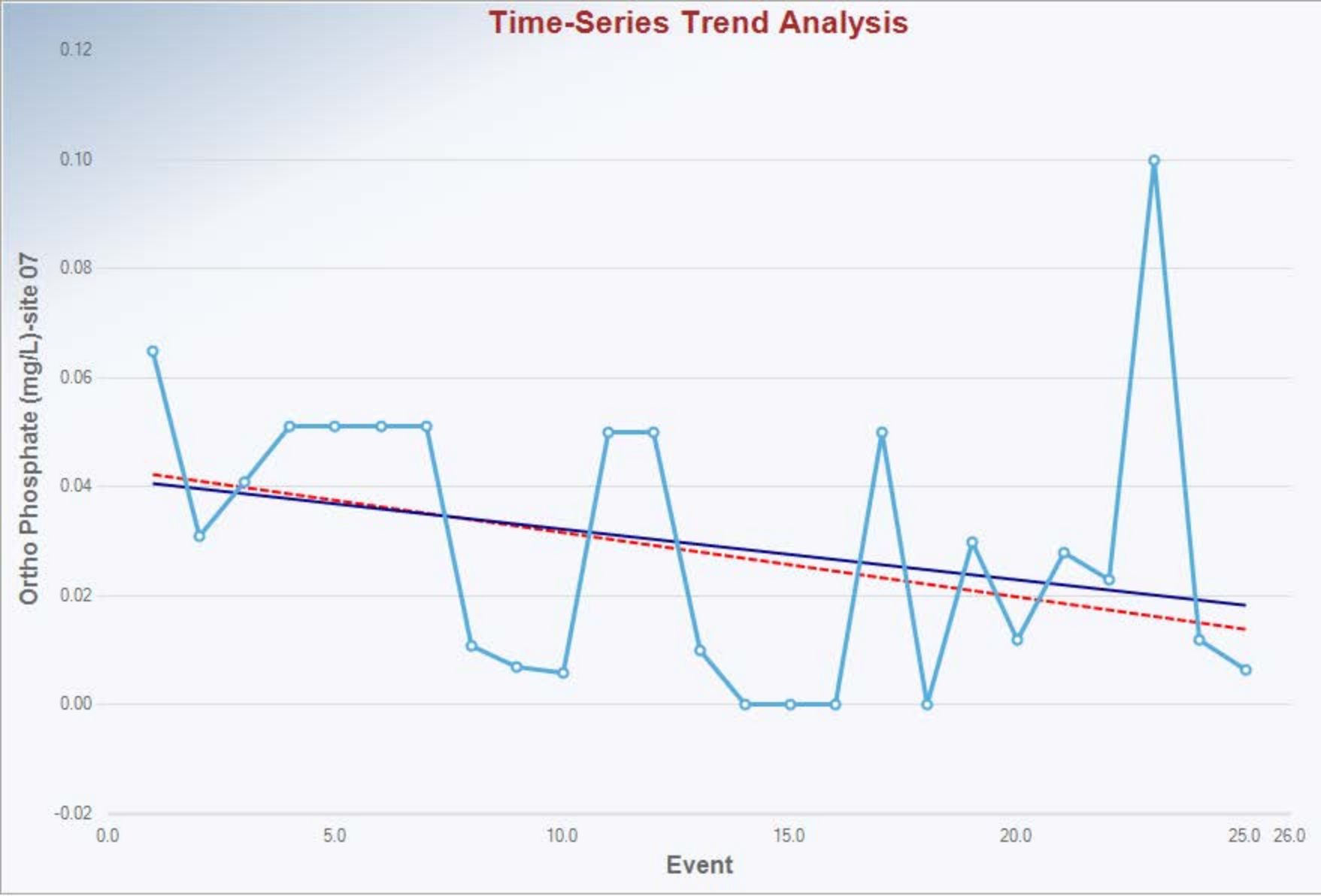
Level of Significance	0.0500
M1	118.7946
M2	206.2054
LCL of Slope	-0.0020
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	44.5982
M-K Standardized Val (S)	-1.6593
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0485

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0009
OLS Regression Intercept	0.0415

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0012
Theil-Sen Intercept	0.0434

Theil-Sen Trend Analysis

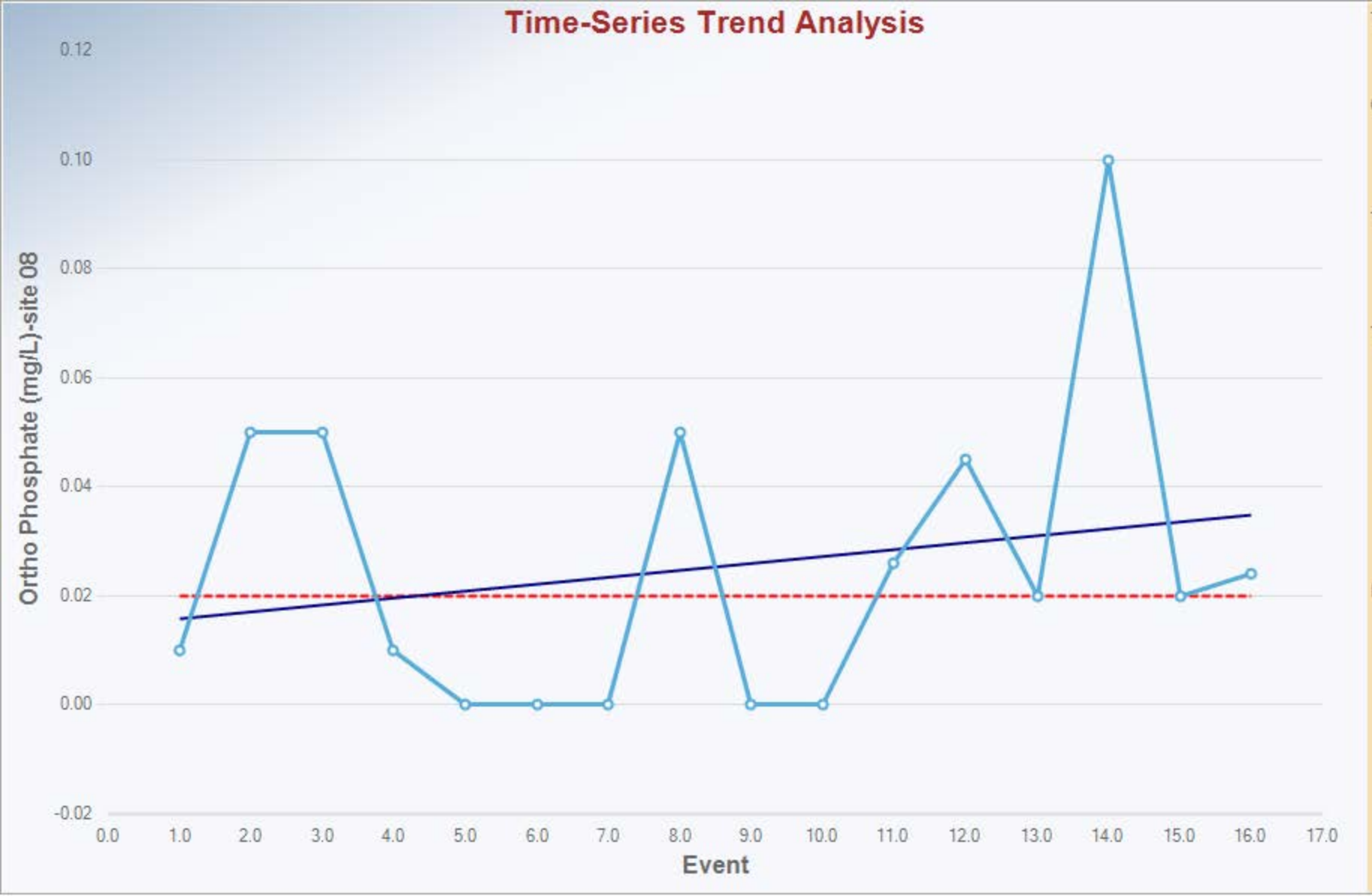
Level of Significance	0.0500
M1	108.2922
M2	191.7078
LCL of Slope	-0.0024
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.5598
M-K Standardized Val (S)	-1.9972
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0229

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	0.0013
OLS Regression Intercept	0.0146

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0200

Theil-Sen Trend Analysis

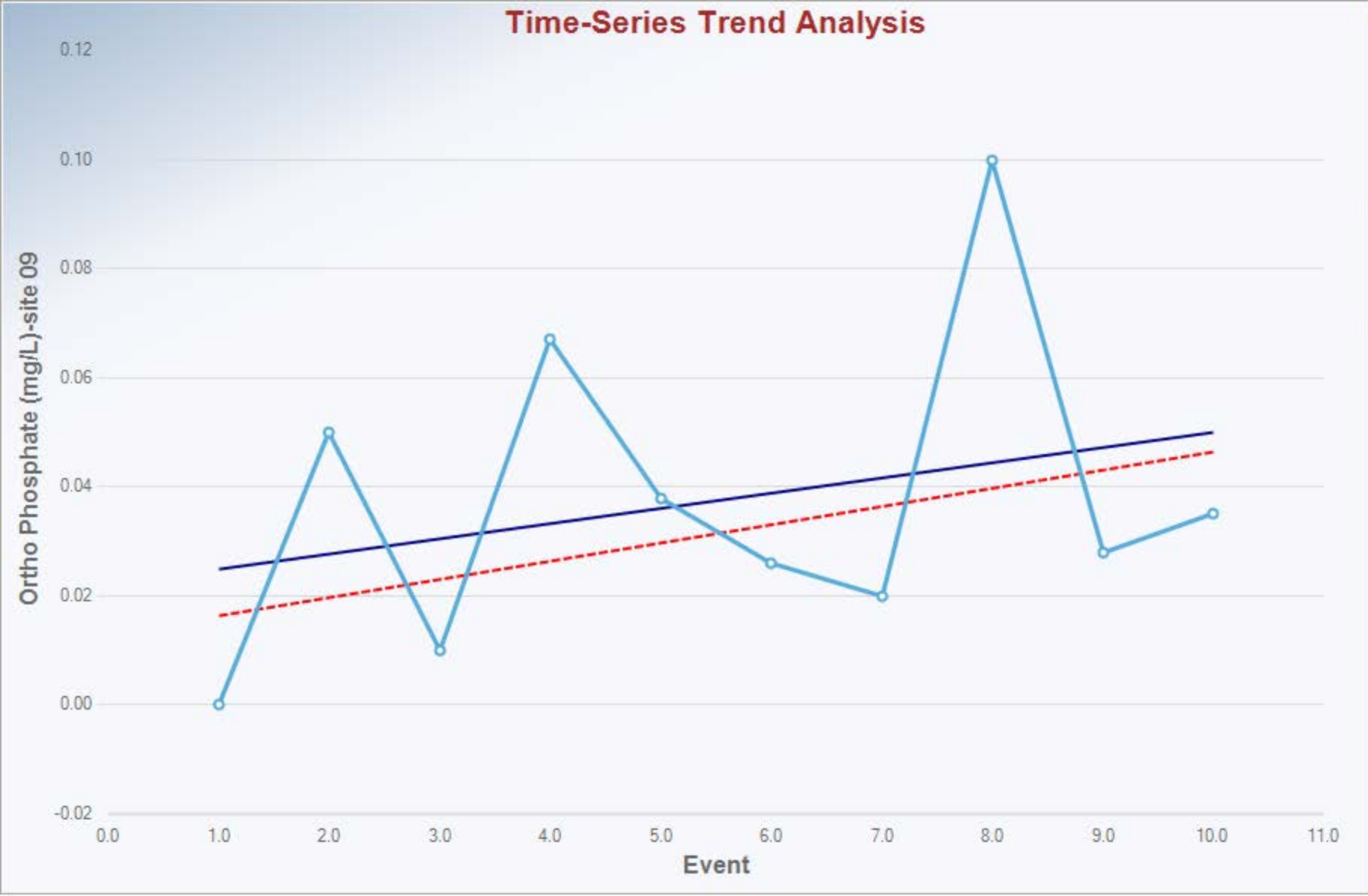
Level of Significance	0.0500
M1	38.7319
M2	81.2681
LCL of Slope	-0.0017
UCL of Slope	0.0033

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	21.7025
M-K Test Value (S)	11
Tabulated p-value	0.3450

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	0.0028
OLS Regression Intercept	0.0221

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0033
Theil-Sen Intercept	0.0132

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	11.5435
M2	33.4565
LCL of Slope	-0.0060
UCL of Slope	0.0083

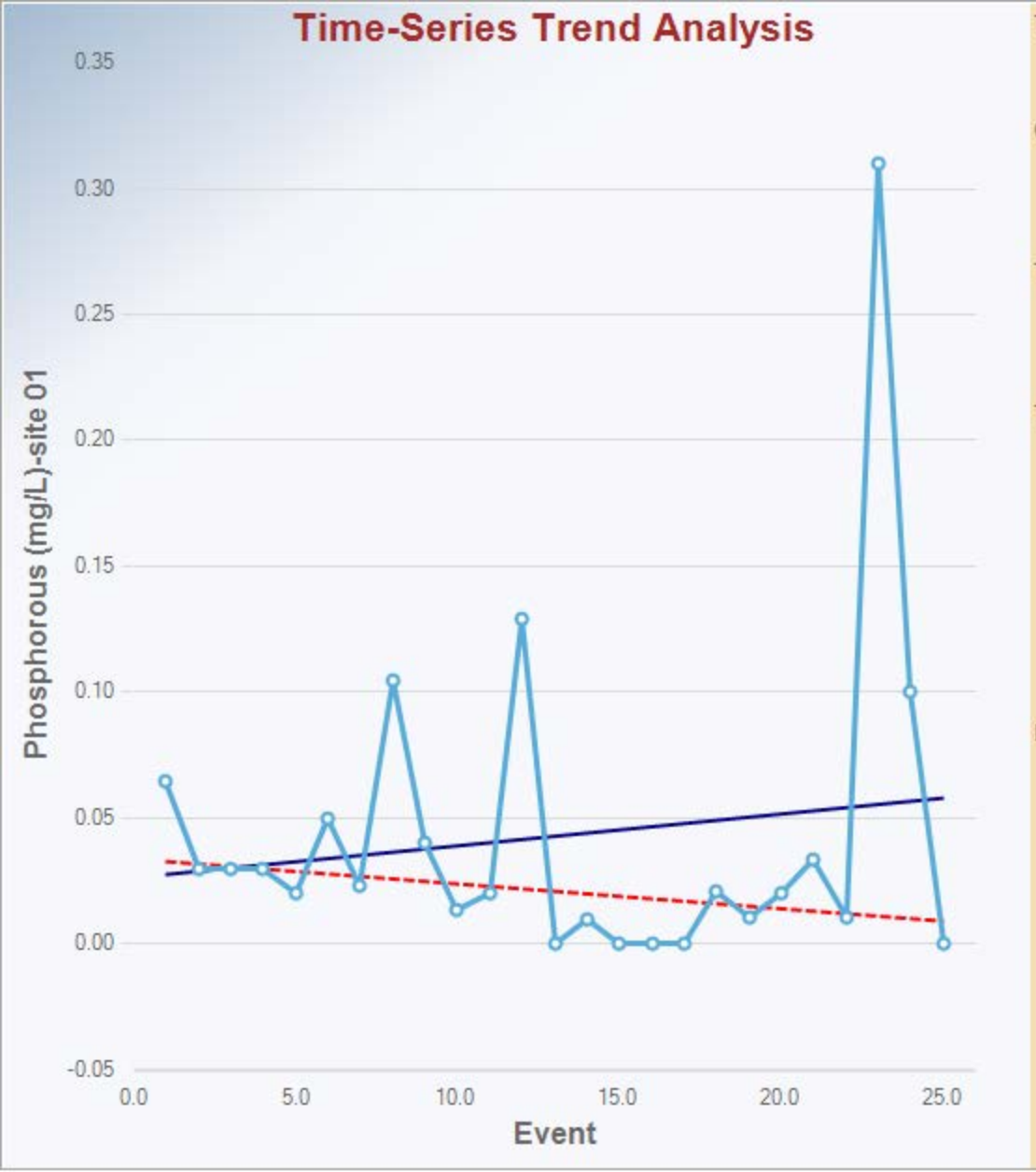
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	11.1803
M-K Test Value (S)	9
Tabulated p-value	0.2420

Insufficient evidence of a significant trend

Phosphorous Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0013
OLS Regression Intercept	0.0262

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0010
Theil-Sen Intercept	0.0337

Theil-Sen Trend Analysis

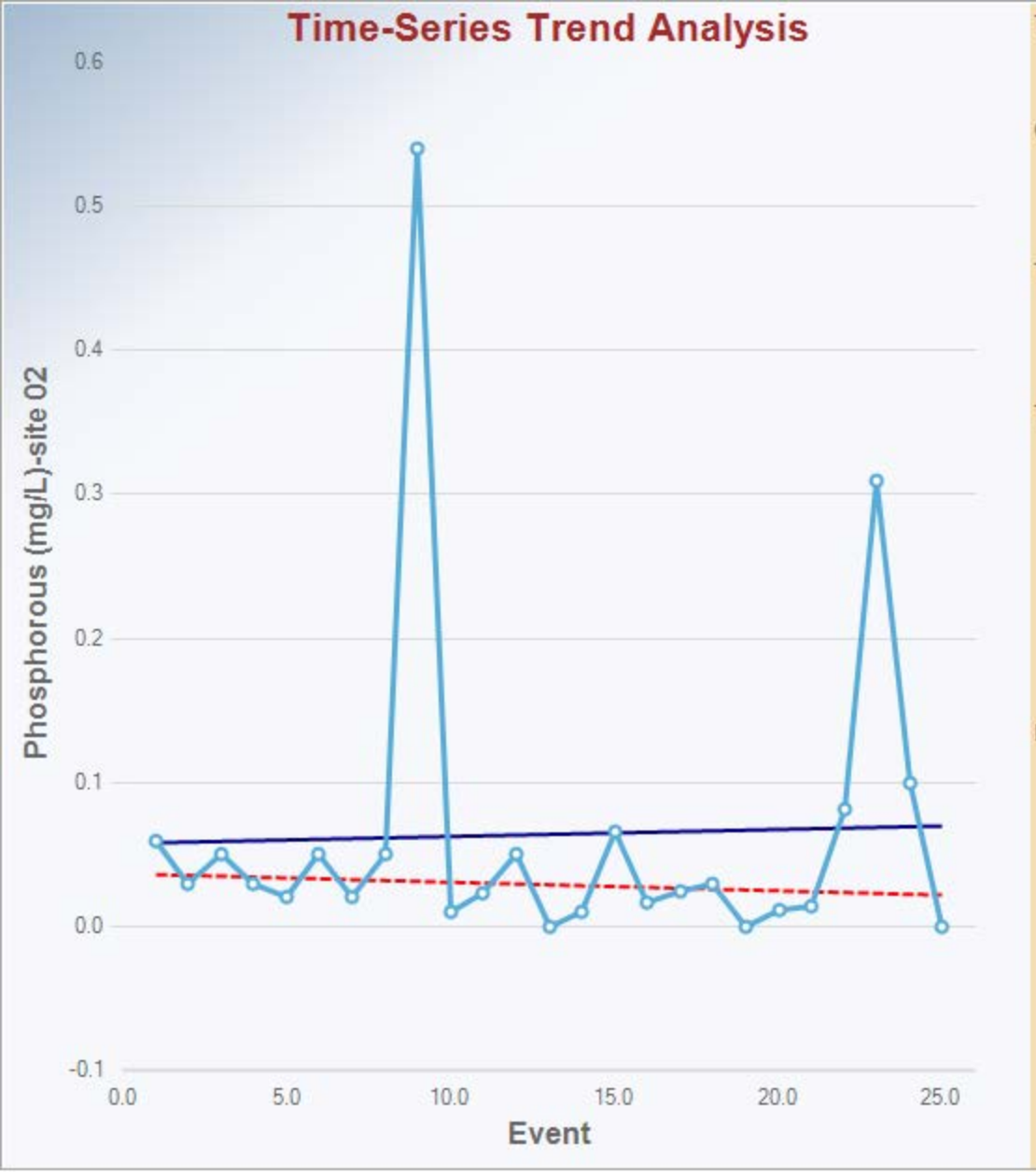
Level of Significance	0.0500
M1	108.3268
M2	191.6732
LCL of Slope	-0.0023
UCL of Slope	0.0002

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.5245
M-K Standardized Val (S)	-1.3639
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0863

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0004
OLS Regression Intercept	0.0581

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0006
Theil-Sen Intercept	0.0369

Theil-Sen Trend Analysis

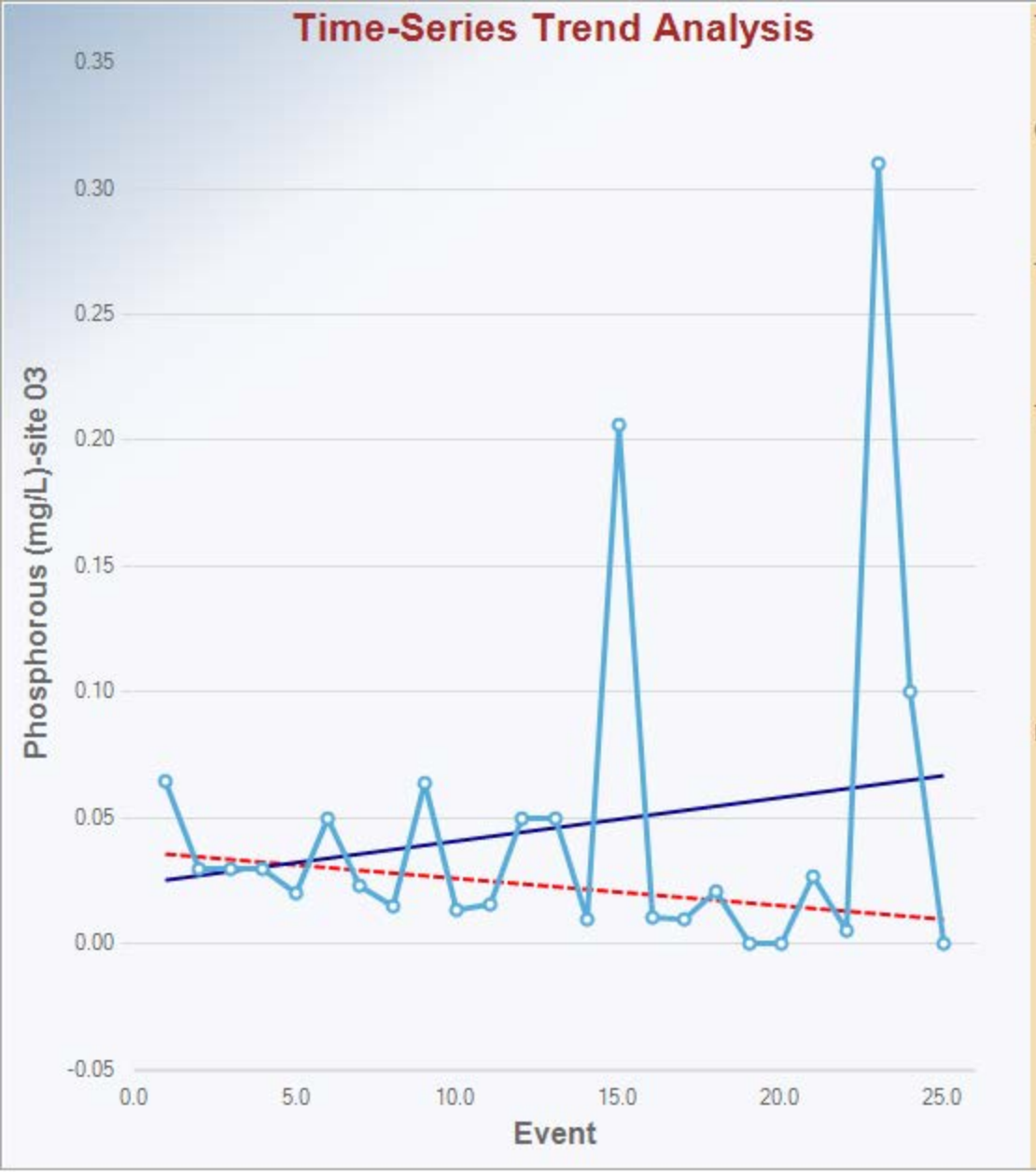
Level of Significance	0.0500
M1	108.2155
M2	191.7845
LCL of Slope	-0.0022
UCL of Slope	0.0017

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.6380
M-K Standardized Val (S)	-0.7271
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2336

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0018
OLS Regression Intercept	0.0235

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0011
Theil-Sen Intercept	0.0367

Theil-Sen Trend Analysis

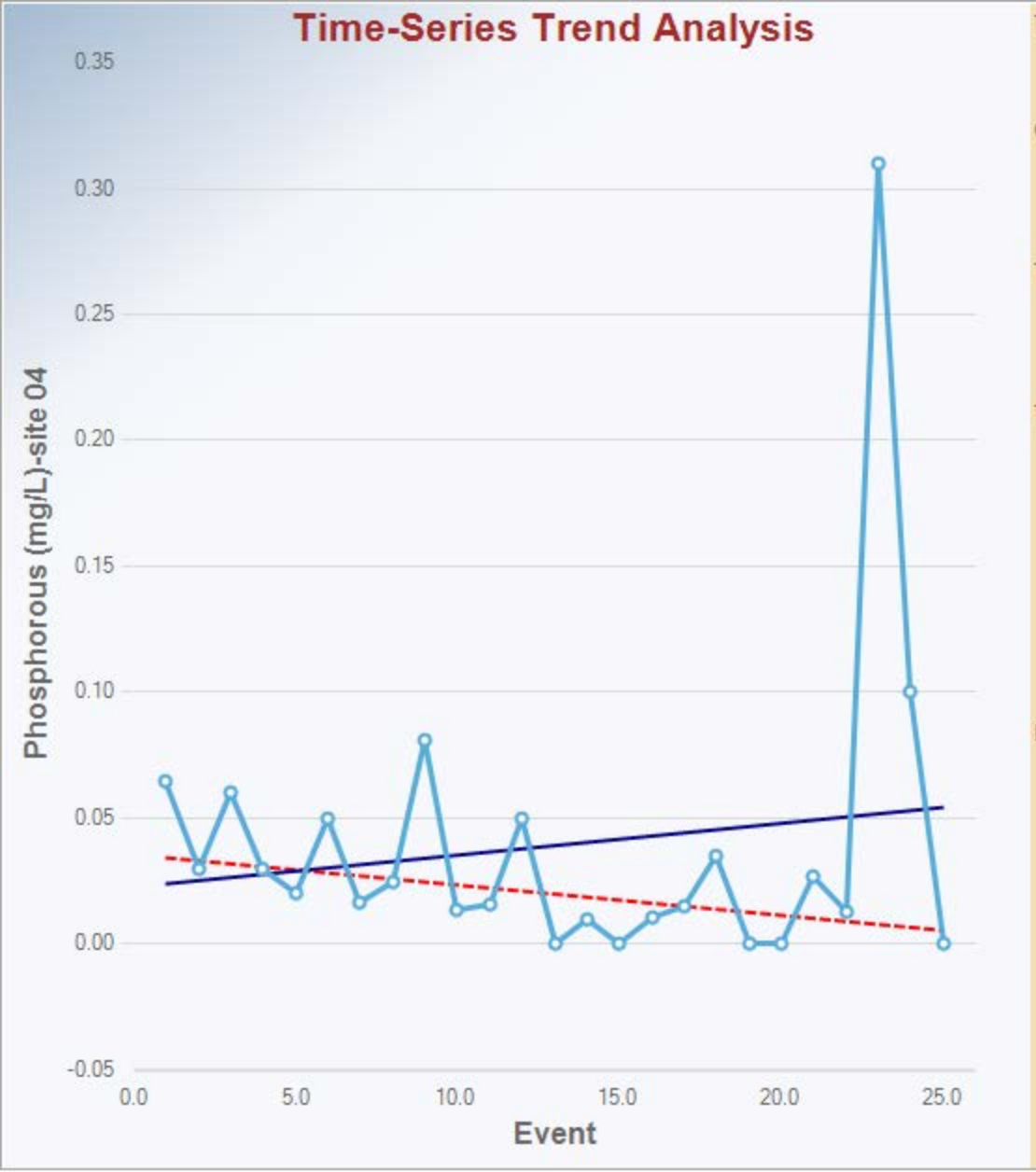
Level of Significance	0.0500
M1	108.1772
M2	191.8228
LCL of Slope	-0.0018
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.6771
M-K Standardized Val (S)	-1.7105
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0436

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0013
OLS Regression Intercept	0.0227

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0012
Theil-Sen Intercept	0.0353

Theil-Sen Trend Analysis

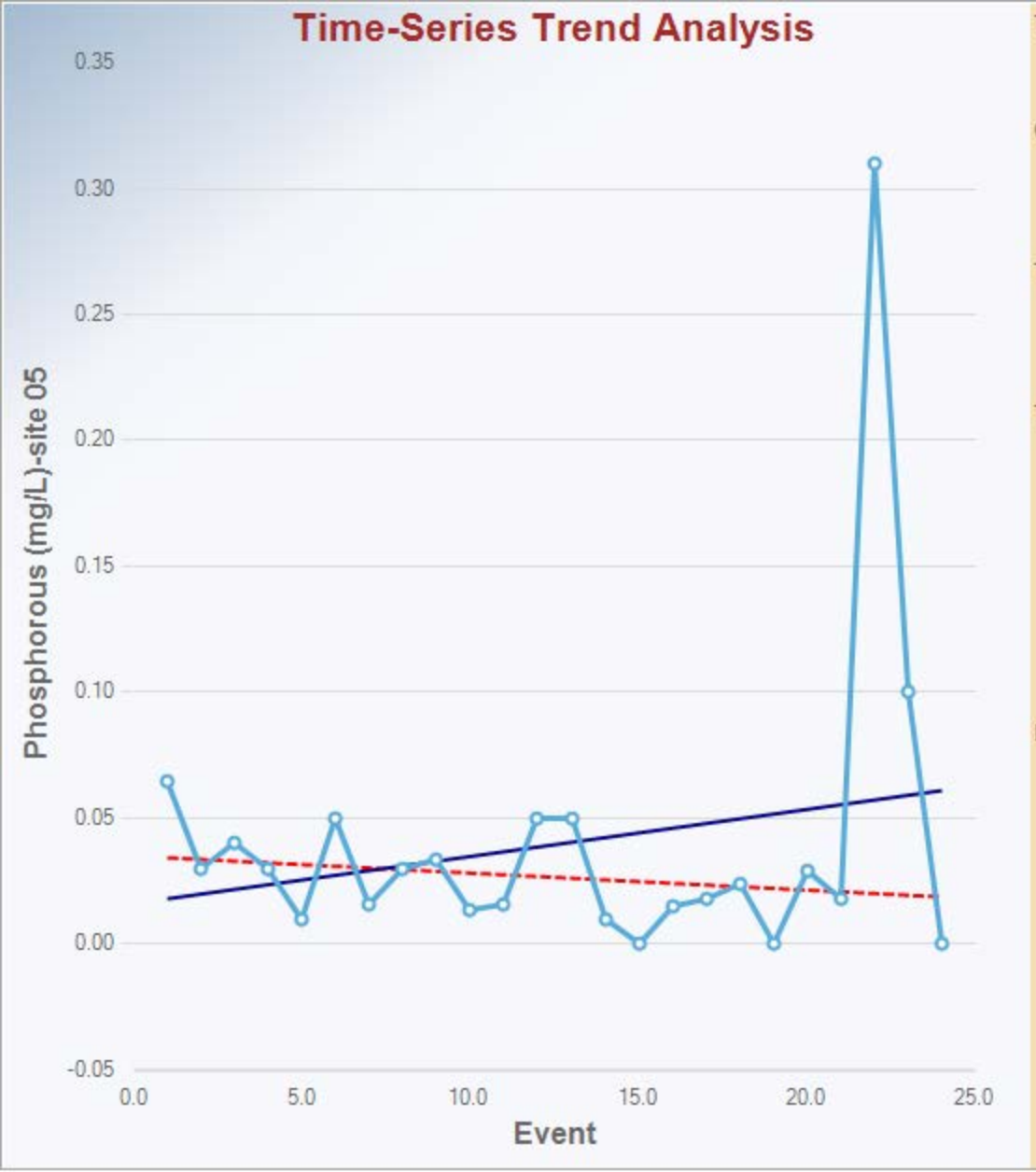
Level of Significance	0.0500
M1	108.2538
M2	191.7462
LCL of Slope	-0.0023
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.5989
M-K Standardized Val (S)	-1.8076
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0353

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	24

OLS Regression Line (Blue)

OLS Regression Slope	0.0019
OLS Regression Intercept	0.0166

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0007
Theil-Sen Intercept	0.0351

Theil-Sen Trend Analysis

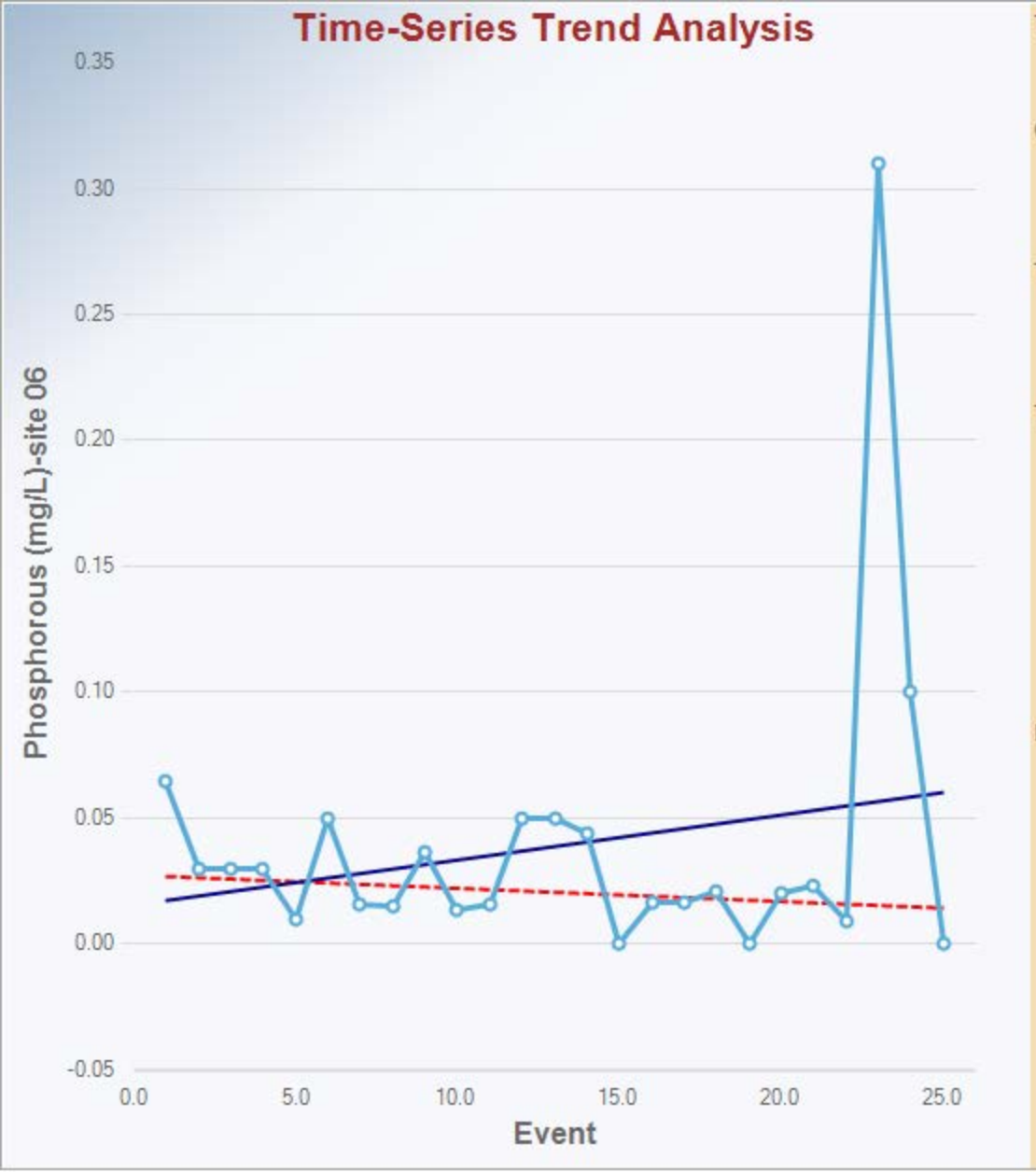
Level of Significance	0.0500
M1	98.6621
M2	177.3379
LCL of Slope	-0.0020
UCL of Slope	0.0008

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	40.1414
M-K Standardized Val (S)	-0.9217
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1783

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0018
OLS Regression Intercept	0.0158

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0005
Theil-Sen Intercept	0.0279

Theil-Sen Trend Analysis

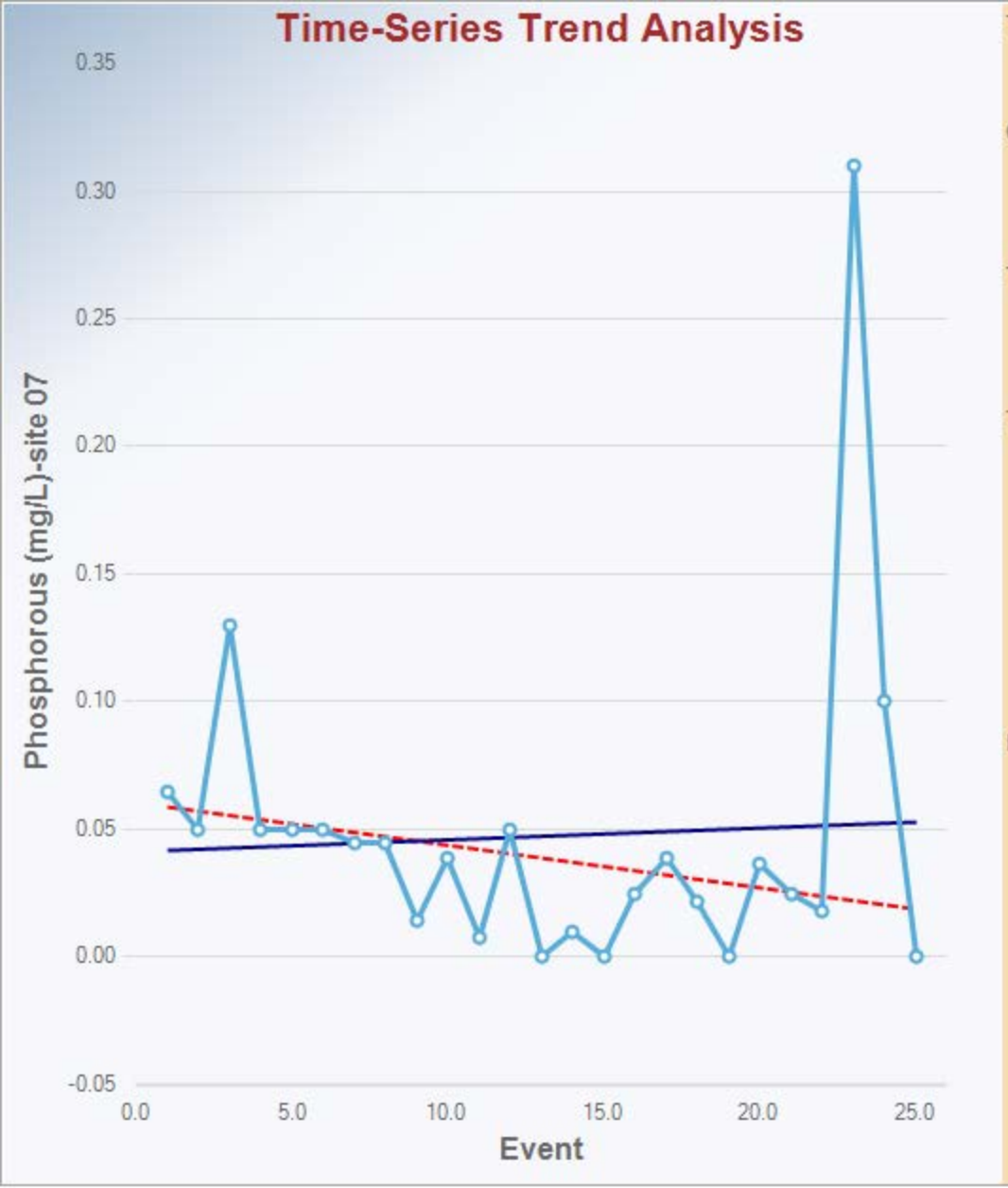
Level of Significance	0.0500
M1	108.1887
M2	191.8113
LCL of Slope	-0.0018
UCL of Slope	0.0007

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.6654
M-K Standardized Val (S)	-0.7031
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2410

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0005
OLS Regression Intercept	0.0413

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0017
Theil-Sen Intercept	0.0607

Theil-Sen Trend Analysis

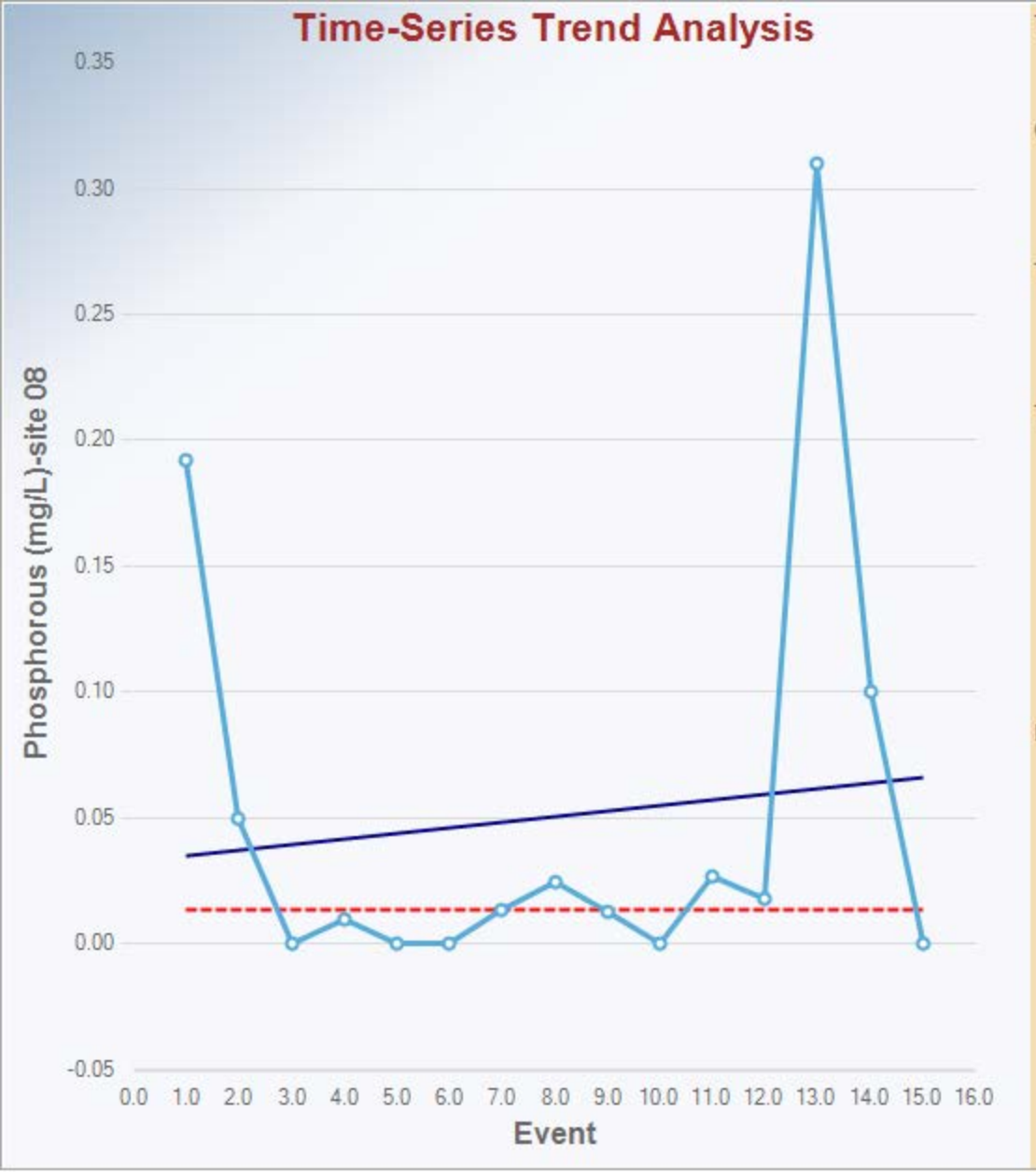
Level of Significance	0.0500
M1	108.3652
M2	191.6348
LCL of Slope	-0.0027
UCL of Slope	-0.0001

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.4853
M-K Standardized Val (S)	-2.3538
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0093

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	15

OLS Regression Line (Blue)

OLS Regression Slope	0.0022
OLS Regression Intercept	0.0329

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	0.0140

Theil-Sen Trend Analysis

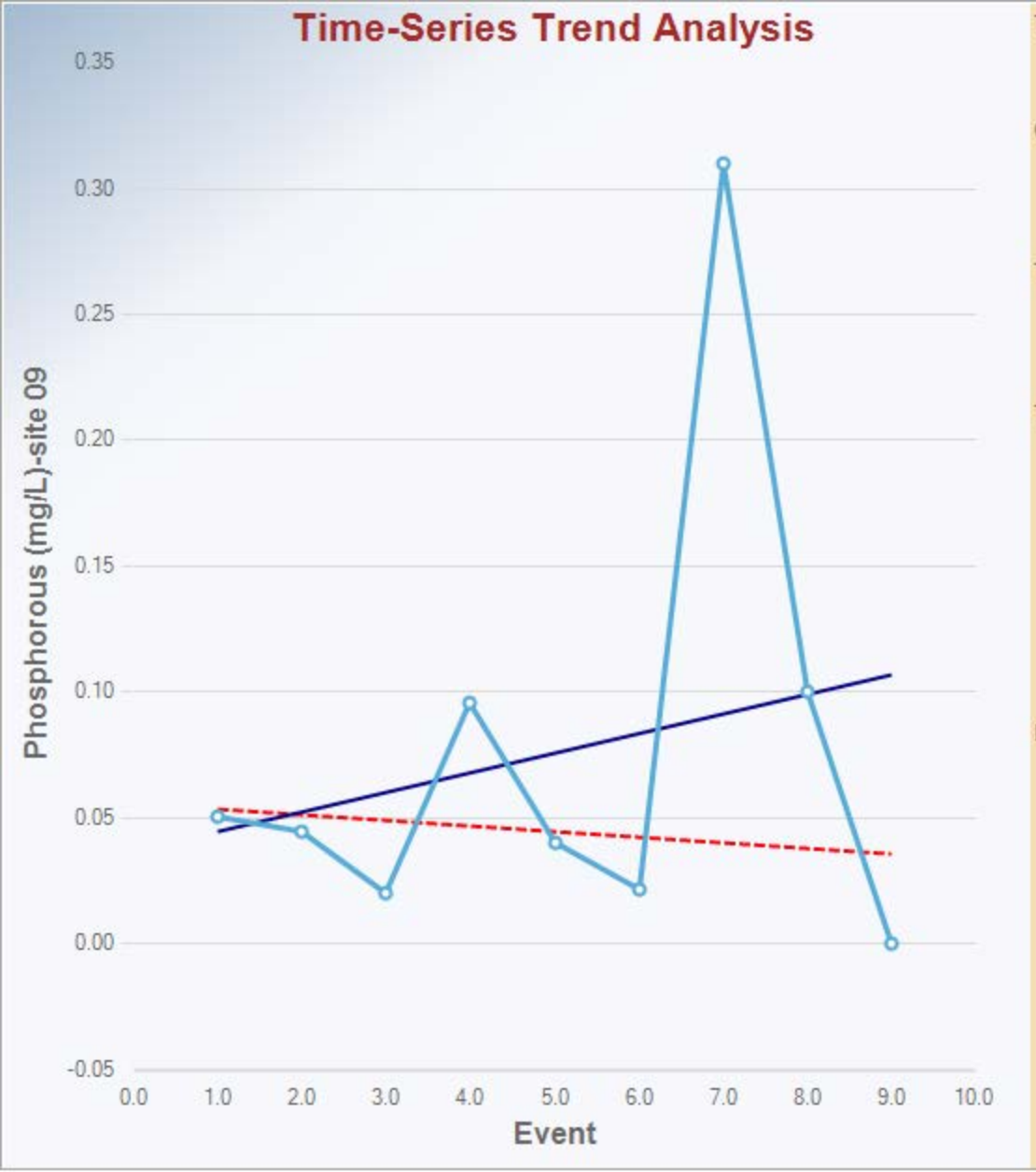
Level of Significance	0.0500
M1	33.1056
M2	71.8944
LCL of Slope	-0.0041
UCL of Slope	0.0045

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	19.7906
M-K Test Value (S)	9
Tabulated p-value	0.3490

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	9

OLS Regression Line (Blue)

OLS Regression Slope	0.0078
OLS Regression Intercept	0.0371

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0022
Theil-Sen Intercept	0.0560

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	8.6003
M2	27.3997
LCL of Slope	-0.0165
UCL of Slope	0.0222

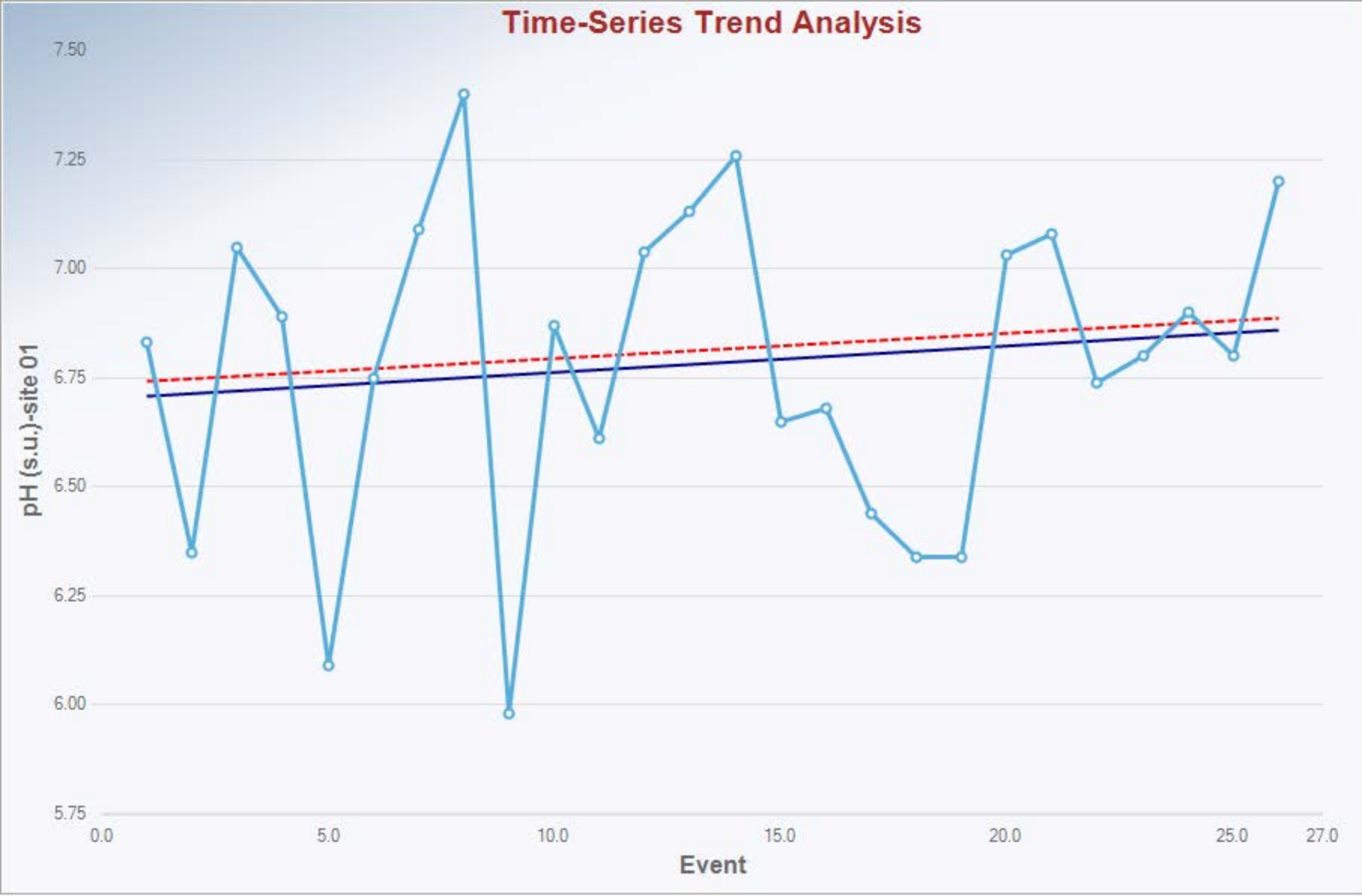
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	9.5917
M-K Test Value (S)	-2
Tabulated p-value	0.4600

Insufficient evidence of a significant trend

pH Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.0061
OLS Regression Intercept	6.7000

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0058
Theil-Sen Intercept	6.7368

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.0609
M2	206.9391
LCL of Slope	-0.0161
UCL of Slope	0.0240

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3468
M-K Standardized Val (S)	0.4410
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.3296

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.0108
OLS Regression Intercept	6.5119

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0100
Theil-Sen Intercept	6.5150

Theil-Sen Trend Analysis

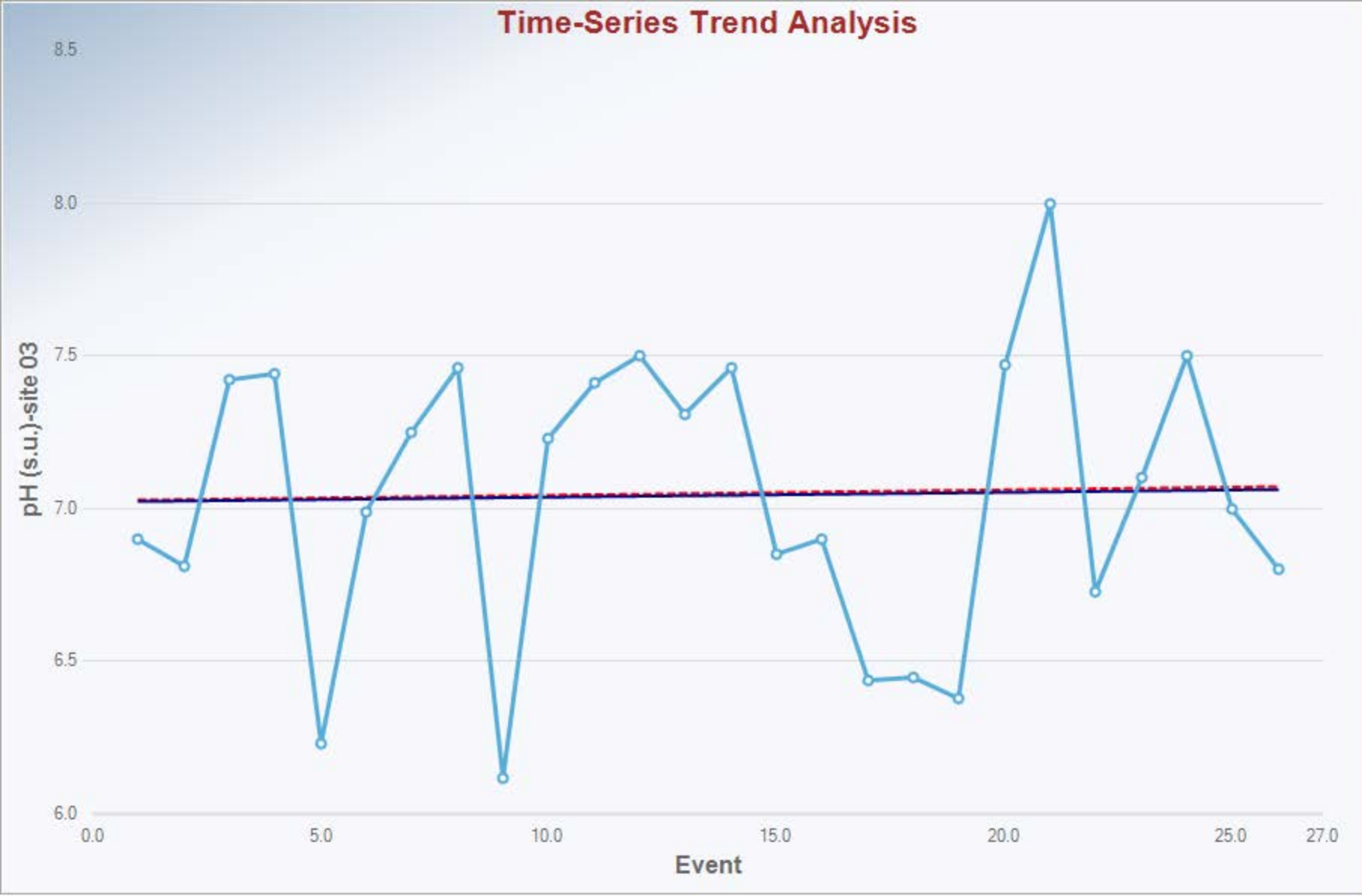
Level of Significance	0.0500
M1	118.0609
M2	206.9391
LCL of Slope	-0.0100
UCL of Slope	0.0283

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3468
M-K Standardized Val (S)	0.9703
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.1659

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.0016
OLS Regression Intercept	7.0220

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0019
Theil-Sen Intercept	7.0247

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	118.0717
M2	206.9283
LCL of Slope	-0.0270
UCL of Slope	0.0282

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3358
M-K Standardized Val (S)	0.1985
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.4213

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0021
OLS Regression Intercept	6.9796

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0044
Theil-Sen Intercept	7.0850

Theil-Sen Trend Analysis

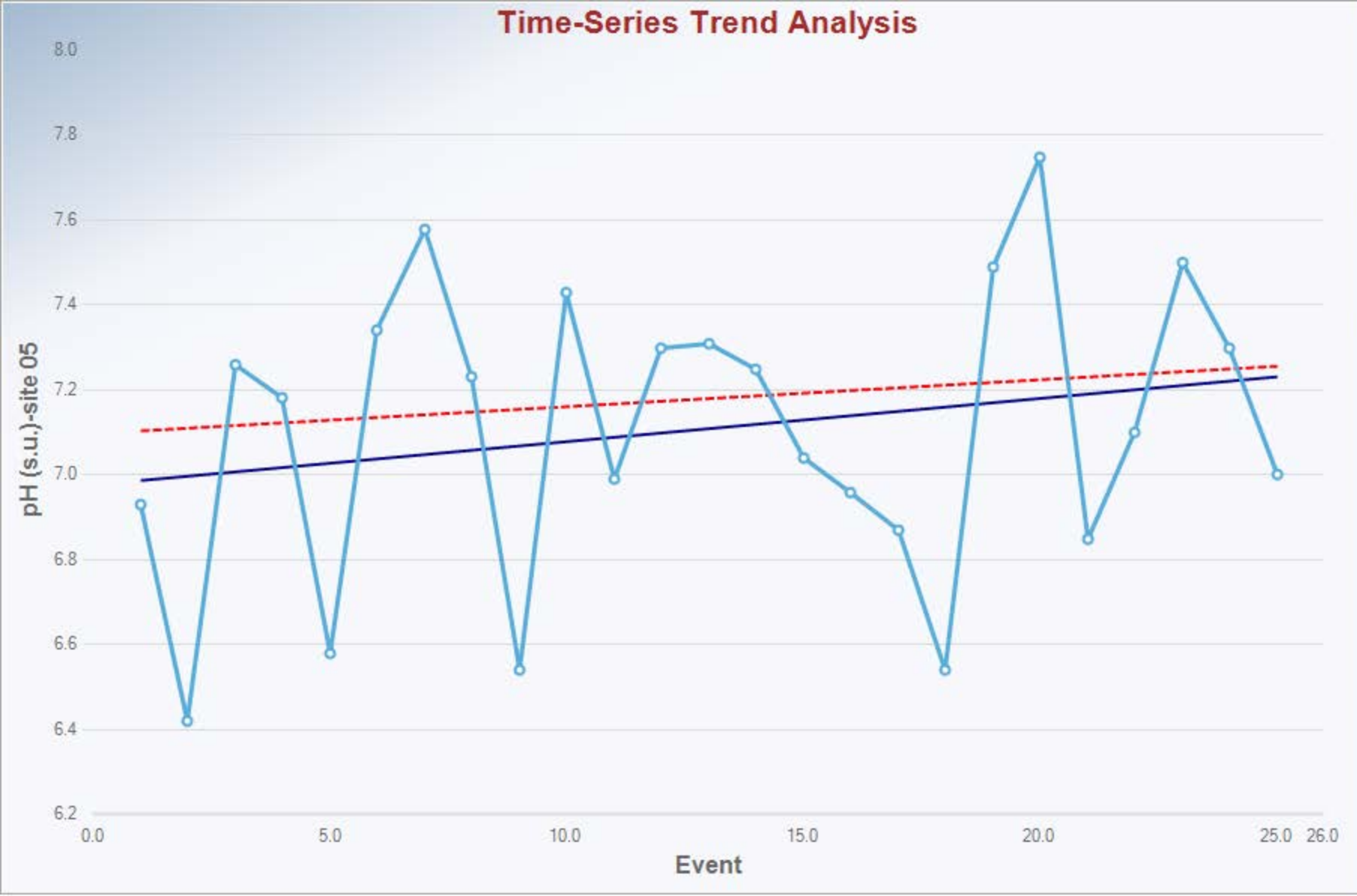
Level of Significance	0.0500
M1	118.0717
M2	206.9283
LCL of Slope	-0.0299
UCL of Slope	0.0143

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3358
M-K Standardized Val (S)	-0.3309
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.3704

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	0.0102
OLS Regression Intercept	6.9776

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0063
Theil-Sen Intercept	7.0977

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	108.0626
M2	191.9374
LCL of Slope	-0.0164
UCL of Slope	0.0271

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.7941
M-K Standardized Val (S)	0.6777
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.2490

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.0053
OLS Regression Intercept	7.0674

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0090
Theil-Sen Intercept	7.0829

Theil-Sen Trend Analysis

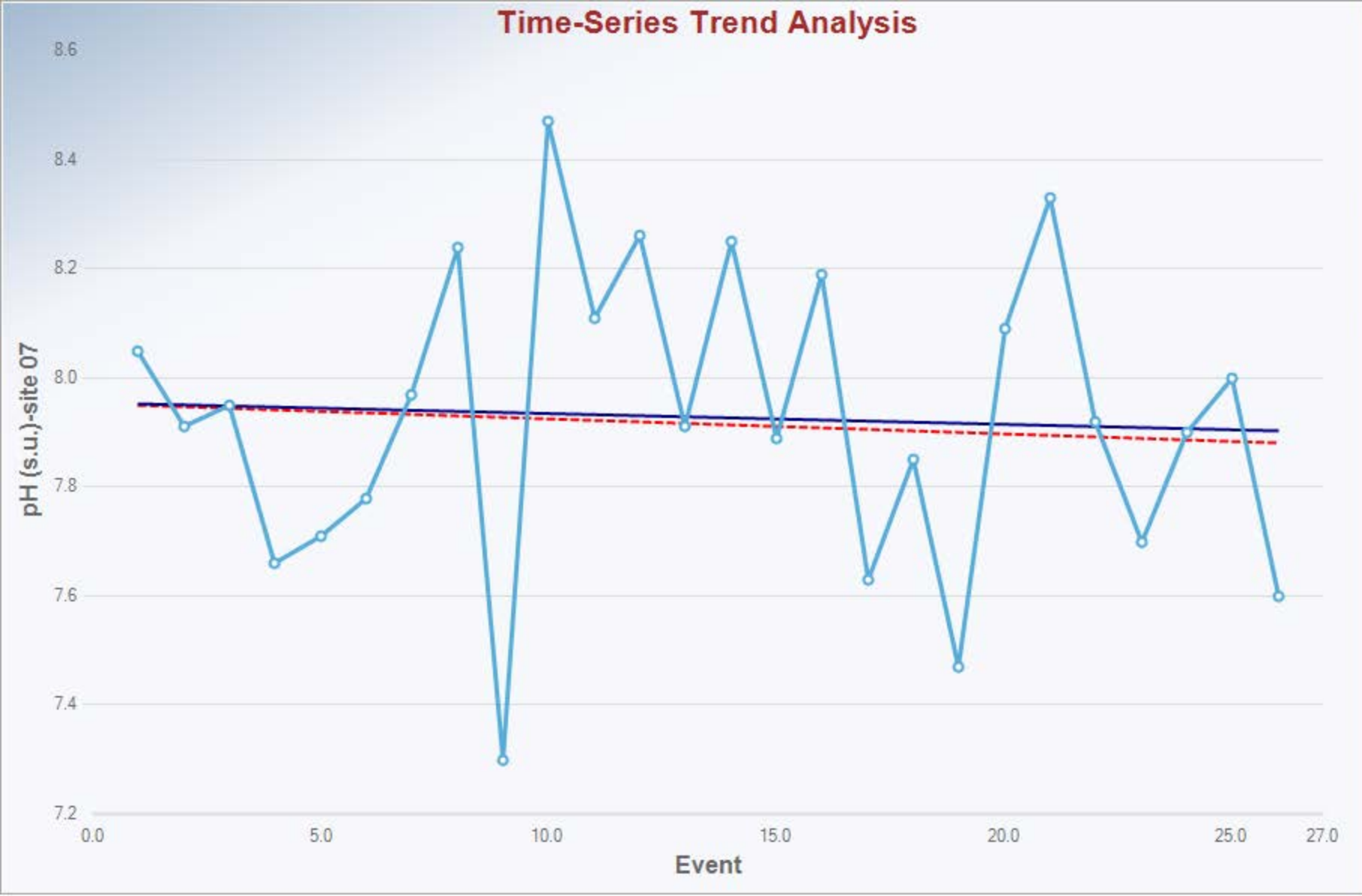
Level of Significance	0.0500
M1	118.0501
M2	206.9499
LCL of Slope	-0.0156
UCL of Slope	0.0250

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3578
M-K Standardized Val (S)	0.8598
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.1949

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.0020
OLS Regression Intercept	7.9555

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0027
Theil-Sen Intercept	7.9518

Theil-Sen Trend Analysis

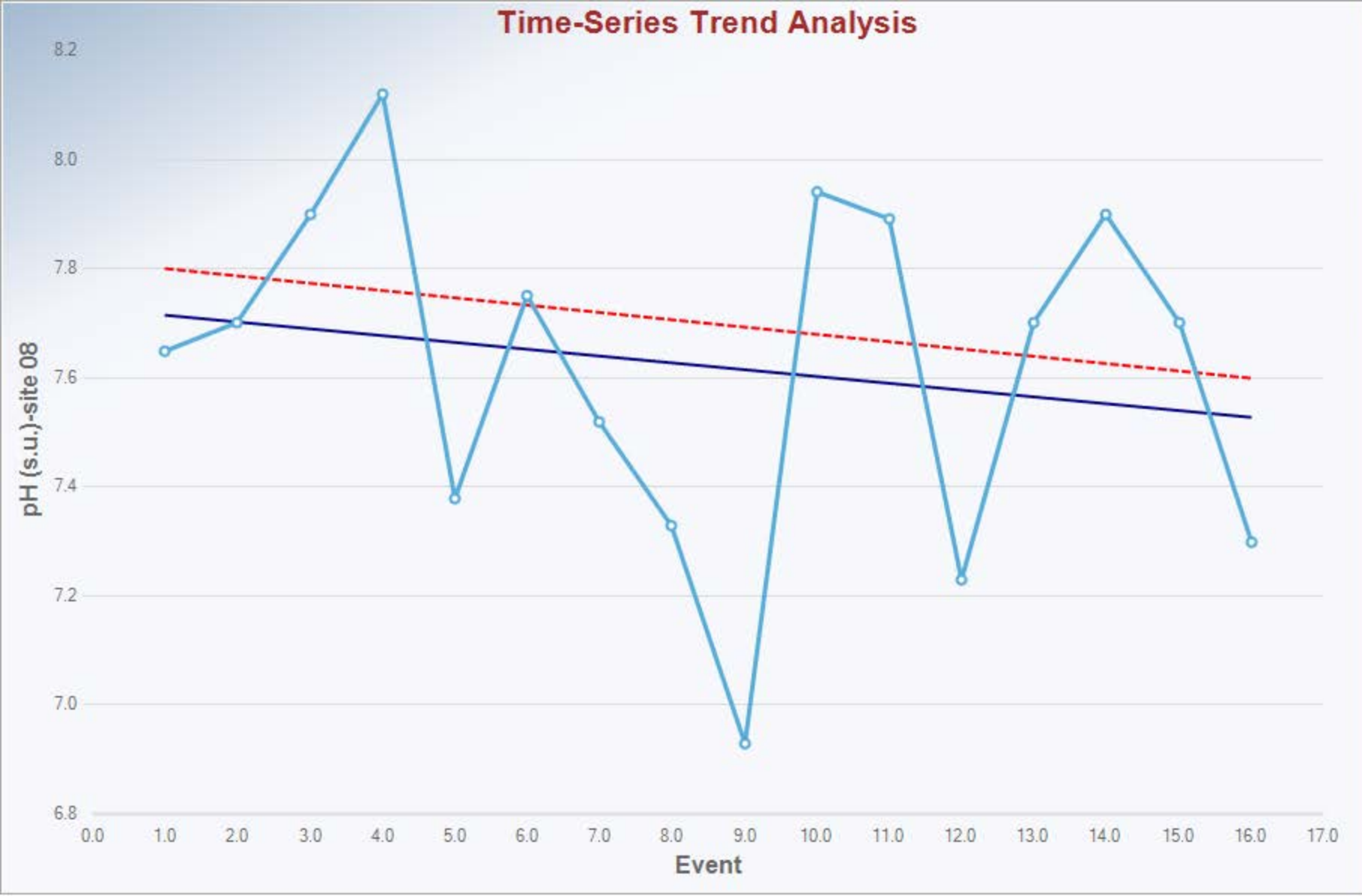
Level of Significance	0.0500
M1	118.0501
M2	206.9499
LCL of Slope	-0.0186
UCL of Slope	0.0123

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3578
M-K Standardized Val (S)	-0.4189
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.3376

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	-0.0125
OLS Regression Intercept	7.7278

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0133
Theil-Sen Intercept	7.8133

Theil-Sen Trend Analysis

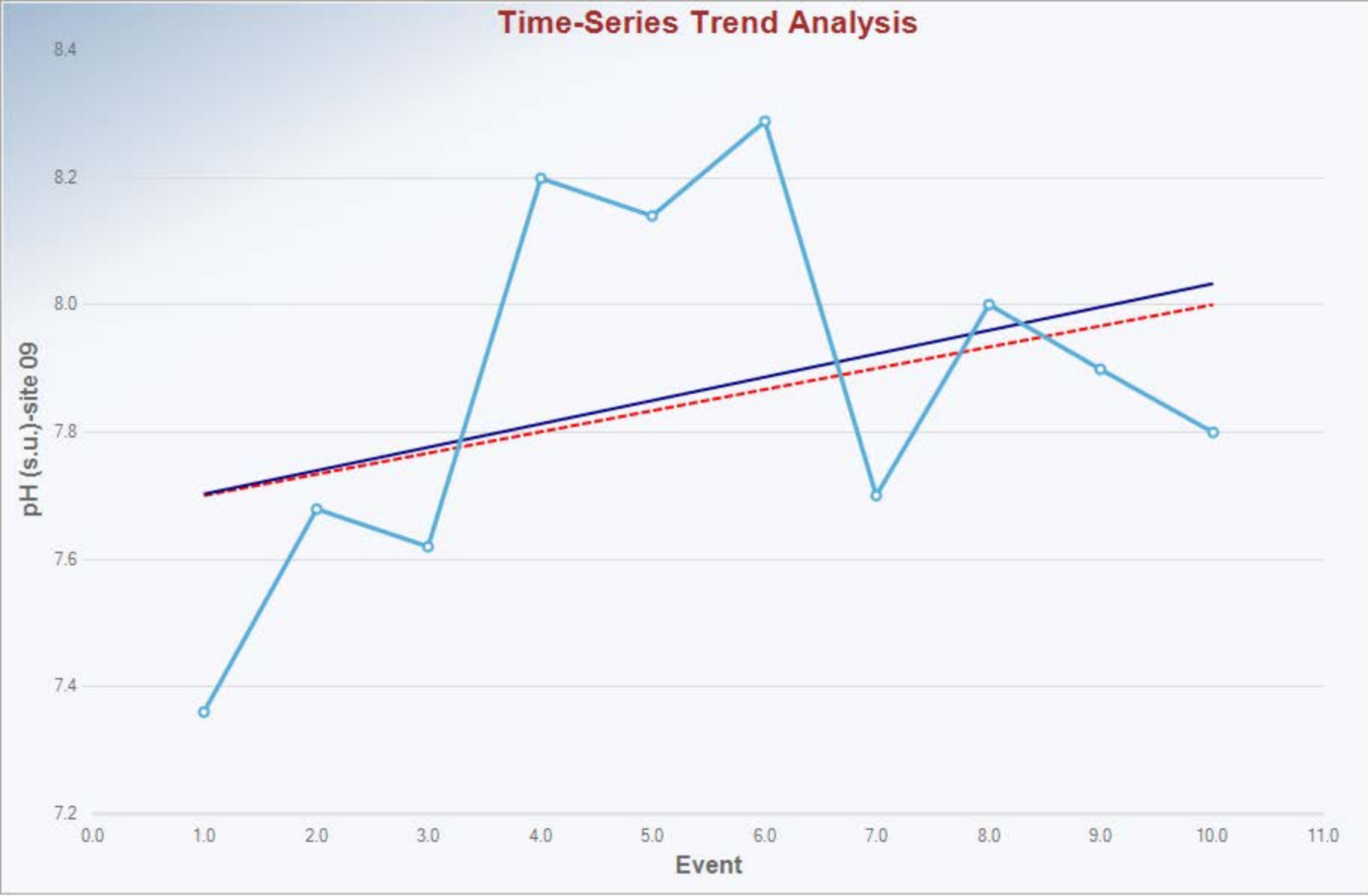
Level of Significance	0.0500
M1	38.3367
M2	81.6633
LCL of Slope	-0.0493
UCL of Slope	0.0220

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	22.1058
M-K Test Value (S)	-16
Tabulated p-value	0.2530

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	0.0367
OLS Regression Intercept	7.6673

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0333
Theil-Sen Intercept	7.6667

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	11.5435
M2	33.4565
LCL of Slope	-0.0630
UCL of Slope	0.1391

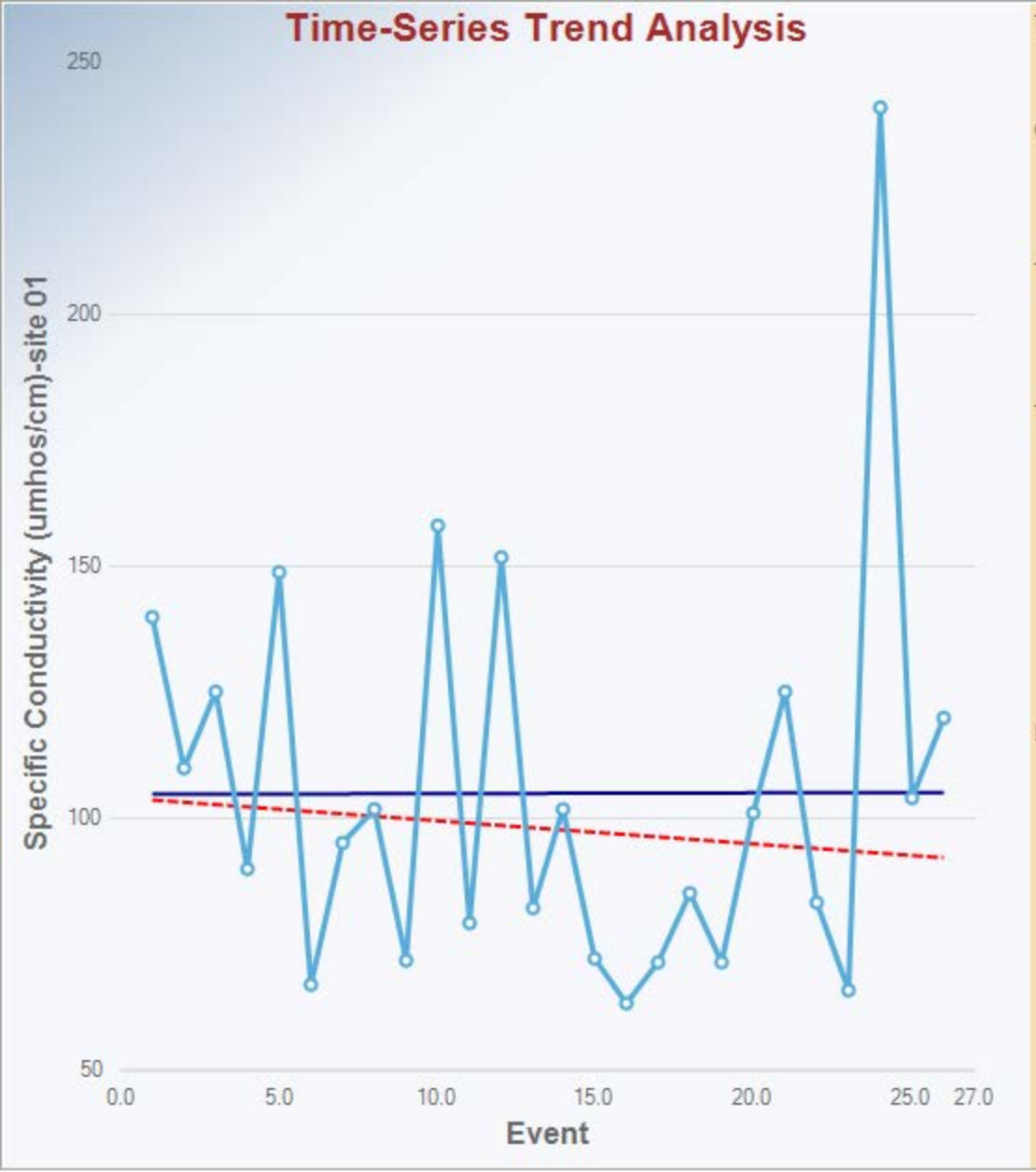
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	11.1803
M-K Test Value (S)	11
Tabulated p-value	0.1900

Insufficient evidence of a significant trend

Specific Conductivity Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.0182
OLS Regression Intercept	104.6665

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.4500
Theil-Sen Intercept	104.0750

Theil-Sen Trend Analysis

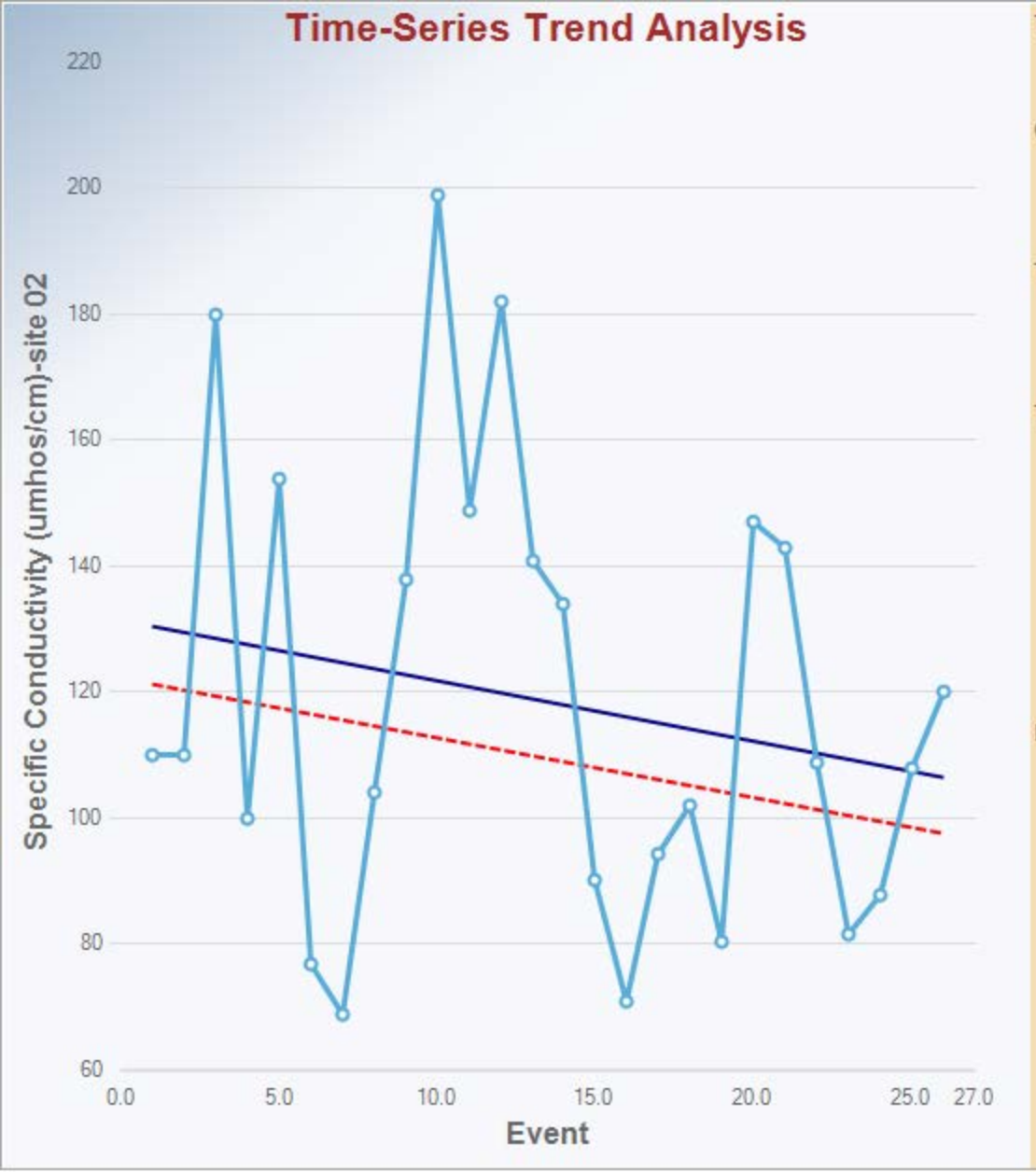
Level of Significance	0.0500
M1	118.0717
M2	206.9283
LCL of Slope	-2.3106
UCL of Slope	1.4490

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3358
M-K Standardized Val (S)	-0.6397
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.2612

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	-0.9668
OLS Regression Intercept	131.5788

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.9571
Theil-Sen Intercept	122.4214

Theil-Sen Trend Analysis

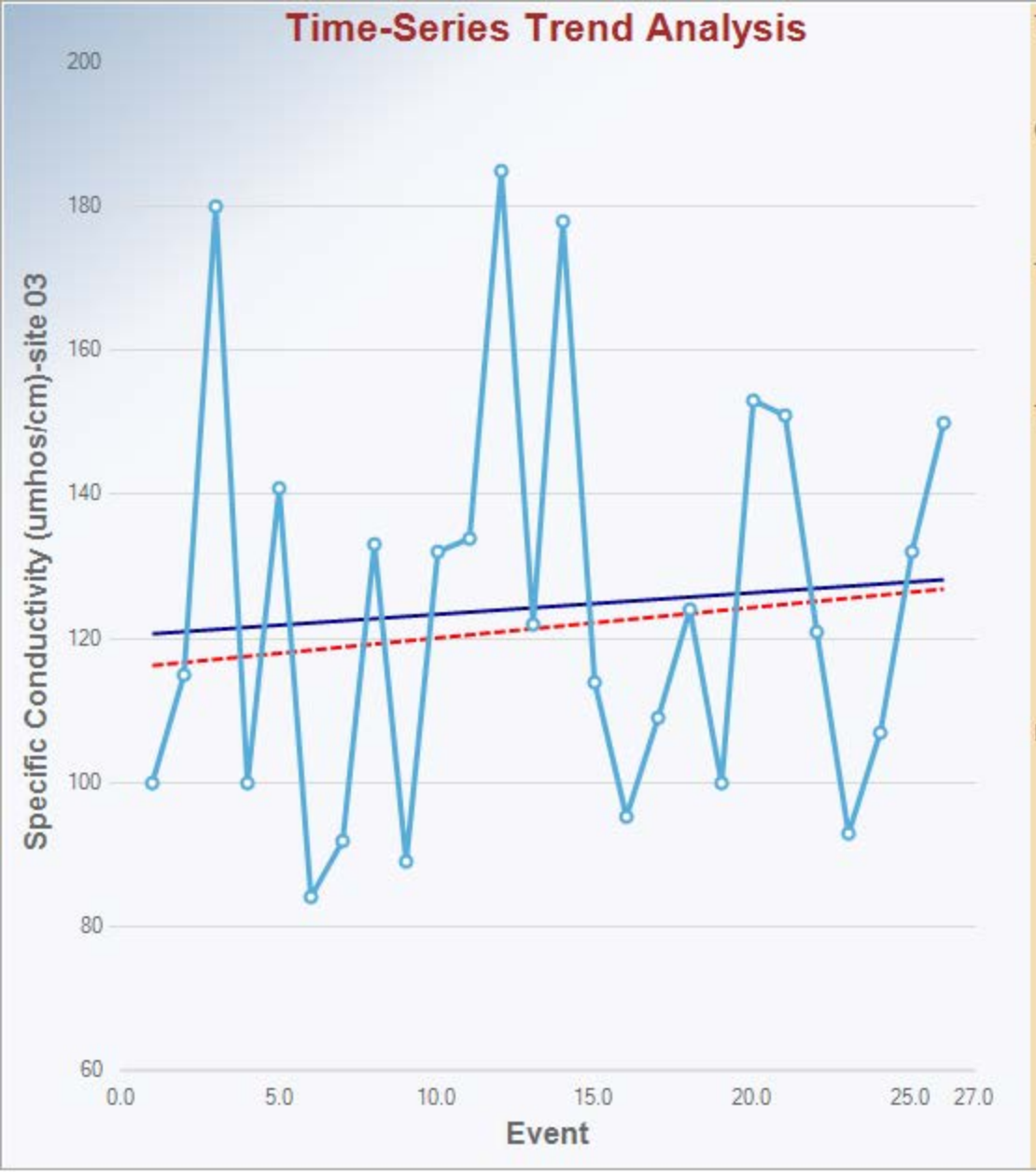
Level of Significance	0.0500
M1	118.0501
M2	206.9499
LCL of Slope	-3.3303
UCL of Slope	0.9479

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3578
M-K Standardized Val (S)	-0.9039
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1830

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.2985
OLS Regression Intercept	120.3631

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.4286
Theil-Sen Intercept	115.7143

Theil-Sen Trend Analysis

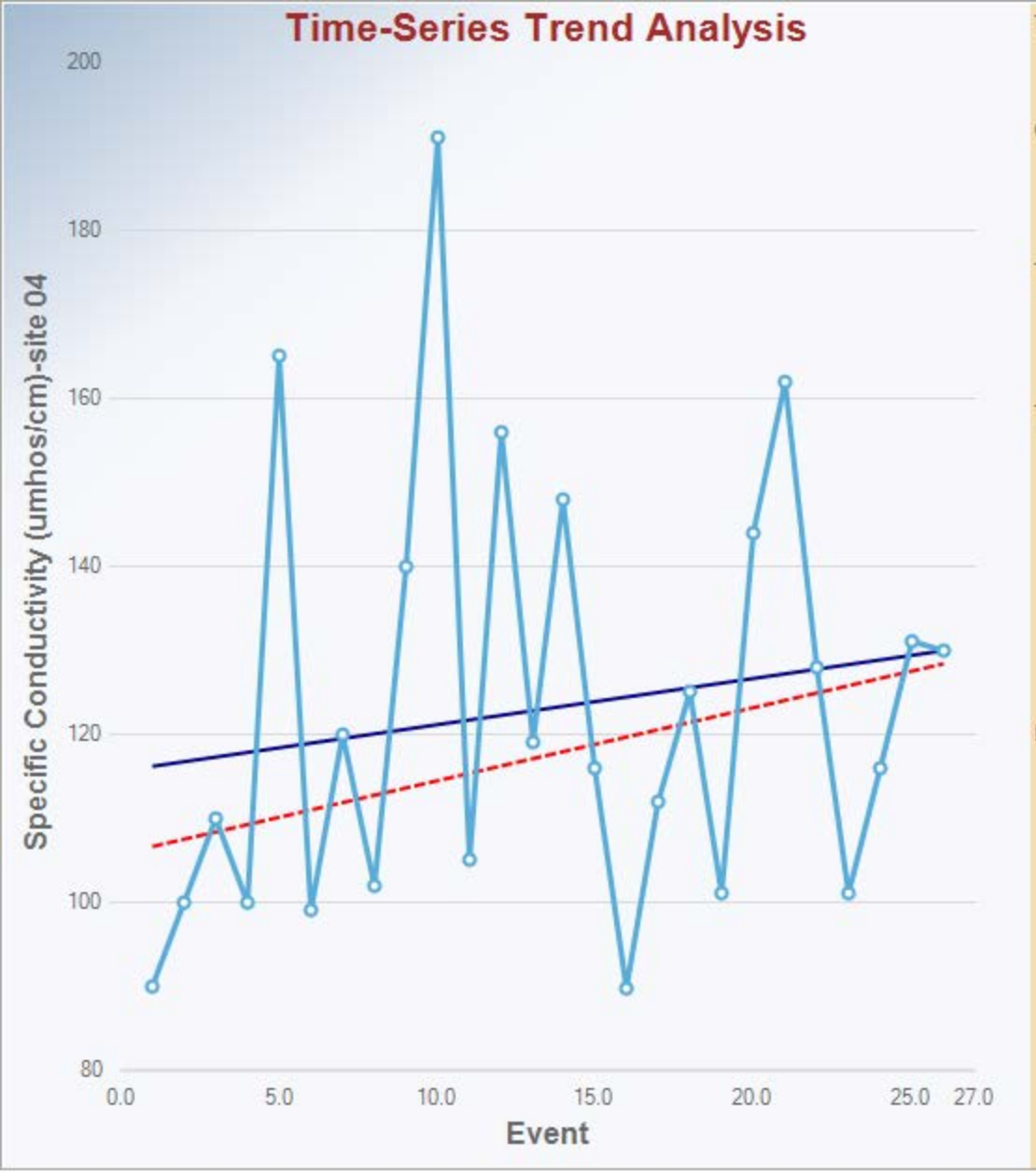
Level of Significance	0.0500
M1	118.0898
M2	206.9102
LCL of Slope	-1.3740
UCL of Slope	1.8892

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3174
M-K Standardized Val (S)	0.4413
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.3295

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	0.5538
OLS Regression Intercept	115.6308

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.8696
Theil-Sen Intercept	105.7609

Theil-Sen Trend Analysis

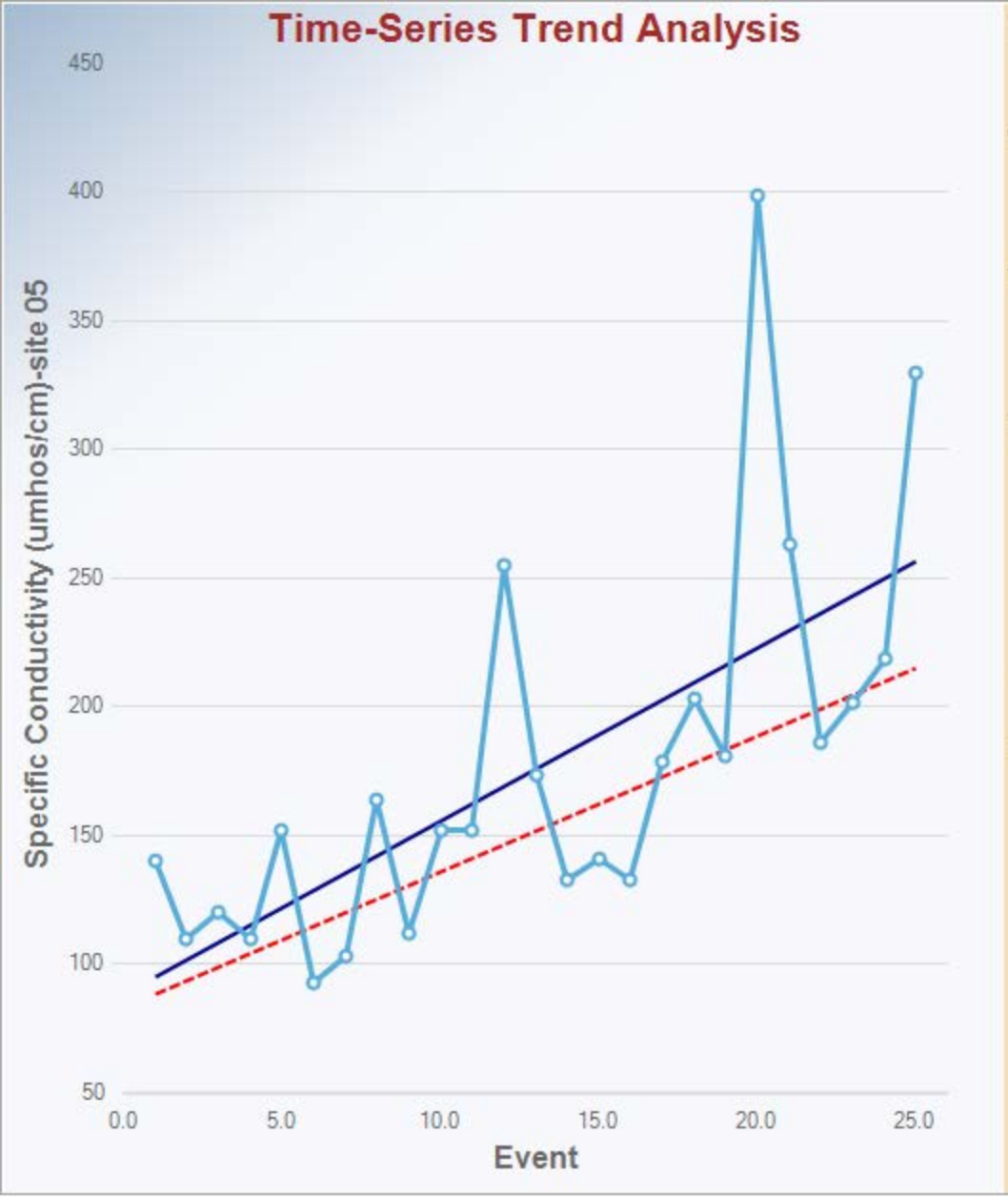
Level of Significance	0.0500
M1	118.0717
M2	206.9283
LCL of Slope	-0.4964
UCL of Slope	1.7815

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3358
M-K Standardized Val (S)	1.4337
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0758

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	6.7254
OLS Regression Intercept	88.8100

Theil-Sen Trend Line (Red)

Theil-Sen Slope	5.2788
Theil-Sen Intercept	83.3750

Theil-Sen Trend Analysis

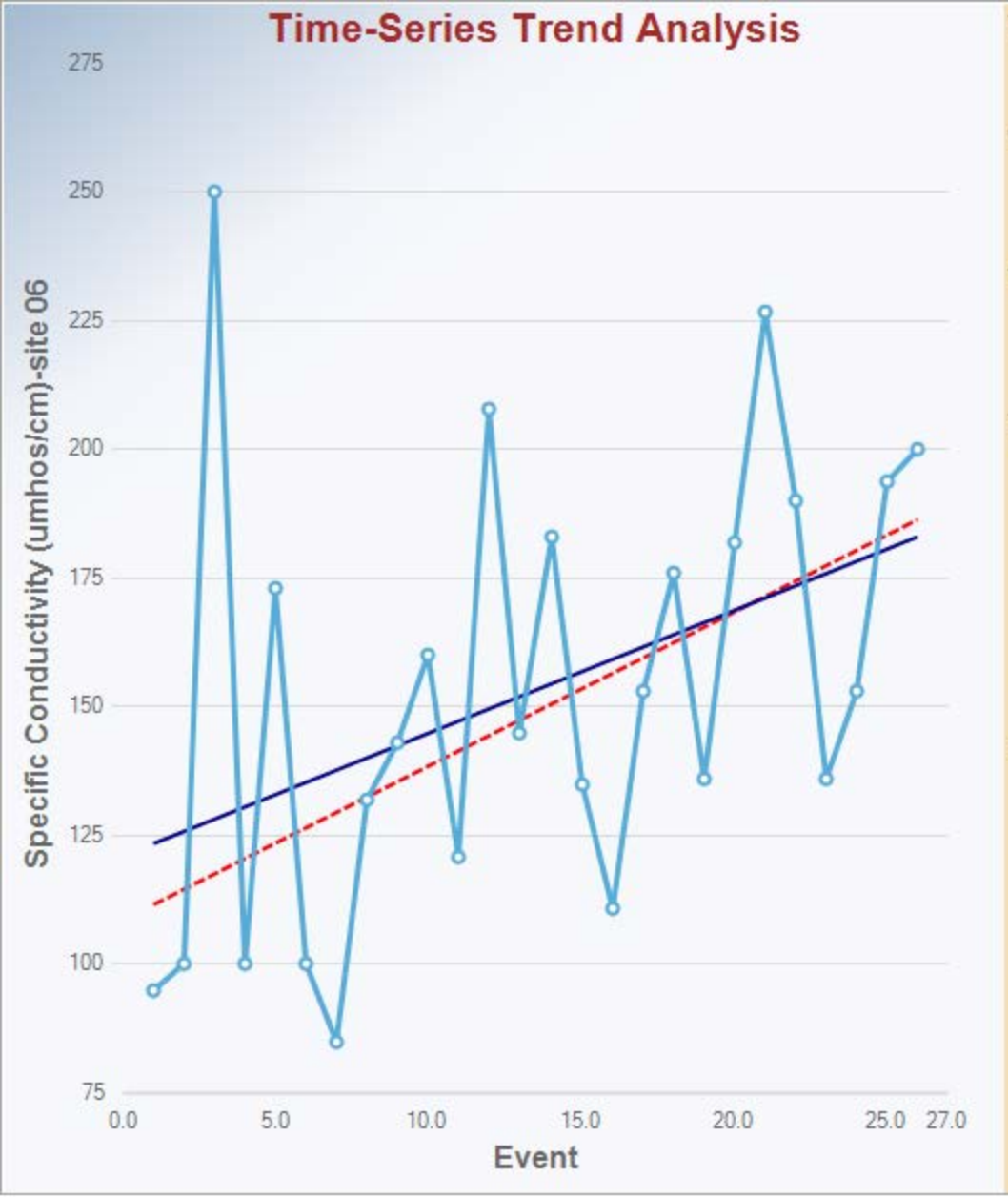
Level of Significance	0.0500
M1	108.1046
M2	191.8954
LCL of Slope	3.3433
UCL of Slope	7.9415

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.7512
M-K Standardized Val (S)	4.1168
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0000

Significant evidence of an increasing trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	2.3761
OLS Regression Intercept	121.3077

Theil-Sen Trend Line (Red)

Theil-Sen Slope	3.0000
Theil-Sen Intercept	108.5000

Theil-Sen Trend Analysis

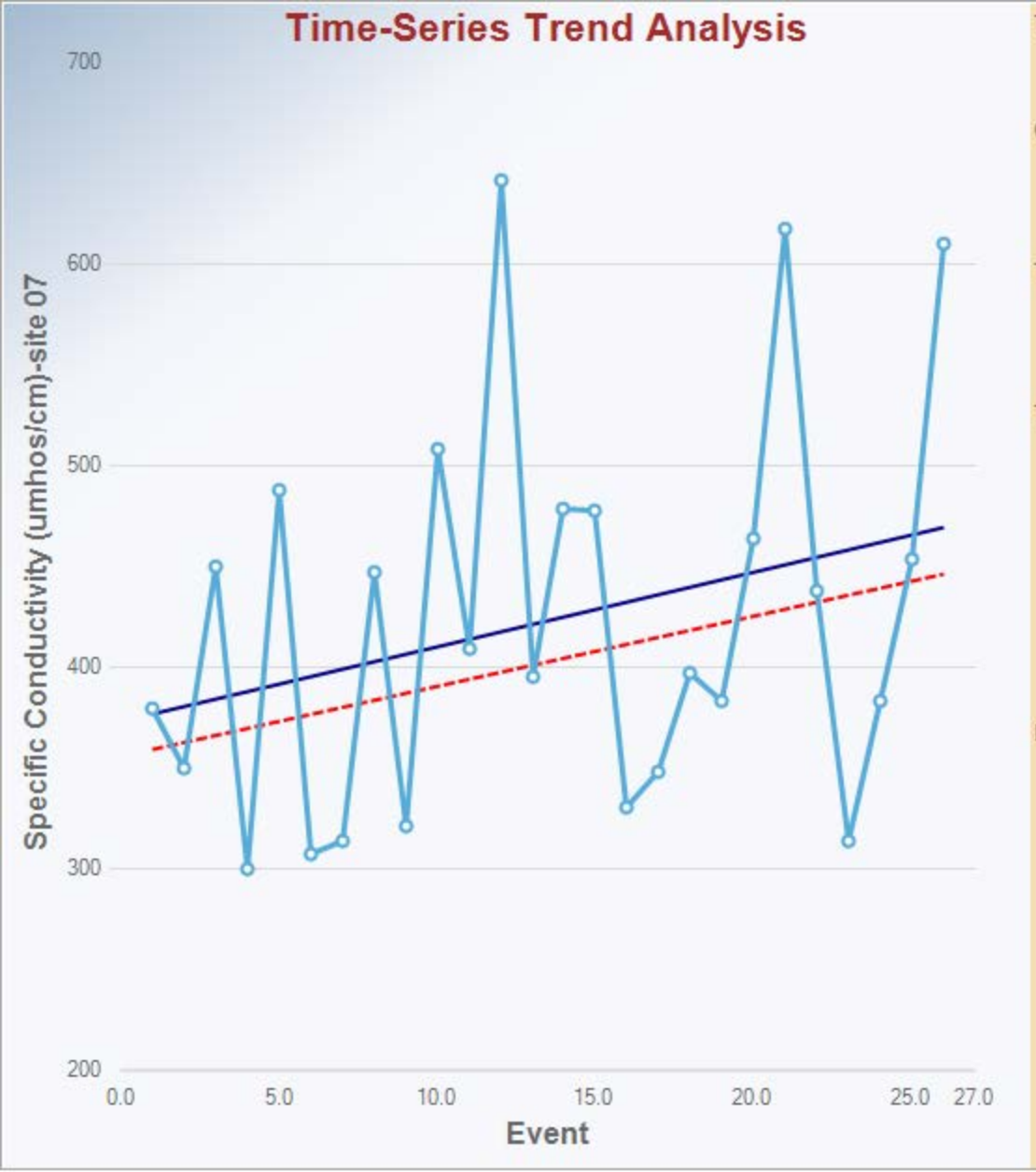
Level of Significance	0.0500
M1	118.1006
M2	206.8994
LCL of Slope	1.0517
UCL of Slope	4.9344

Statistically significant evidence of an increasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3064
M-K Standardized Val (S)	2.8031
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.0025

Significant evidence of an increasing trend



Time-Series Trend Analysis

# Events/Time Periods	26

OLS Regression Line (Blue)

OLS Regression Slope	3.7019
OLS Regression Intercept	373.4092

Theil-Sen Trend Line (Red)

Theil-Sen Slope	3.5000
Theil-Sen Intercept	355.7500

Theil-Sen Trend Analysis

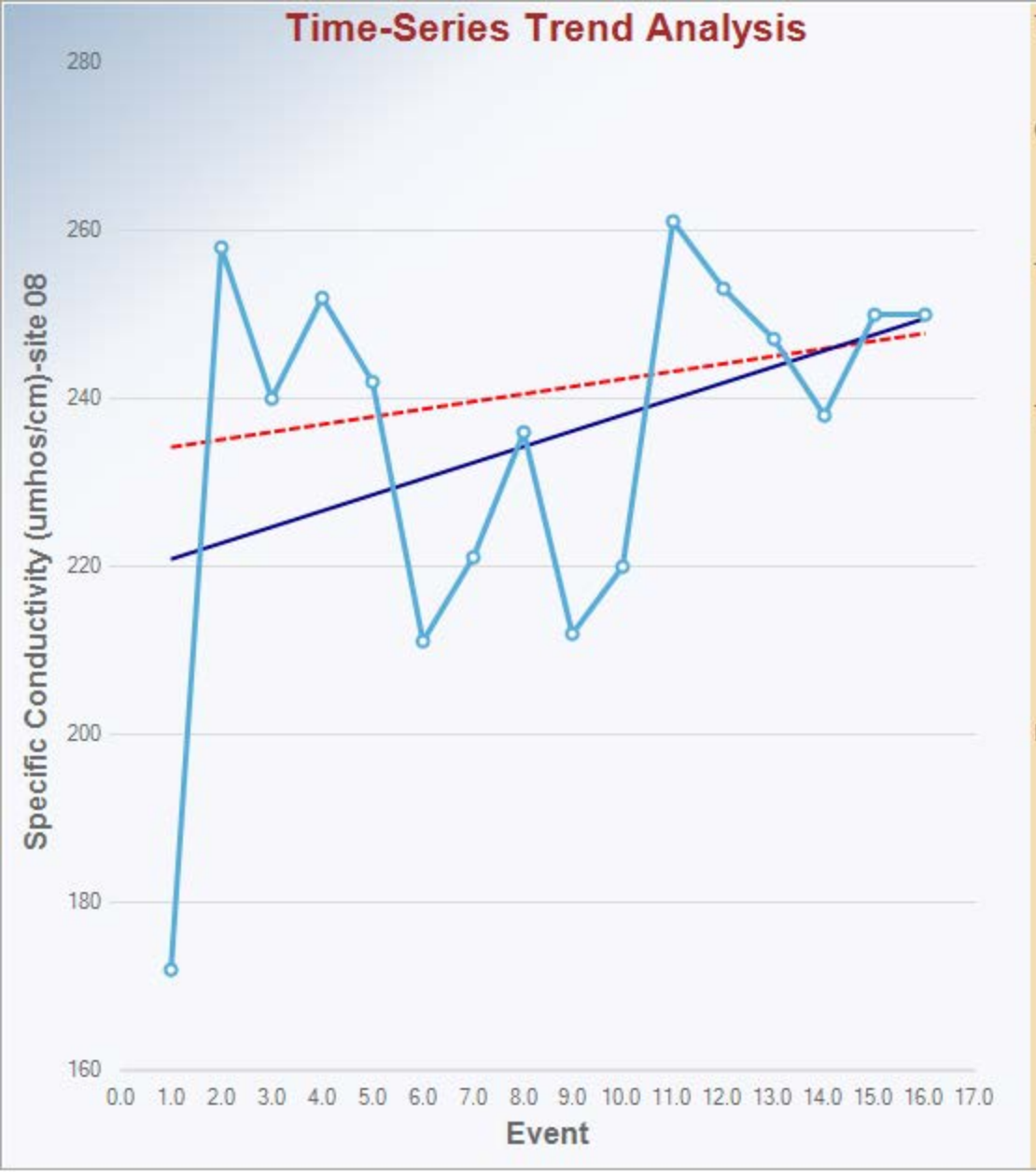
Level of Significance	0.0500
M1	118.0609
M2	206.9391
LCL of Slope	-1.7143
UCL of Slope	8.1848

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	45.3468
M-K Standardized Val (S)	1.2790
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.1004

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	16

OLS Regression Line (Blue)

OLS Regression Slope	1.9103
OLS Regression Intercept	218.9500

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.9167
Theil-Sen Intercept	233.2083

Theil-Sen Trend Analysis

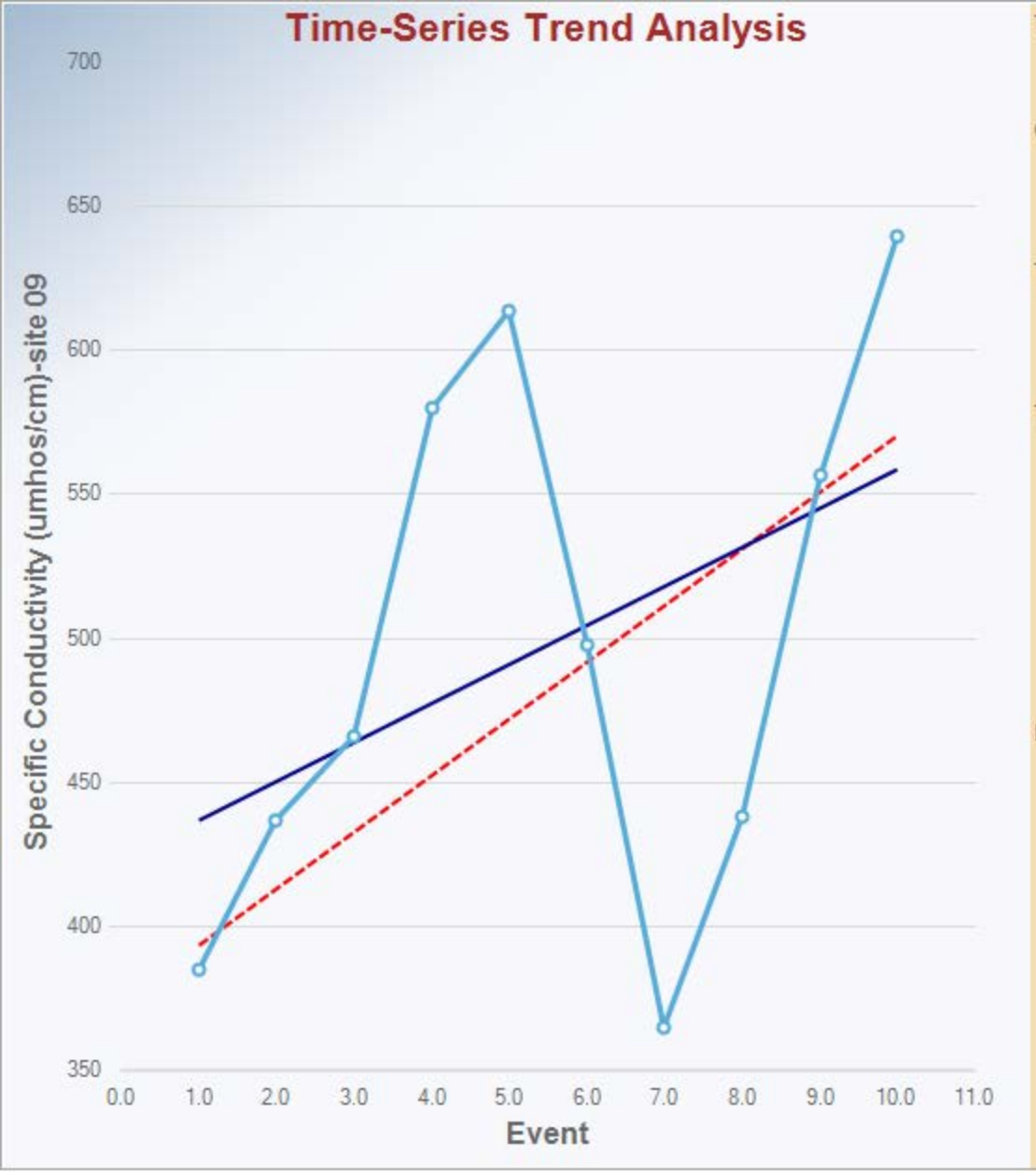
Level of Significance	0.0500
M1	38.2556
M2	81.7444
LCL of Slope	-0.9489
UCL of Slope	4.8722

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	22.1886
M-K Test Value (S)	21
Tabulated p-value	0.1990

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	10

OLS Regression Line (Blue)

OLS Regression Slope	13.5394
OLS Regression Intercept	423.5333

Theil-Sen Trend Line (Red)

Theil-Sen Slope	19.6667
Theil-Sen Intercept	373.8333

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	11.5435
M2	33.4565
LCL of Slope	-9.5490
UCL of Slope	54.3968

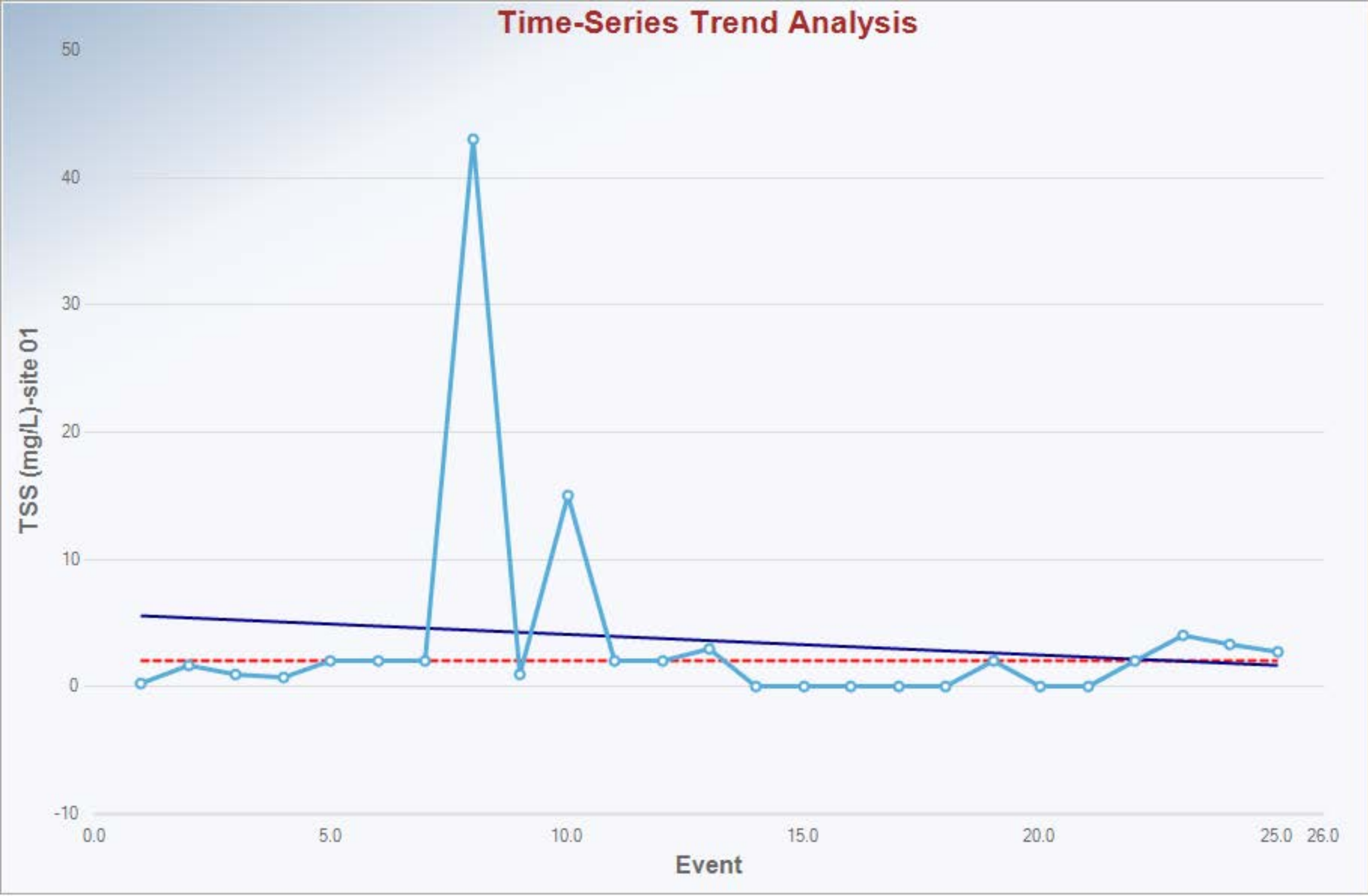
Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	11.1803
M-K Test Value (S)	17
Tabulated p-value	0.0780

Insufficient evidence of a significant trend

Total Suspended Solids (TSS) Trend Graphs



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.1621
OLS Regression Intercept	5.6990

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	2.0000

Theil-Sen Trend Analysis

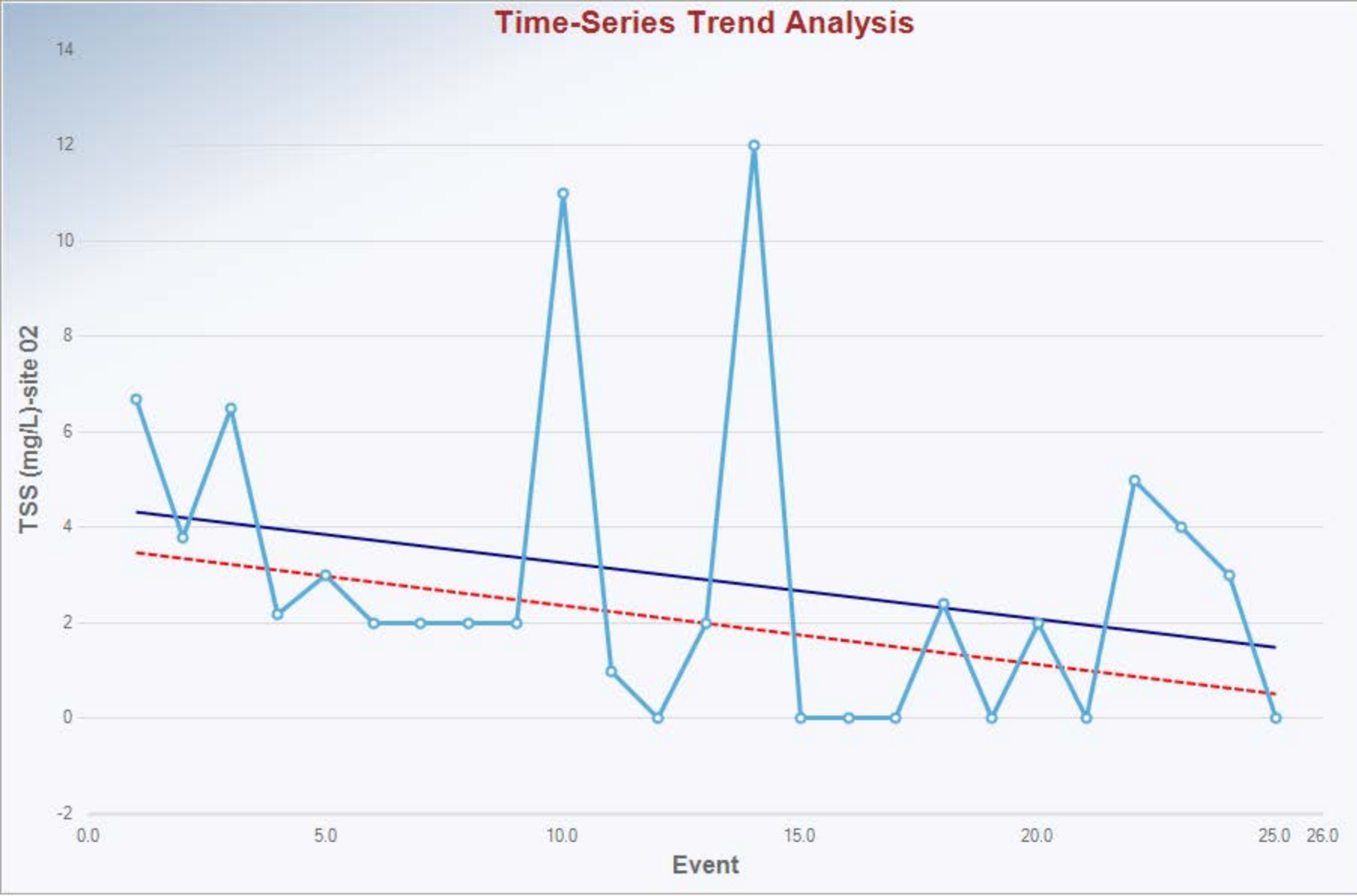
Level of Significance	0.0500
M1	109.0787
M2	190.9213
LCL of Slope	-0.0633
UCL of Slope	0.0818

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.7572
M-K Standardized Val (S)	0.1916
Appx. Critical Value (0.05)	1.6449
Approximate p-value (S)	0.4240

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.1185
OLS Regression Intercept	4.4440

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1239
Theil-Sen Intercept	3.6102

Theil-Sen Trend Analysis

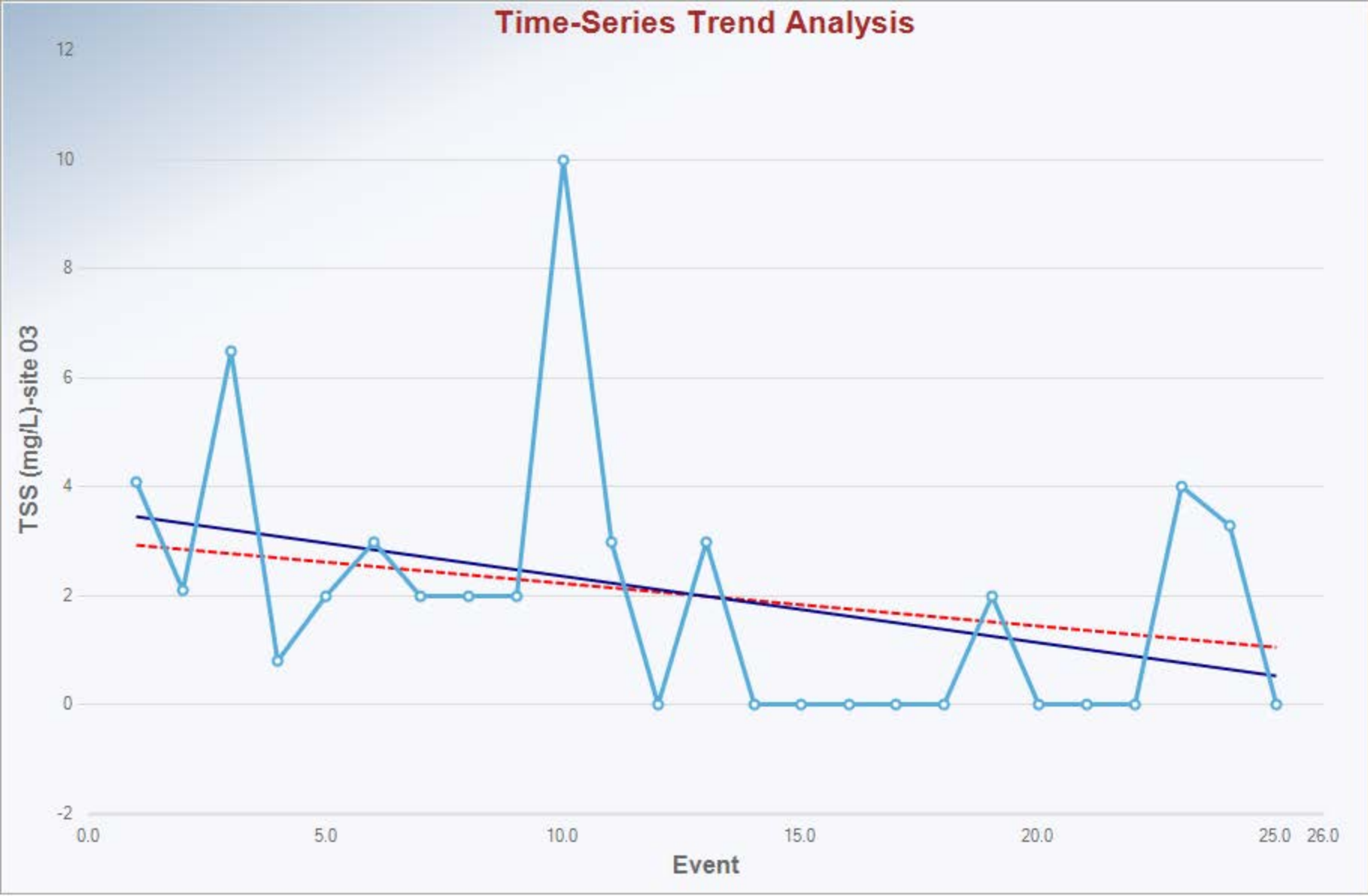
Level of Significance	0.0500
M1	108.8913
M2	191.1087
LCL of Slope	-0.2500
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.9484
M-K Standardized Val (S)	-1.8594
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0315

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.1225
OLS Regression Intercept	3.5840

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0785
Theil-Sen Intercept	3.0200

Theil-Sen Trend Analysis

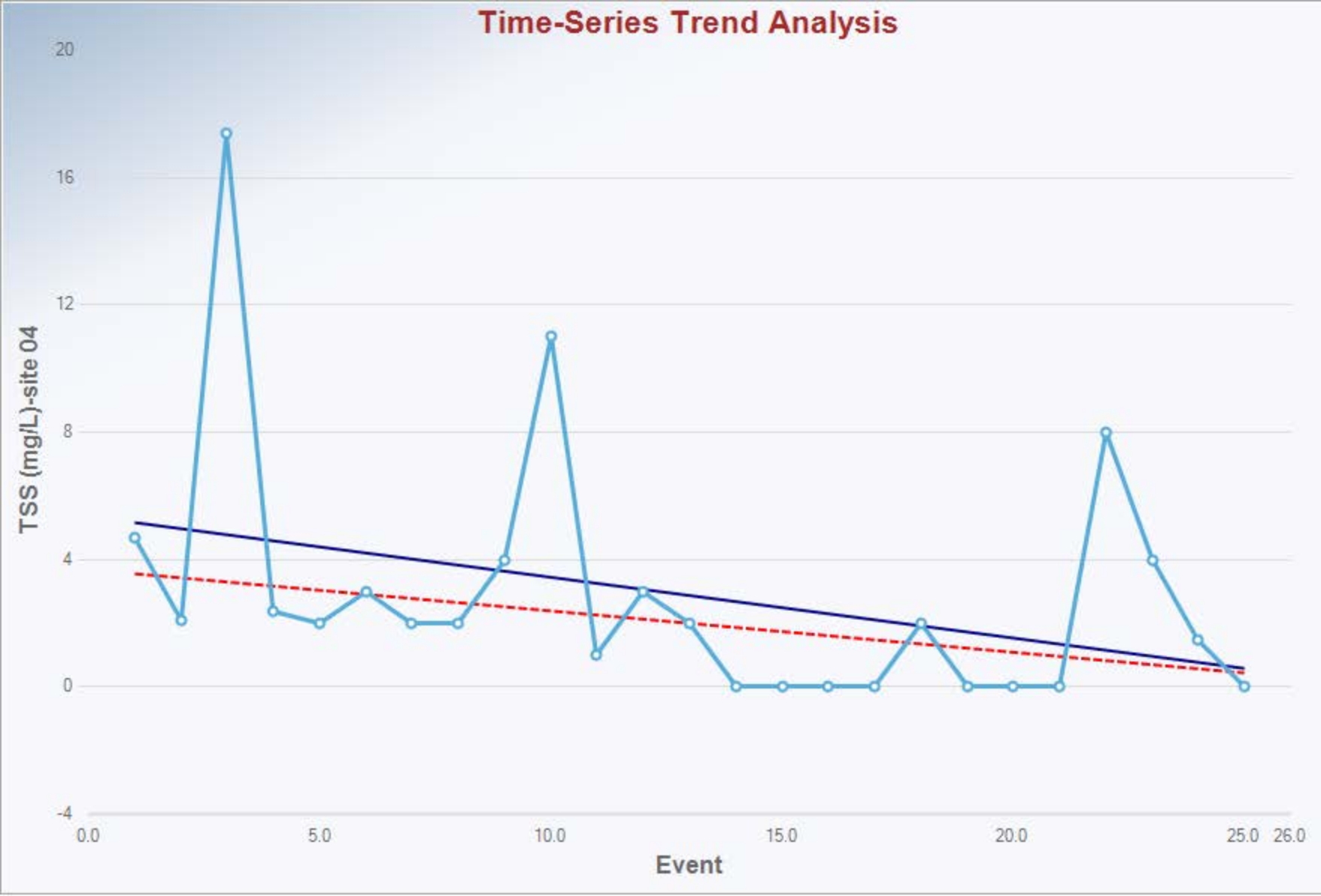
Level of Significance	0.0500
M1	109.7372
M2	190.2628
LCL of Slope	-0.1895
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.0853
M-K Standardized Val (S)	-2.1662
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0151

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.1920
OLS Regression Intercept	5.3800

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1292
Theil-Sen Intercept	3.6792

Theil-Sen Trend Analysis

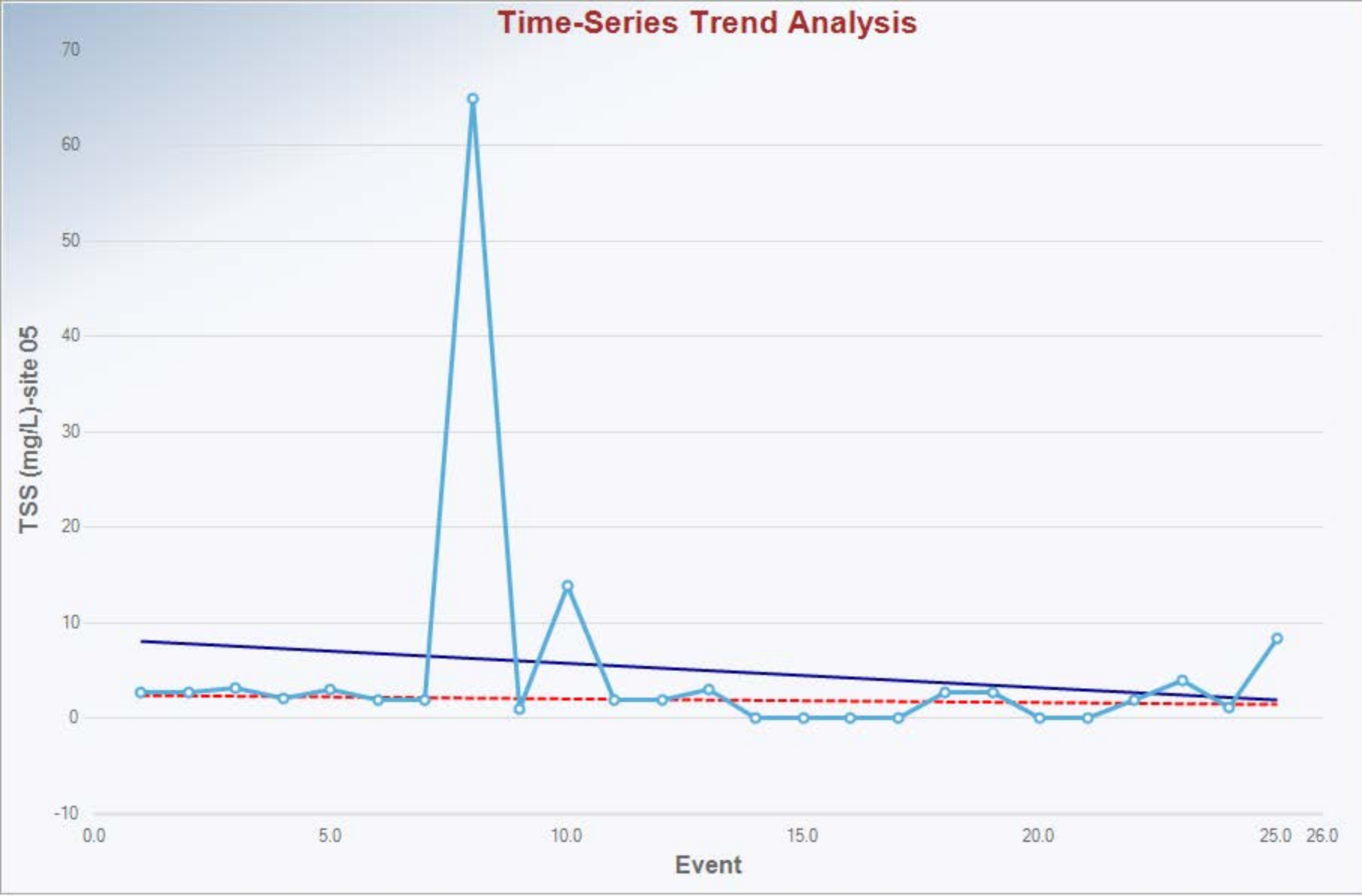
Level of Significance	0.0500
M1	109.0122
M2	190.9878
LCL of Slope	-0.2222
UCL of Slope	0.0000

Statistically significant evidence of a decreasing trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.8250
M-K Standardized Val (S)	-2.5583
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0053

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.2617
OLS Regression Intercept	8.4500

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.0422
Theil-Sen Intercept	2.5489

Theil-Sen Trend Analysis

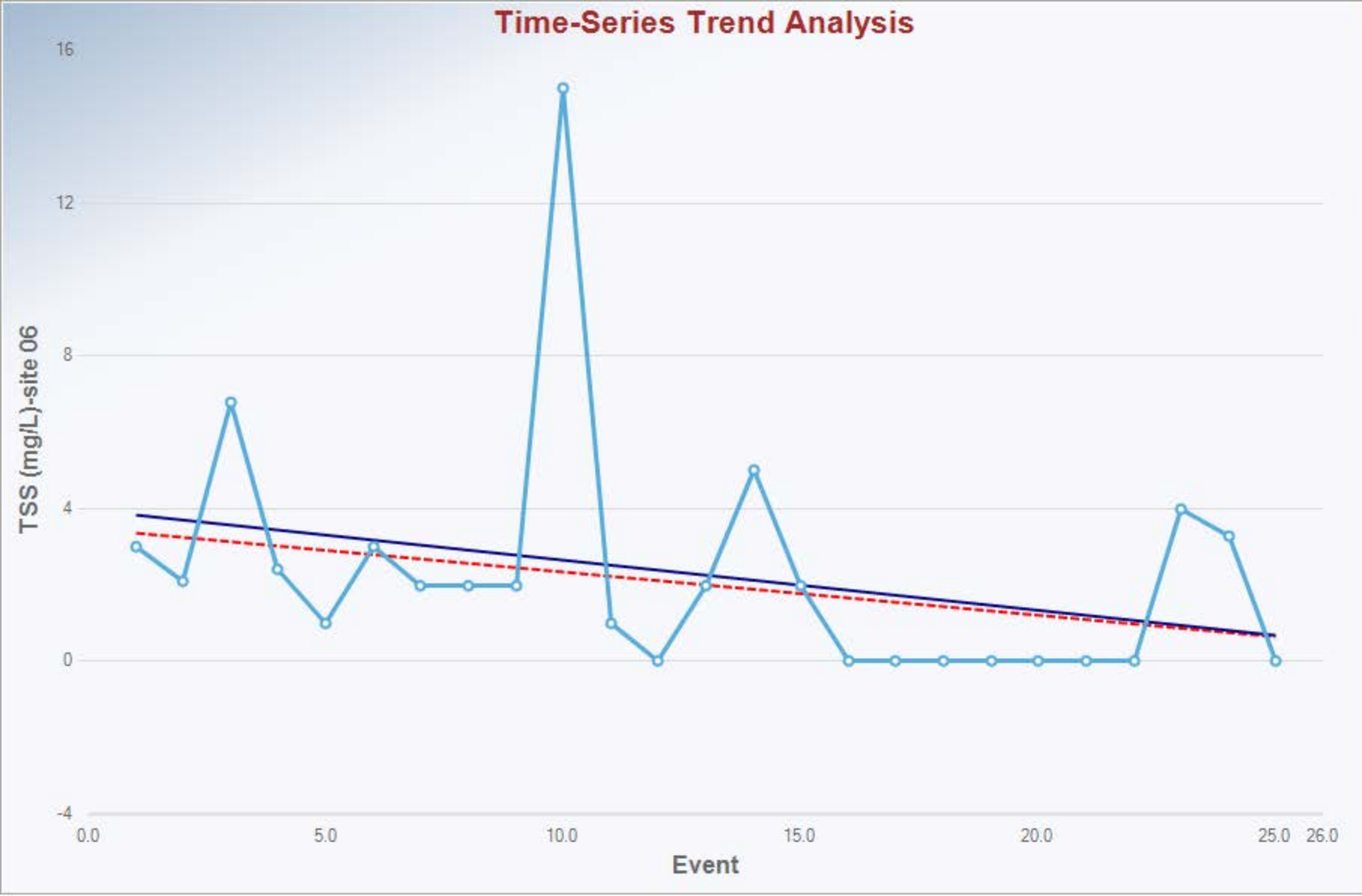
Level of Significance	0.0500
M1	108.6120
M2	191.3880
LCL of Slope	-0.1667
UCL of Slope	0.0022

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.2335
M-K Standardized Val (S)	-1.2313
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.1091

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.1303
OLS Regression Intercept	3.9580

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1127
Theil-Sen Intercept	3.4651

Theil-Sen Trend Analysis

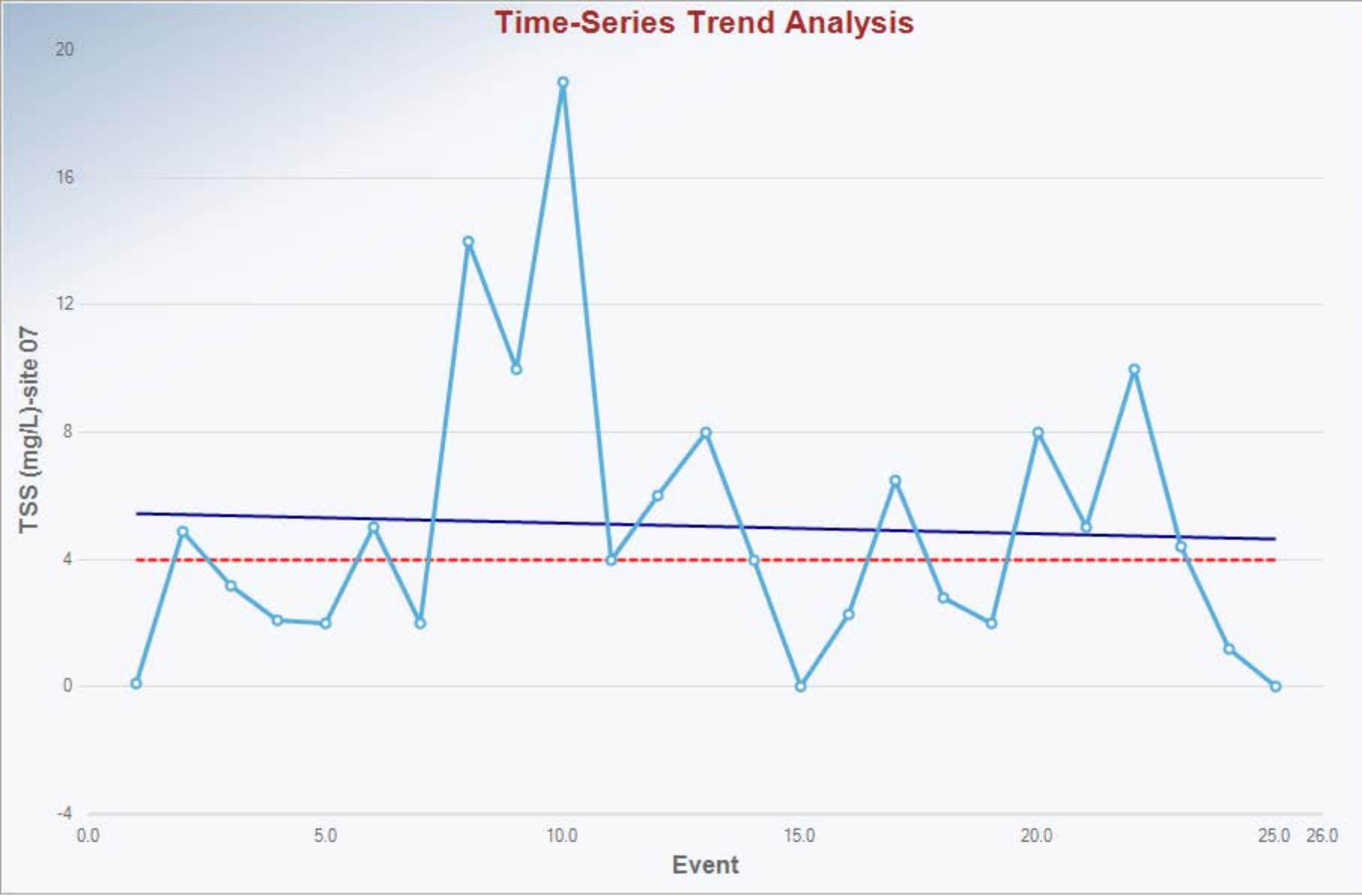
Level of Significance	0.0500
M1	109.3258
M2	190.6742
LCL of Slope	-0.1689
UCL of Slope	0.0000

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	41.5050
M-K Standardized Val (S)	-2.5298
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.0057

Significant evidence of a decreasing trend



Time-Series Trend Analysis

# Events/Time Periods	25

OLS Regression Line (Blue)

OLS Regression Slope	-0.0338
OLS Regression Intercept	5.4990

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.0000
Theil-Sen Intercept	4.0000

Theil-Sen Trend Analysis

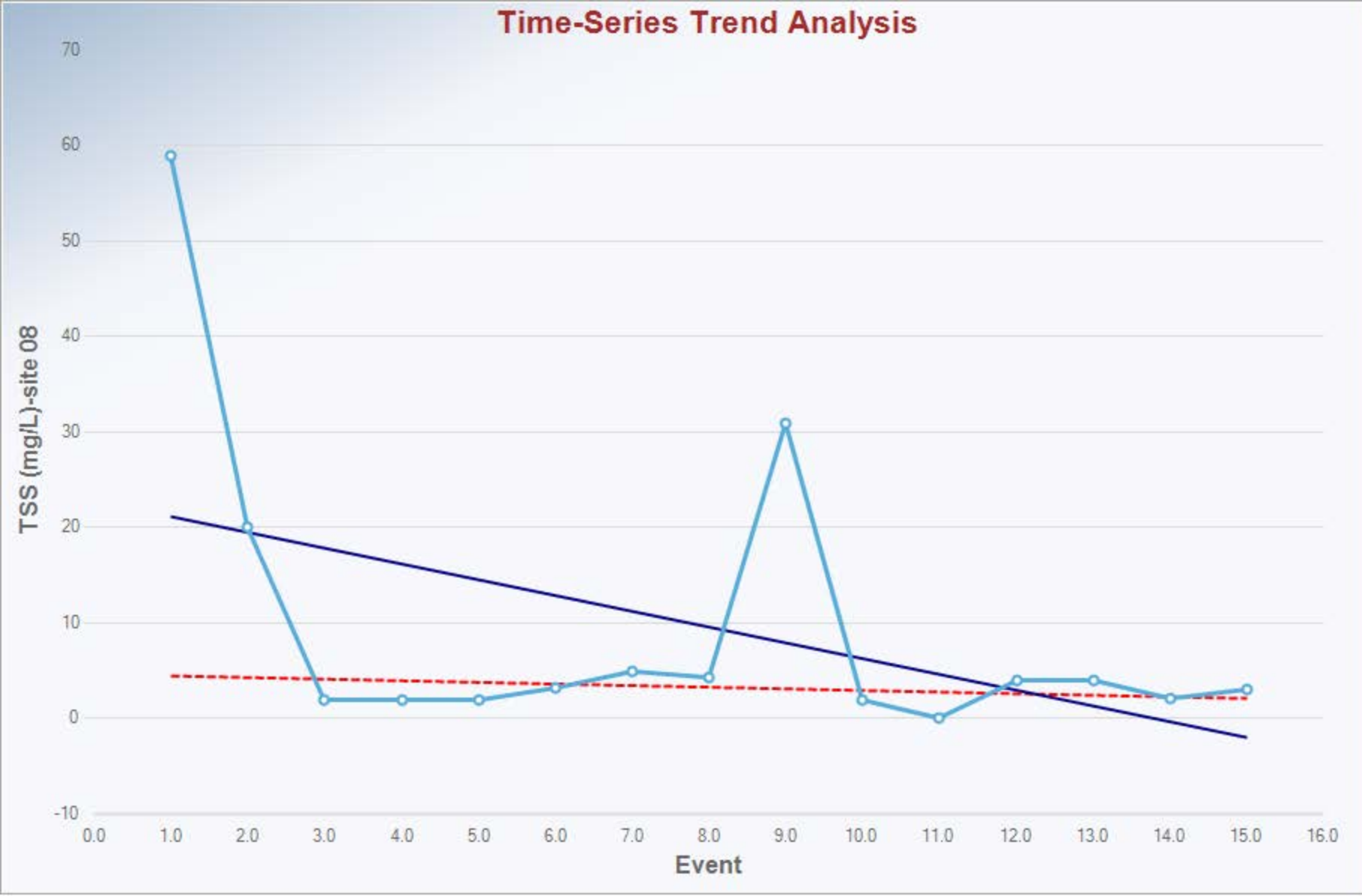
Level of Significance	0.0500
M1	108.1390
M2	191.8610
LCL of Slope	-0.2500
UCL of Slope	0.2117

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	42.7161
M-K Standardized Val (S)	-0.1171
Appx. Critical Value (0.05)	-1.6449
Approximate p-value (S)	0.4534

Insufficient evidence of a significant trend



Time-Series Trend Analysis

# Events/Time Periods	15

OLS Regression Line (Blue)

OLS Regression Slope	-1.6525
OLS Regression Intercept	22.8200

Theil-Sen Trend Line (Red)

Theil-Sen Slope	-0.1667
Theil-Sen Intercept	4.6333

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	32.9331
M2	72.0669
LCL of Slope	-1.4678
UCL of Slope	0.1104

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	19.9666
M-K Test Value (S)	-16
Tabulated p-value	0.2180

Insufficient evidence of a significant trend

Time-Series Trend Analysis

# Events/Time Periods	9

OLS Regression Line (Blue)

OLS Regression Slope	0.9683
OLS Regression Intercept	5.9917

Theil-Sen Trend Line (Red)

Theil-Sen Slope	0.2000
Theil-Sen Intercept	6.0000

Theil-Sen Trend Analysis

Level of Significance	0.0500
M1	8.6516
M2	27.3484
LCL of Slope	-2.7394
UCL of Slope	2.9348

Insufficient evidence to identify a significant trend at the specified level of significance.

Mann-Kendall Trend Analysis

Standard Deviation of S	9.5394
M-K Test Value (S)	1
Tabulated p-value	0.5400

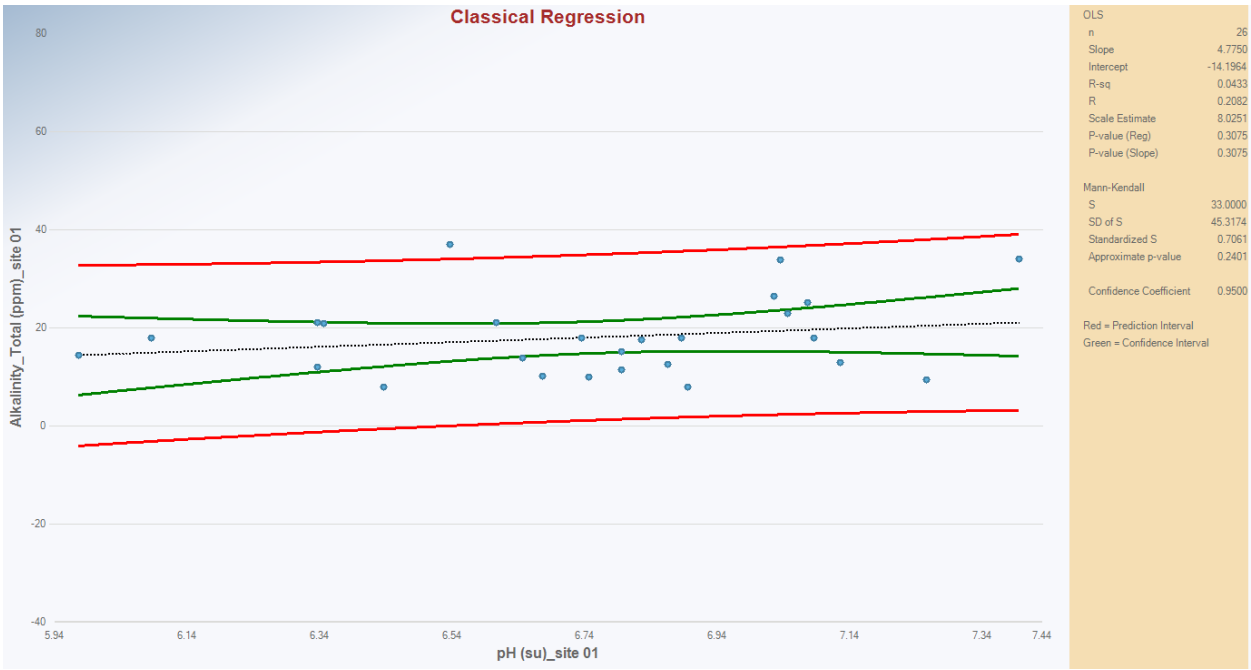
Insufficient evidence of a significant trend

Appendix E

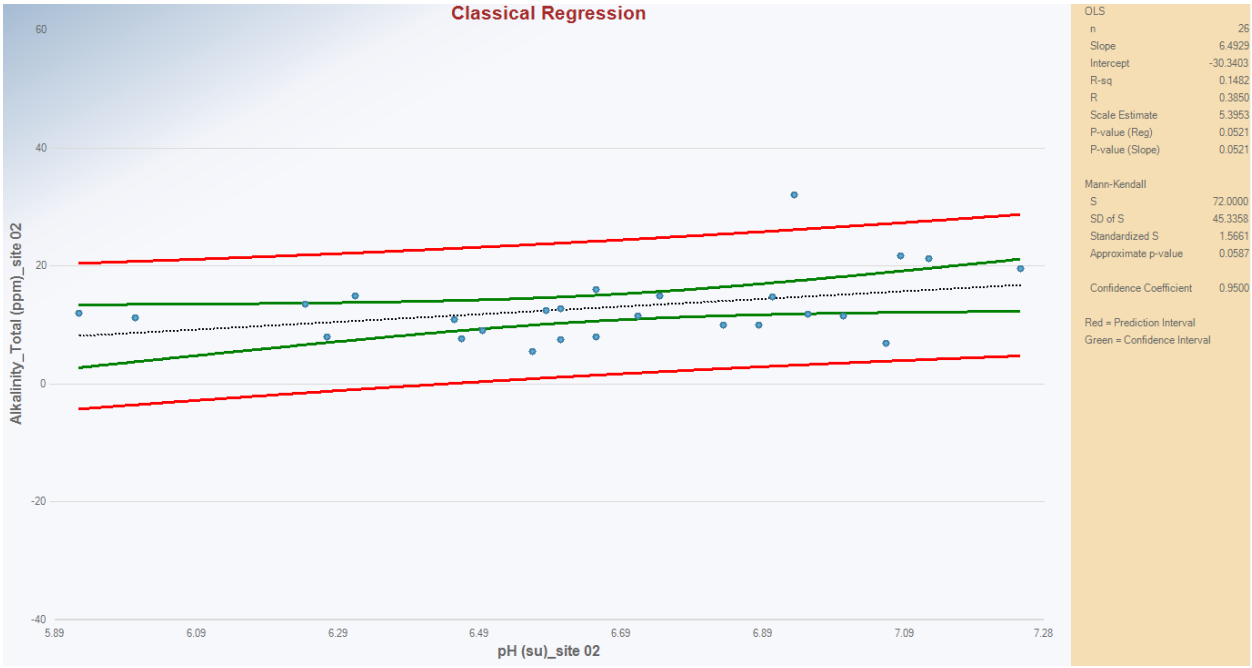
Miscellaneous Statistical Analysis Graphs and Calculations

Alkalinity vs. pH OLS Trend Analysis (Correlation) Graphs

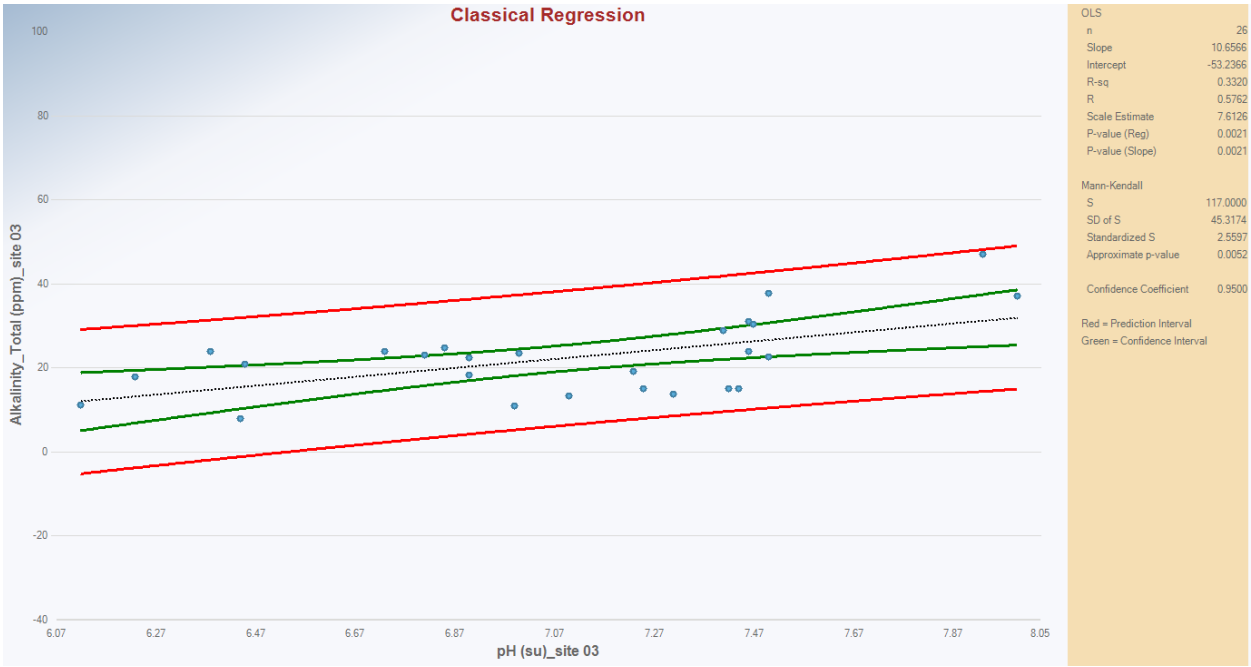
Site 1:



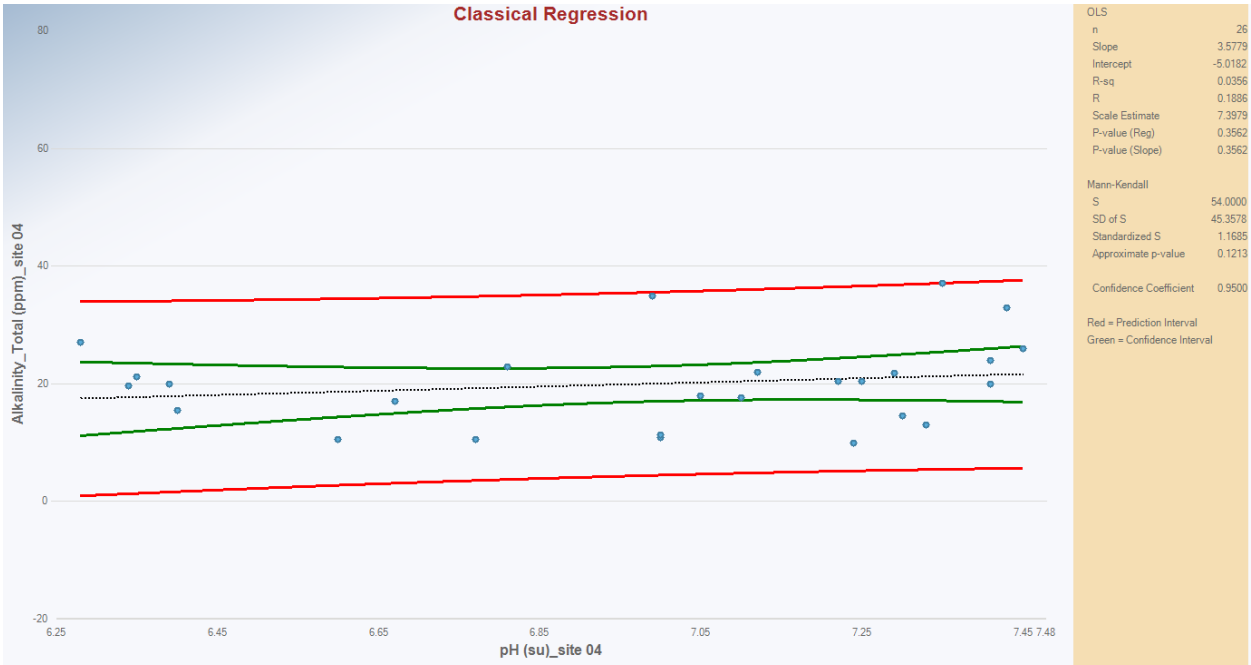
Site 2:



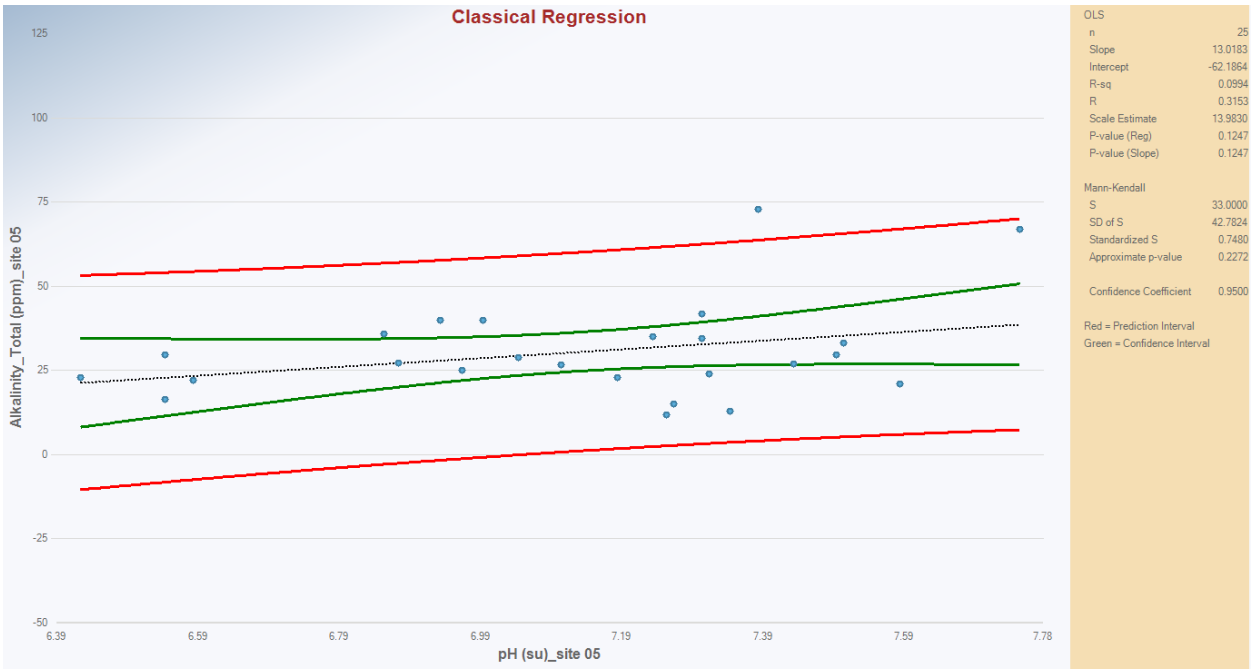
Site 3:


Classical Regression
Alkalinity_Total (ppm)_site 03
pH (su)_site 03
100
80
60
40
20
0
-20
-40
6.07
6.27
6.47
6.67
6.87
7.07
7.27
7.47
7.67
7.87
8.05
OLS
n 26
Slope 10.6566
Intercept -53.2366
R-sq 0.3320
R 0.5762
Scale Estimate 7.6126
P-value (Reg) 0.0021
P-value (Slope) 0.0021
Mann-Kendall
S 117.0000
SD of S 45.3174
Standardized S 2.5597
Approximate p-value 0.0052
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

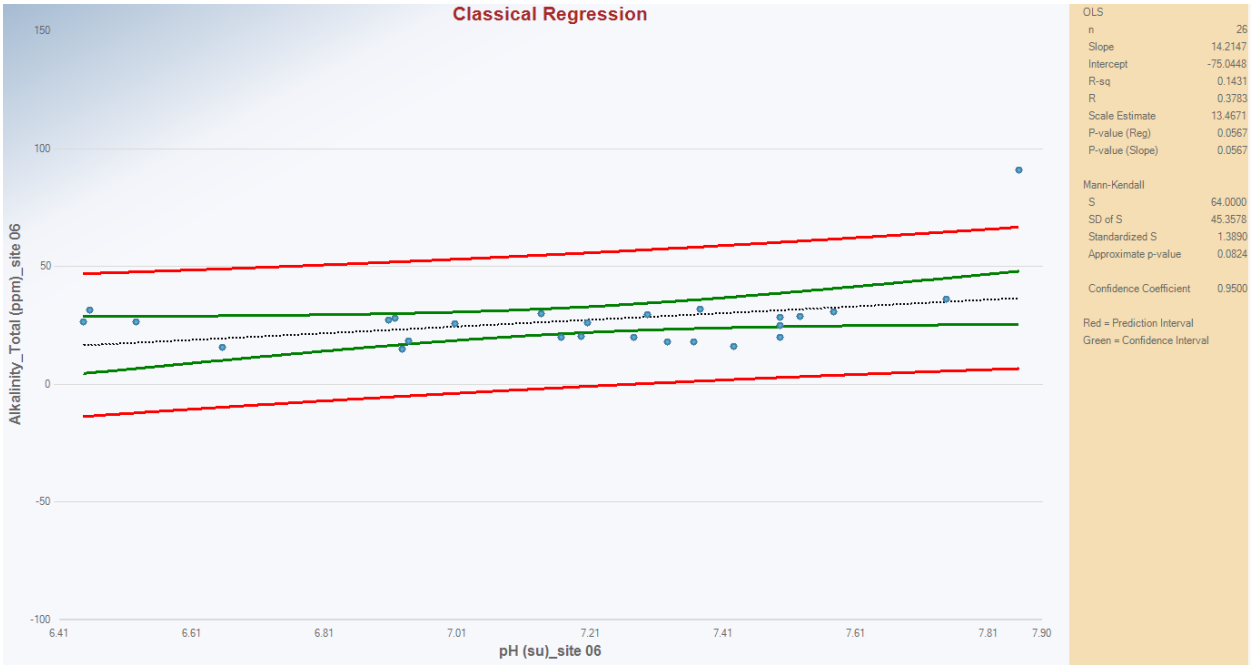
Site 4:


Classical Regression
Alkalinity_Total (ppm)_site 04
pH (su)_site 04
80
60
40
20
0
-20
6.25
6.45
6.65
6.85
7.05
7.25
7.45 7.48
OLS
n 26
Slope 3.5779
Intercept -5.0182
R-sq 0.0356
R 0.1886
Scale Estimate 7.3979
P-value (Reg) 0.3562
P-value (Slope) 0.3562
Mann-Kendall
S 54.0000
SD of S 45.3578
Standardized S 1.1685
Approximate p-value 0.1213
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

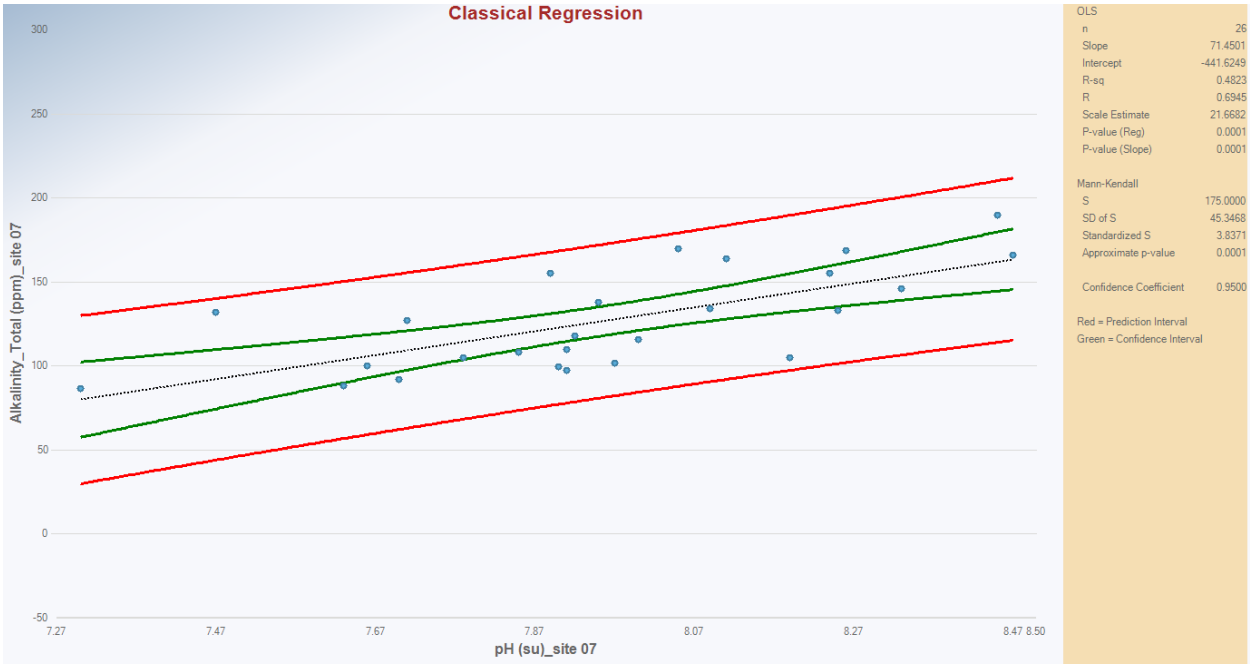
Site 5:


Classical Regression
Alkalinity_Total (ppm)_site 05
pH (su)_site 05
125
100
75
50
25
0
-25
-50
6.39
6.59
6.79
6.99
7.19
7.39
7.59
7.78
OLS
n 25
Slope 13.0183
Intercept -62.1864
R-sq 0.0994
R 0.3153
Scale Estimate 13.9830
P-value (Reg) 0.1247
P-value (Slope) 0.1247
Mann-Kendall
S 33.0000
SD of S 42.7824
Standardized S 0.7480
Approximate p-value 0.2272
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

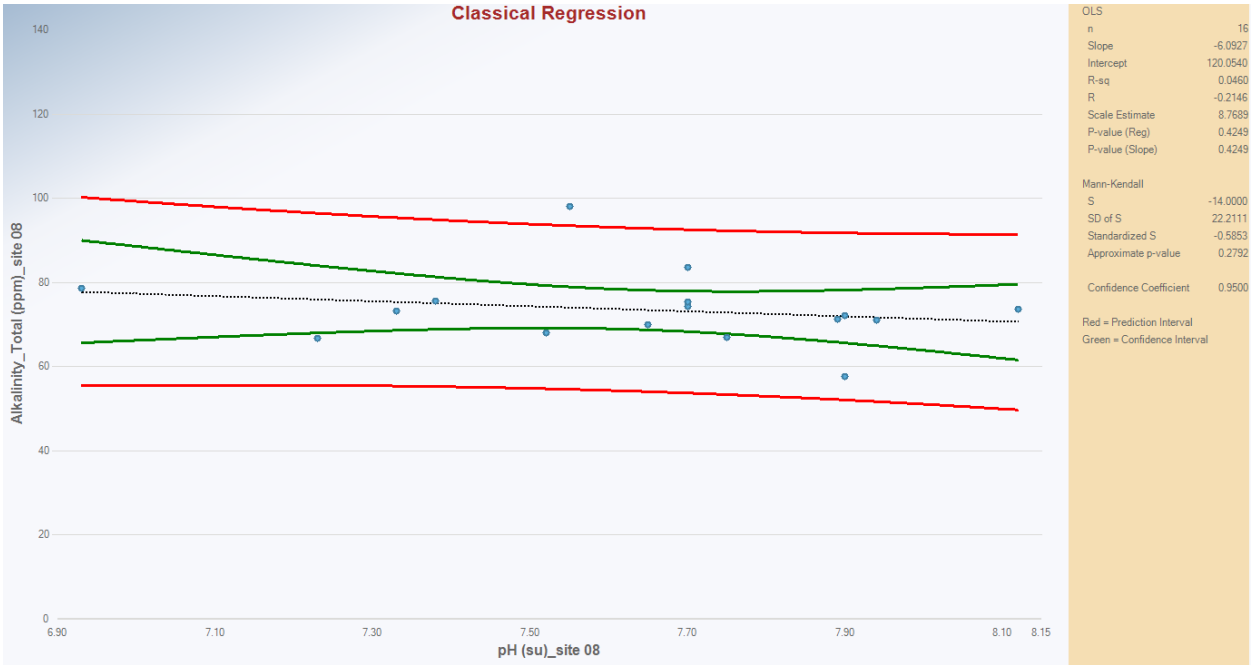
Site 6:


Classical Regression
Alkalinity_Total (ppm)_site 06
pH (su)_site 06
150
100
50
0
-50
-100
6.41
6.61
6.81
7.01
7.21
7.41
7.61
7.81
7.90
OLS
n 26
Slope 14.2147
Intercept -75.0448
R-sq 0.1431
R 0.3783
Scale Estimate 13.4671
P-value (Reg) 0.0567
P-value (Slope) 0.0567
Mann-Kendall
S 64.0000
SD of S 45.3578
Standardized S 1.3890
Approximate p-value 0.0824
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

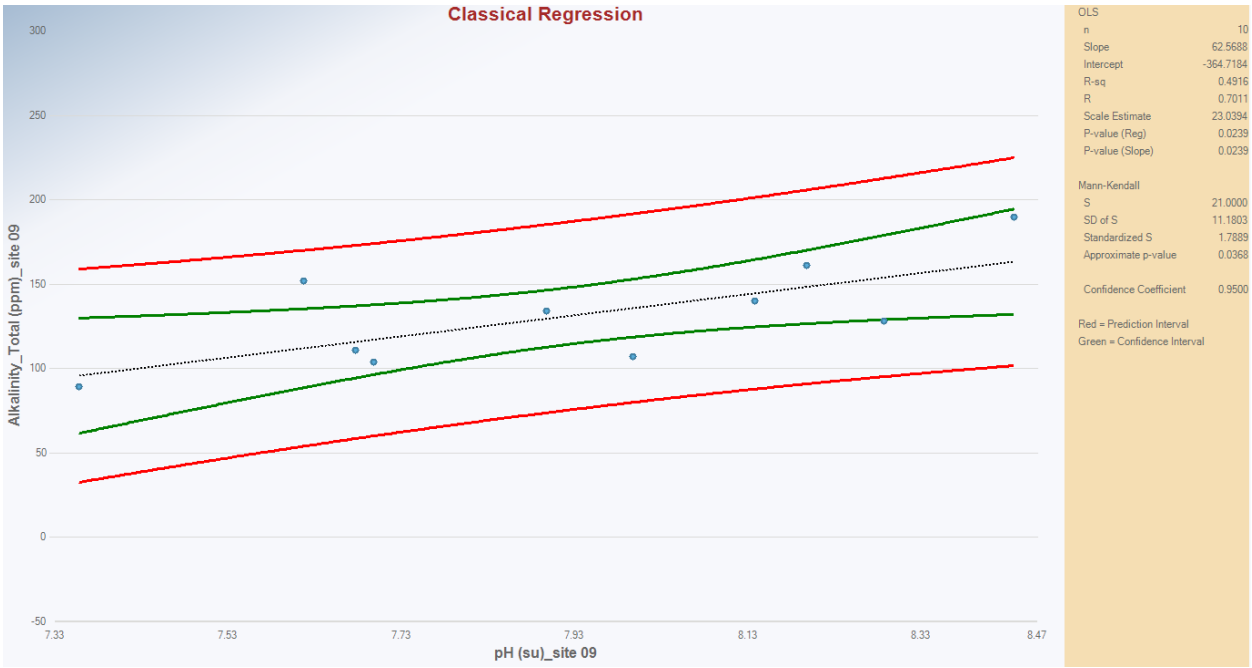
Site 7:


Classical Regression
Alkalinity_Total (ppm)_site 07
pH (su)_site 07
300
250
200
150
100
50
0
-50
7.27
7.47
7.67
7.87
8.07
8.27
8.47 8.50
OLS
n 26
Slope 71.4501
Intercept -441.6249
R-sq 0.4823
R 0.6945
Scale Estimate 21.6682
P-value (Reg) 0.0001
P-value (Slope) 0.0001
Mann-Kendall
S 175.0000
SD of S 45.3468
Standardized S 3.8371
Approximate p-value 0.0001
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

Site 8:


Classical Regression
Alkalinity_Total (ppm)_site 08
pH (su)_site 08
140
120
100
80
60
40
20
0
6.90
7.10
7.30
7.50
7.70
7.90
8.10
8.15
OLS
n 16
Slope -6.0927
Intercept 120.0540
R-sq 0.0460
R -0.2146
Scale Estimate 8.7689
P-value (Reg) 0.4249
P-value (Slope) 0.4249
Mann-Kendall
S -14.0000
SD of S 22.2111
Standardized S -0.5853
Approximate p-value 0.2792
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

Site 9:


Classical Regression
Alkalinity_Total (ppm)_site 09
pH (su)_site 09
300
250
200
150
100
50
0
-50
7.33
7.53
7.73
7.93
8.13
8.33
8.47
OLS
n 10
Slope 62.5688
Intercept -364.7184
R-sq 0.4916
R 0.7011
Scale Estimate 23.0394
P-value (Reg) 0.0239
P-value (Slope) 0.0239
Mann-Kendall
S 21.0000
SD of S 11.1803
Standardized S 1.7889
Approximate p-value 0.0368
Confidence Coefficient 0.9500
Red = Prediction Interval
Green = Confidence Interval

Alkalinity in Paulins Kill vs. Tributaries

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/13/2024 5:54:07 PM
From File	All Data_ProUCL_11.12.2024_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean = Sample 2 Mean (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean <> Sample 2 Mean

Sample 1 Data: Alkalinity, Total (mg/L)(paulins kill)

Sample 2 Data: Alkalinity, Total (mg/L)(tributaries)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	36	171
Number of Distinct Observations	32	123
Minimum	86.8	5.52
Maximum	190	98
Mean	128.4	26.61
Median	127.5	21.1
SD	29.4	18.96
SE of Mean	4.901	1.45

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 = Mean of Sample 2

		t-Test	Lower C.Val	Upper C.Val	
Method	DF	Value	t (0.025)	t (0.975)	P-Value
Pooled (Equal Variance)	205	26.305	-1.972	1.972	0.000
Welch-Satterthwaite (Unequal Variance)	41.3	19.925	-2.020	2.020	0.000

Pooled SD: 21.110

Conclusion with Alpha = 0.050

Student t (Pooled): Reject H0, Conclude Sample 1 <> Sample 2

Welch-Satterthwaite: Reject H0, Conclude Sample 1 <> Sample 2

Test of Equality of Variances

Variance of Sample 1	864.6
Variance of Sample 2	359.4

Numerator DF	Denominator DF	F-Test Value	P-Value
35	170	2.406	0.000

Conclusion with Alpha = 0.05

Two variances are not equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/13/2024 5:57:50 PM
From File	All Data_ProUCL_11.12.2024_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Alkalinity, Total (mg/L)(paulins kill)

Sample 2 Data: Alkalinity, Total (mg/L)(tributaries)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	36	171
Number of Distinct Observations	32	123
Minimum	86.8	5.52
Maximum	190	98
Mean	128.4	26.61
Median	127.5	21.1
SD	29.4	18.96
SE of Mean	4.901	1.45

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	6814
WMW U-Stat	6148
Standardized WMW U-Stat	9.399
Mean (U)	3078
SD(U) - Adj ties	326.6
Lower Approximate U-Stat Critical Value (0.025)	-1.96
Upper Approximate U-Stat Critical Value (0.975)	1.96
P-Value (Adjusted for Ties)	5.521E-21

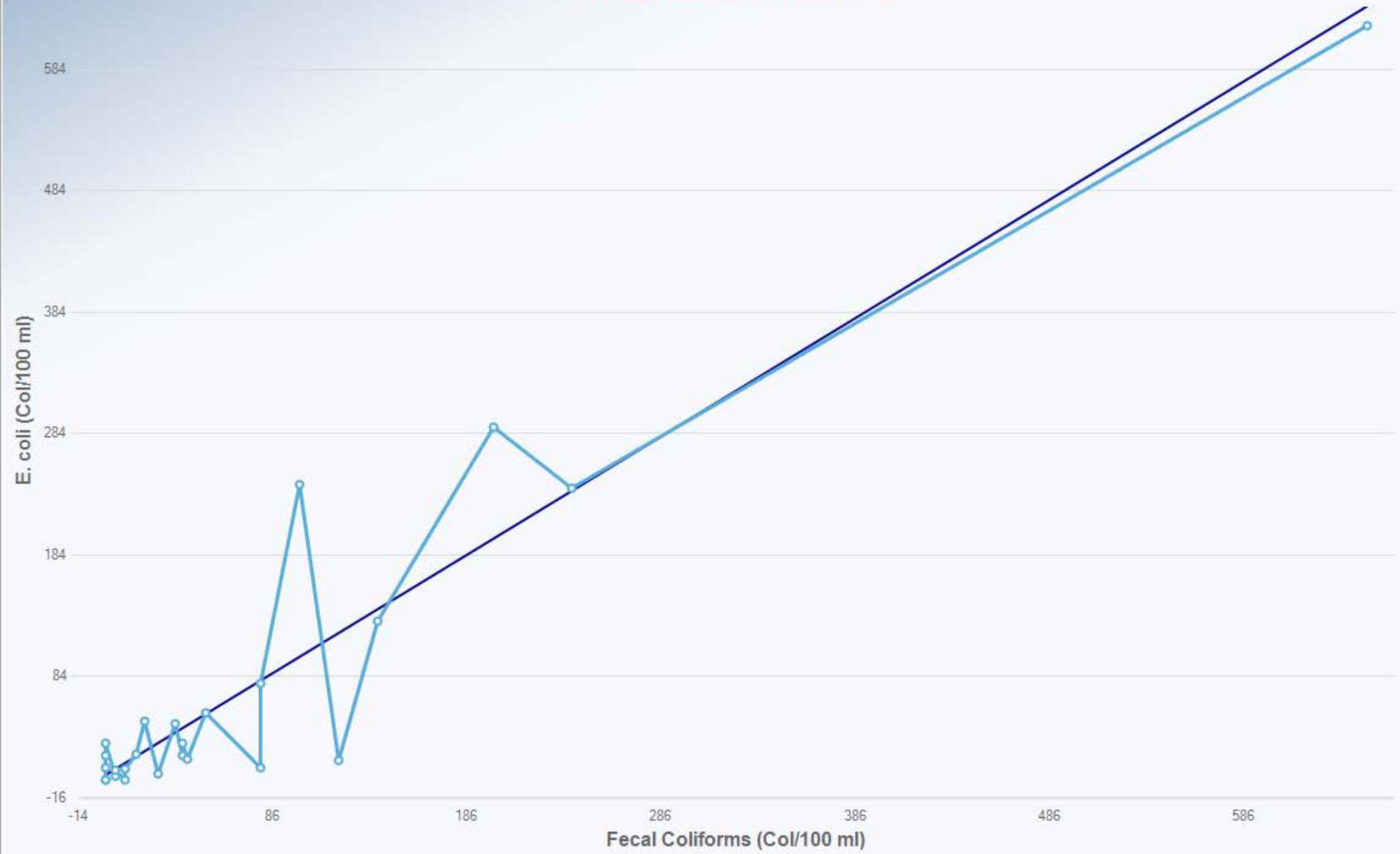
Conclusion with Alpha = 0.05

Reject H0, Conclude Sample 1 <> Sample 2

P-Value < alpha (0.05)

Fecal Coliforms and E. coli

Mann-Kendall Trend Test



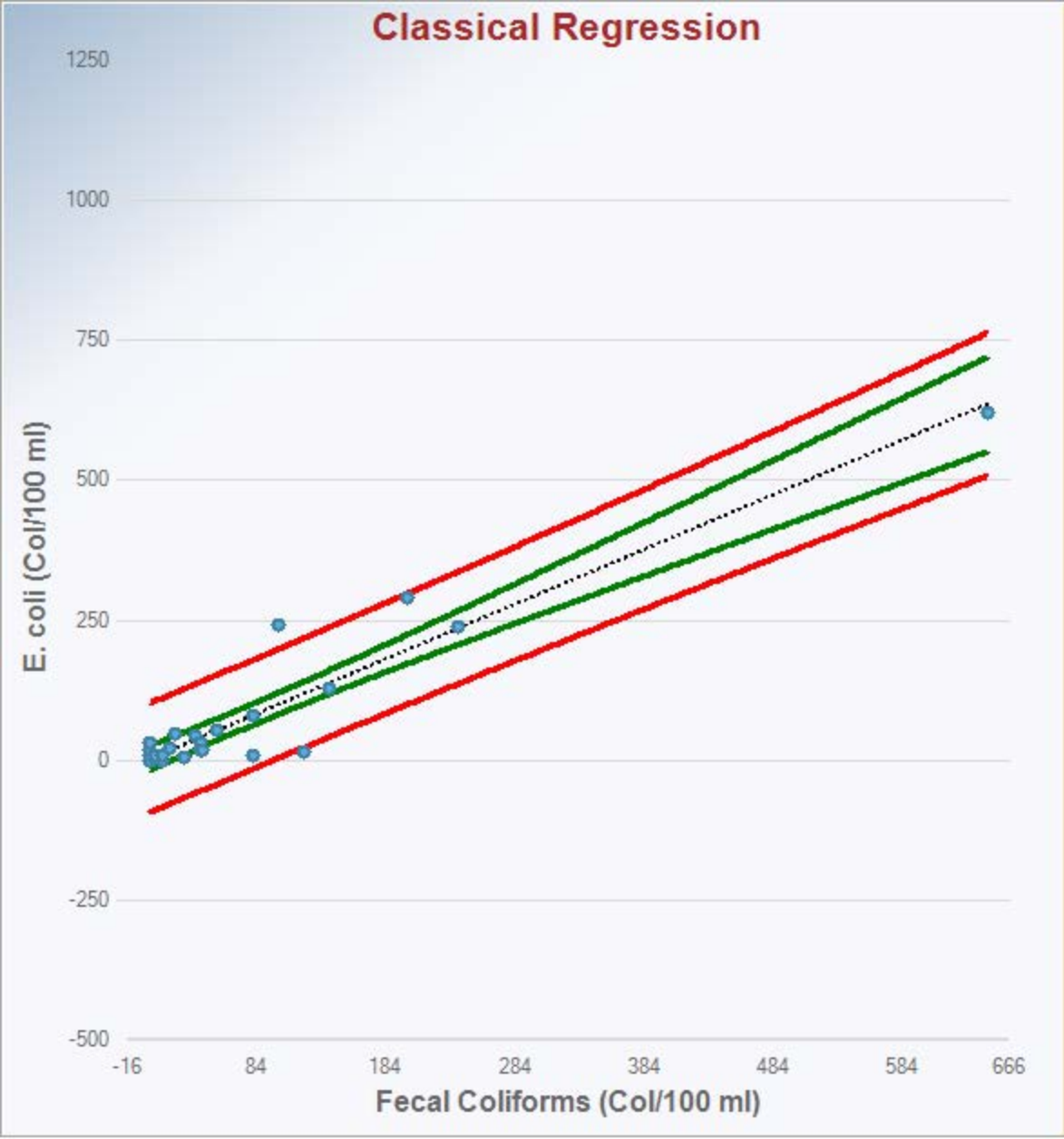
Mann-Kendall Trend Analysis

n	25
Confidence Coefficient	0.9500
Level of Significance	0.0500
Standard Deviation of S	42.7395
Standardized Value of S	4.0946
M-K Test Value (S)	176
Appx. Critical Value (0.05)	1.6449
Approximate p-value	0.0000

OLS Regression Line (Blue)

OLS Regression Slope	0.9742
OLS Regression Intercept	3.4483

Statistically significant evidence of an increasing trend at the specified level of significance.



OLS	
n	25
Slope	0.9742
Intercept	3.4483
R-sq	0.8952
R	0.9462
Scale Estimate	46.1567
P-value (Reg)	0.0000
P-value (Slope)	0.0000

Mann-Kendall	
S	176.0000
SD of S	42.7395
Standardized S	4.0946
Approximate p-value	0.0000

Confidence Coefficient	0.9500

Red = Prediction Interval
Green = Confidence Interval

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 1/1/2025 11:47:50 PM
From File	ProUCL Input_E.coli_FC Data_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0
Selected Null Hypothesis	Sample 1 Mean = Sample 2 Mean (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean <> Sample 2 Mean

Sample 1 Data: E. coli (Col/100 ml)

Sample 2 Data: Fecal Coliforms (Col/100 ml)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	25	25
Number of Distinct Observations	20	17
Minimum	0	0
Maximum	620	650
Mean	77.99	76.52
Median	20	36
SD	139.6	135.6
SE of Mean	27.92	27.11

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 = Mean of Sample 2

		t-Test	Lower C.Val	Upper C.Val	
Method	DF	Value	t (0.025)	t (0.975)	P-Value
Pooled (Equal Variance)	48	0.038	-2.011	2.011	0.97
Welch-Satterthwaite (Unequal Varian	48	0.038	-2.011	2.011	0.97

Pooled SD: 137.594

Conclusion with Alpha = 0.050

Student t (Pooled): Do Not Reject H0, Conclude Sample 1 = Sample 2

Welch-Satterthwaite: Do Not Reject H0, Conclude Sample 1 = Sample 2

Test of Equality of Variances

Variance of Sample 1	19484
Variance of Sample 2	18380

Numerator DF	Denominator DF	F-Test Value	P-Value
24	24	1.06	0.888

Conclusion with Alpha = 0.05

Two variances appear to be equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/19/2024 4:52:50 PM
From File	ProUCL Input_E.coli_FC Data.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Bacterial quality (Col/100 ml)(fecal coliforms)

Sample 2 Data: Bacterial quality (Col/100 ml)(e. coli)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	25	25
Number of Distinct Observations	17	20
Minimum	0	0
Maximum	650	620
Mean	76.52	77.99
Median	36	20
SD	135.6	139.6
SE of Mean	27.11	27.92

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	644
WMW U-Stat	319
Standardized WMW U-Stat	0.126
Mean (U)	312.5
SD(U) - Adj ties	51.51
Lower Approximate U-Stat Critical Value (0.025)	-1.96
Upper Approximate U-Stat Critical Value (0.975)	1.96
P-Value (Adjusted for Ties)	0.899

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

P-Value >= alpha (0.05)

Phosphorus and Orthophosphate

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/22/2024 12:50:16 PM
From File	2024.12_P Data_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: Phosphate, Ortho (mg/L)

Sample 2 Data: Phosphorous (mg/L)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	199	199
Number of Distinct Observations	37	45
Minimum	0	0
Maximum	0.1	0.54
Mean	0.0275	0.048
Median	0.021	0.025
SD	0.0263	0.077
SE of Mean	0.00186	0.00546

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

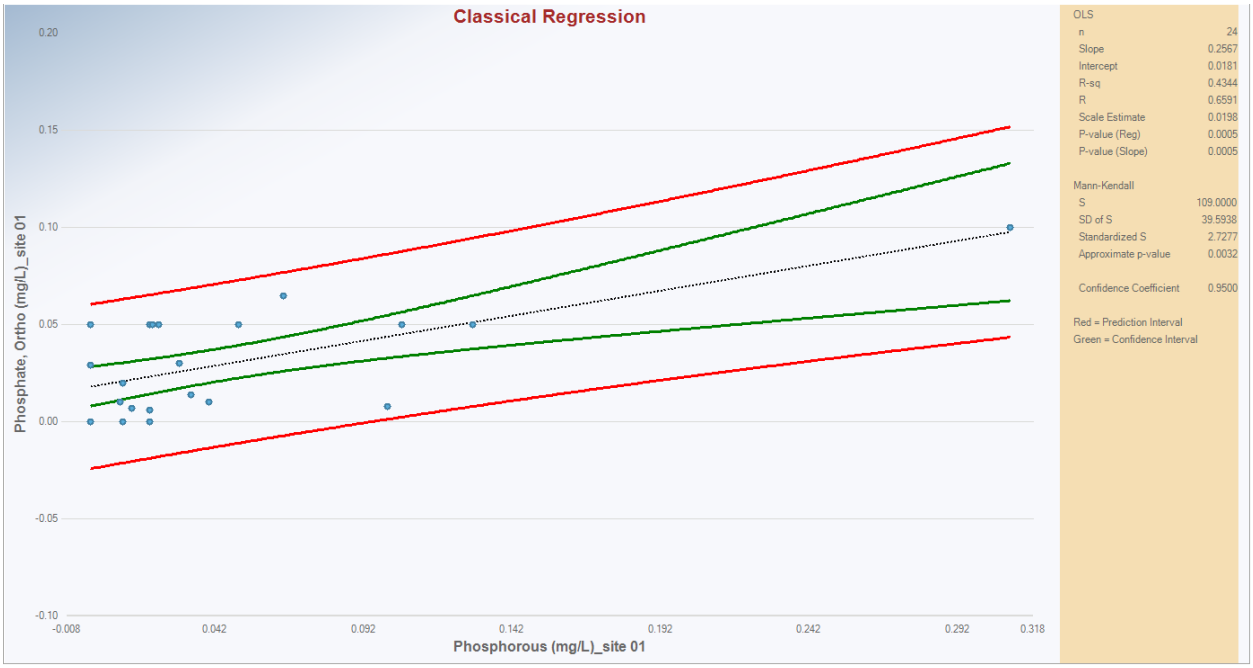
Sample 1 Rank Sum W-Stat	37508
WMW U-Stat	17608
Standardized WMW U-Stat	-1.923
Mean (U)	19801
SD(U) - Adj ties	1145
Lower Approximate U-Stat Critical Value (0.025)	-1.96
Upper Approximate U-Stat Critical Value (0.975)	1.96
P-Value (Adjusted for Ties)	0.0544

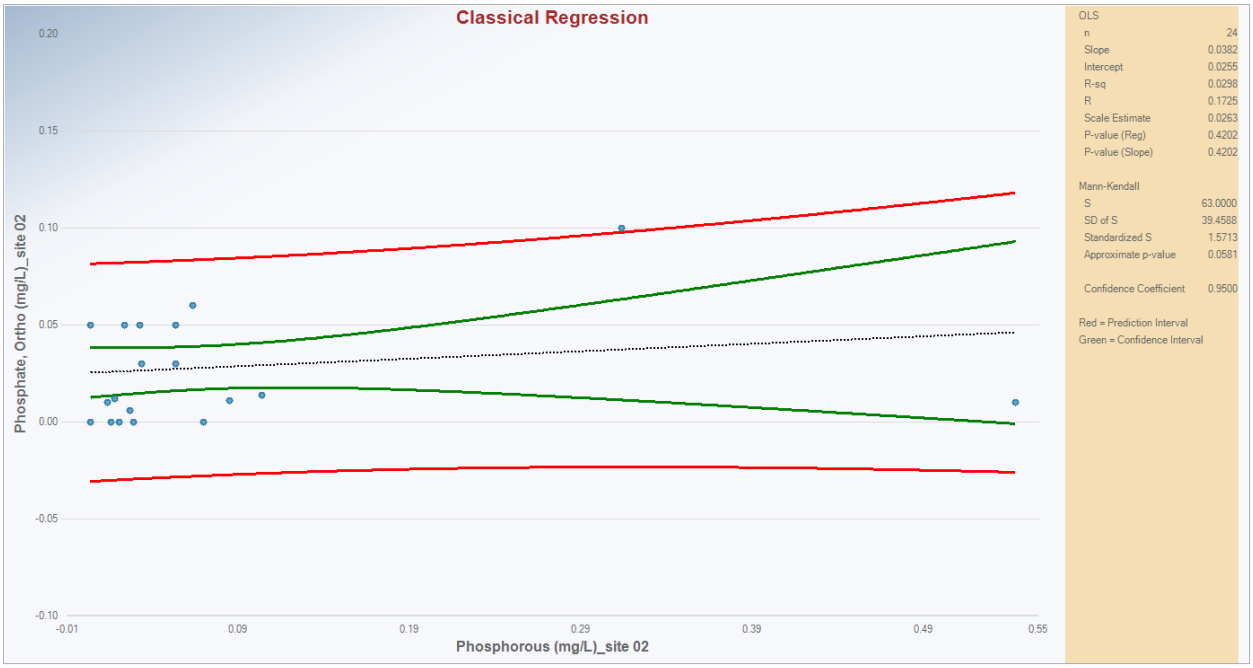
Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

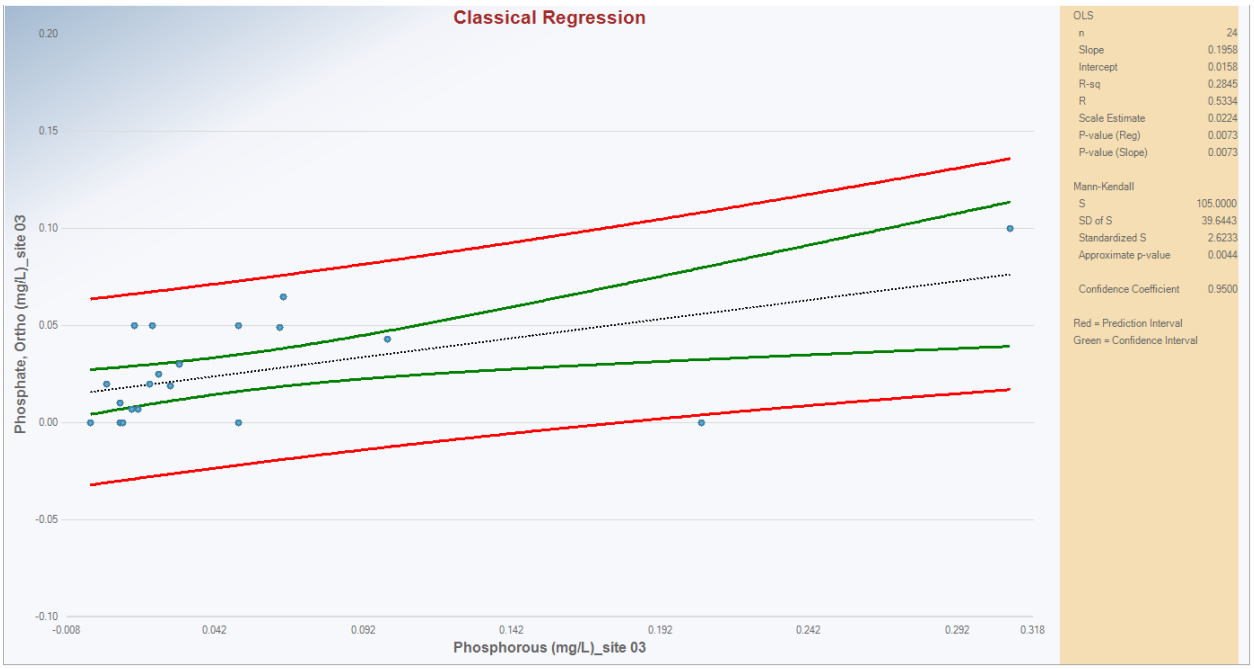
P-Value >= alpha (0.05)

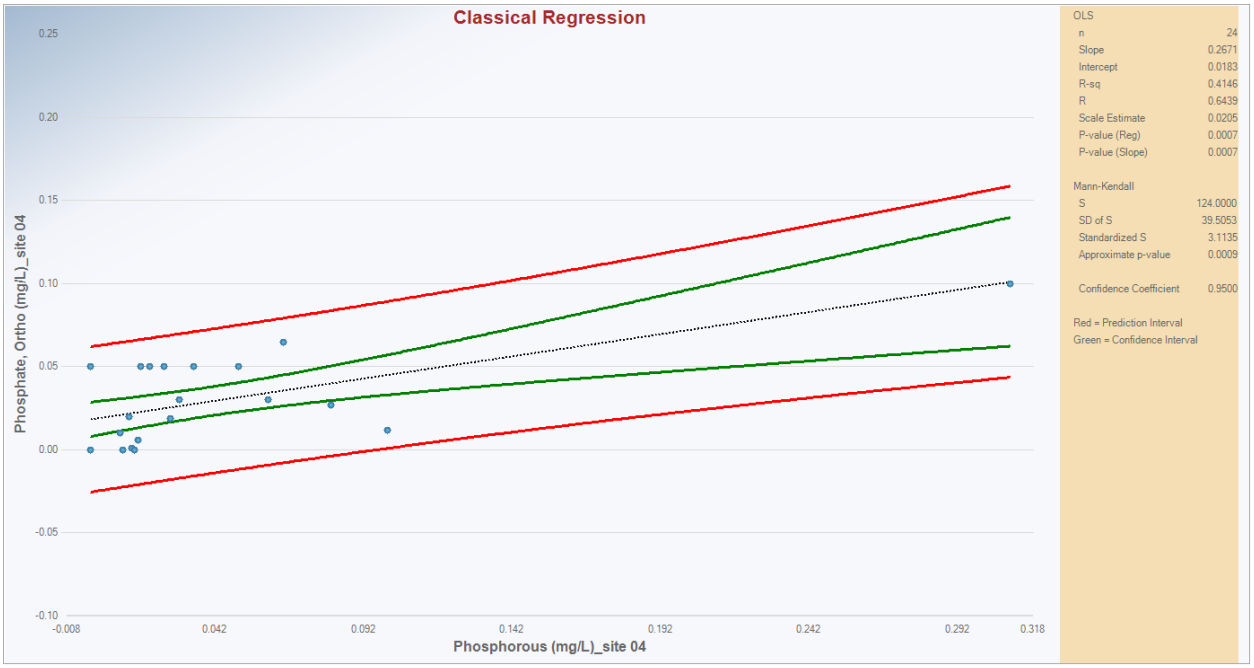
OLS Regression
Phosphorus_Orthophosphate



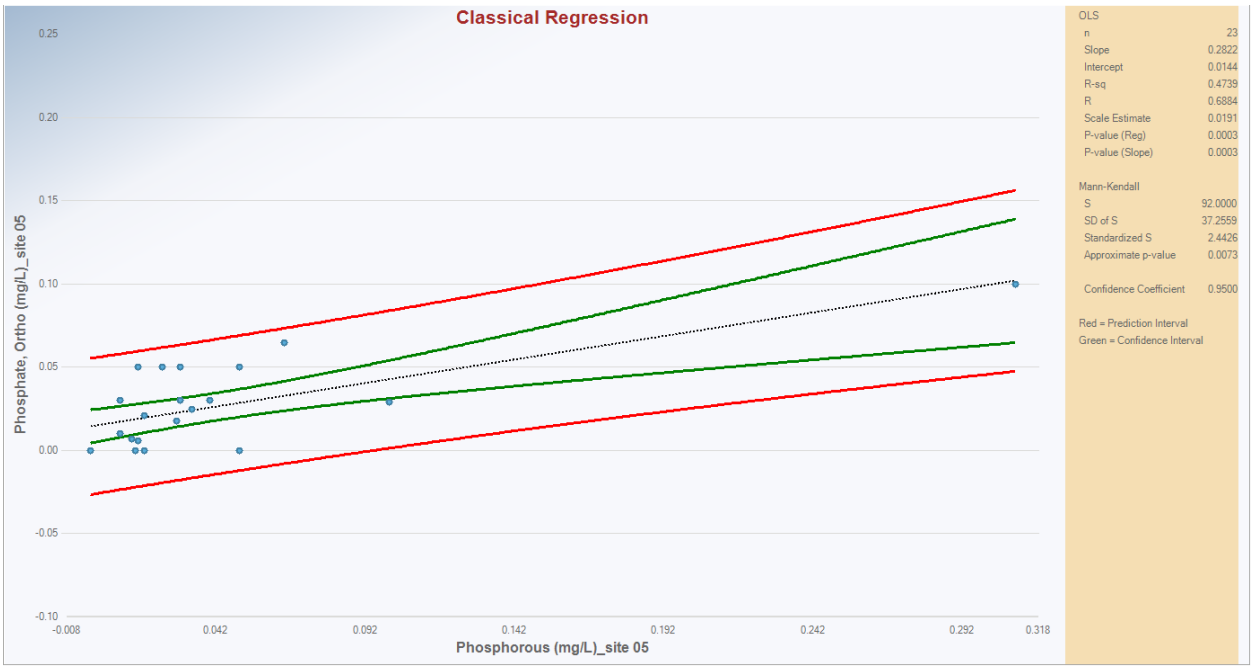


OLS Regression
Phosphorus_Orthophosphate

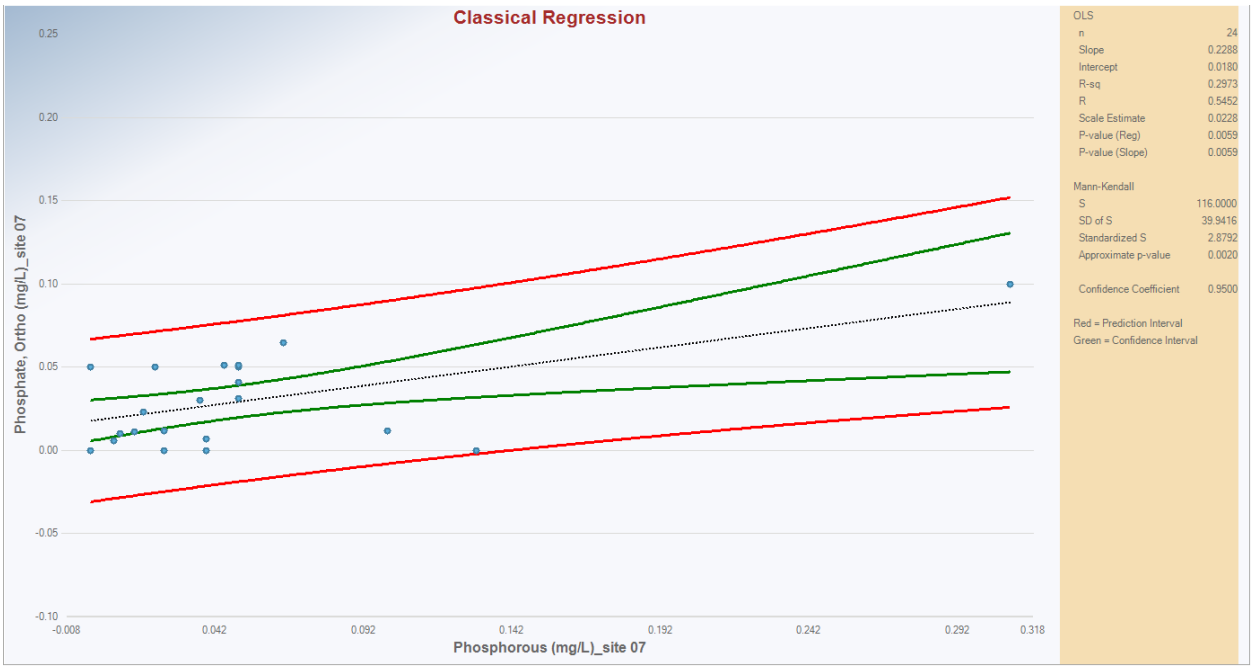


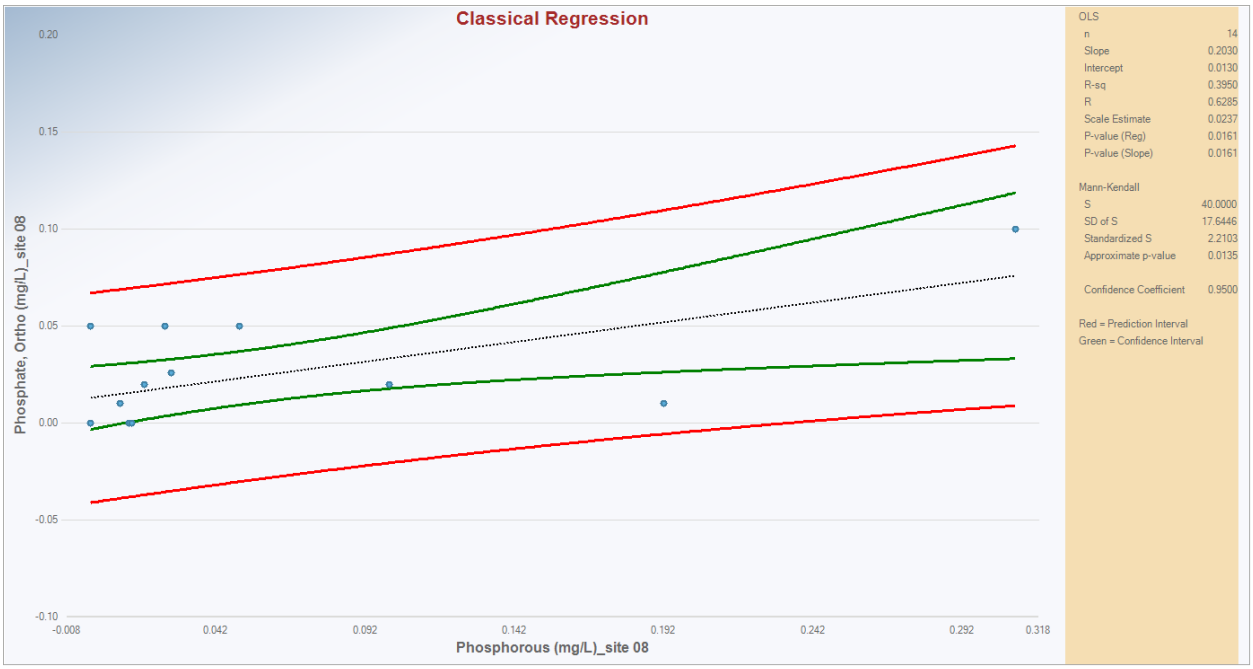


OLS Regression
Phosphorus_Orthophosphate

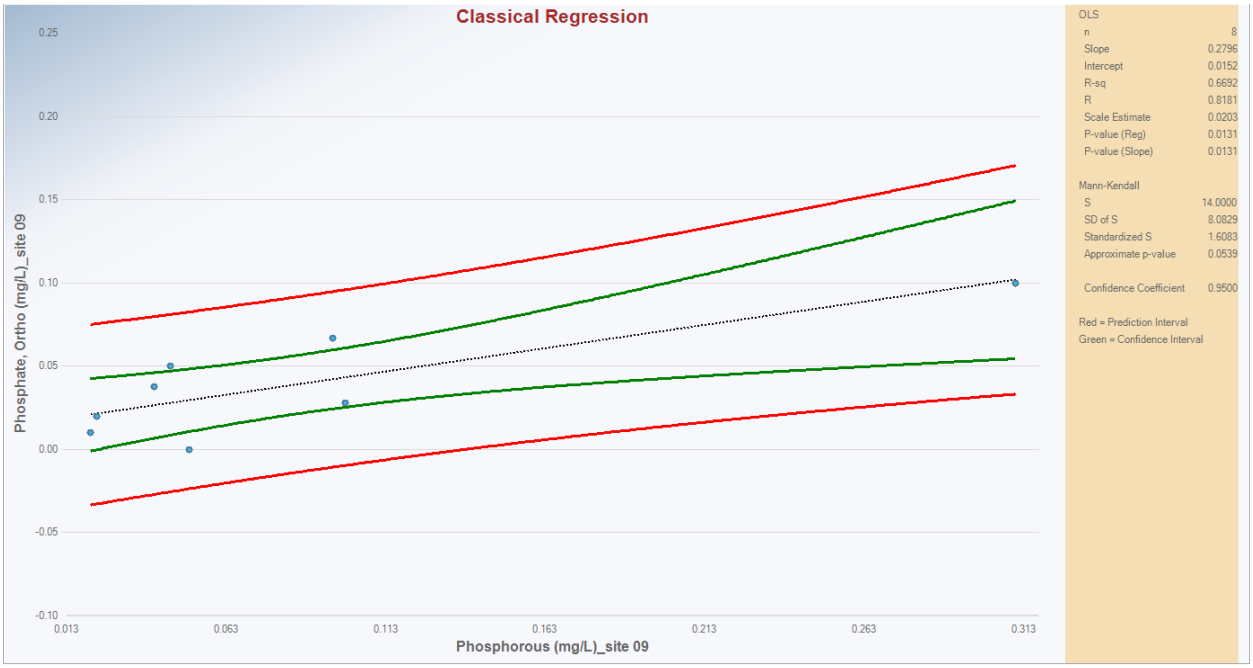


OLS Regression
Phosphorus_Orthophosphate





OLS Regression
Phosphorus_Orthophosphate



Specific Conductivity in Paulins Kill vs. Tributaries

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 9/1/2024 6:26:29 PM
From File	All Data_ProUCL_04182024_n.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean = Sample 2 Mean (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean <> Sample 2 Mean

Sample 1 Data: Specific Conductivity (umhos/cm)(paulins kill)

Sample 2 Data: Specific Conductivity (umhos/cm)(tributaries)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	34	165
Number of Distinct Observations	31	115
Minimum	300	63.4
Maximum	642	399
Mean	433.5	141.4
Median	437.5	132
SD	92.88	54.3
SE of Mean	15.93	4.227

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 = Mean of Sample 2

		t-Test	Lower C.Val	Upper C.Val	
Method	DF	Value	t (0.025)	t (0.975)	P-Value
Pooled (Equal Variance)	197	24.835	-1.972	1.972	0.000
Welch-Satterthwaite (Unequal Variance)	37.8	17.724	-2.024	2.024	0.000

Pooled SD: 62.450

Conclusion with Alpha = 0.050

Student t (Pooled): Reject H0, Conclude Sample 1 <> Sample 2

Welch-Satterthwaite: Reject H0, Conclude Sample 1 <> Sample 2

Test of Equality of Variances

Variance of Sample 1	8627
Variance of Sample 2	2949

Numerator DF	Denominator DF	F-Test Value	P-Value
33	164	2.926	0.000

Conclusion with Alpha = 0.05

Two variances are not equal

Specific Conductivity and TDS Regression Analysis

OLS

n	19
Slope	1.8743
Intercept	4.6283
R-sq	0.9654
R	0.9825
Scale Estimate	33.6632
P-value (Reg)	0.0000
P-value (Slope)	0.0000

Mann-Kendall

S	147.0000
SD of S	28.5015
Standardized S	5.1225
Approximate p-value	0.0000
Confidence Coefficient	0.9500

Red = Prediction Interval
Green = Confidence Interval

TDS from Specific Conductivity and TDS Analysis

t-Test Sample 1 vs Sample 2 Comparison for Uncensored Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/22/2024 2:14:27 PM
From File	2024_ProUCL_Input_Spec.Cond_TDS_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference (S)	0.000
Selected Null Hypothesis	Sample 1 Mean = Sample 2 Mean (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean <> Sample 2 Mean

Sample 1 Data: TDS (mg/L)

Sample 2 Data: TDS from SC(SC*0.65) (mg/L)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	19	19
Number of Distinct Observations	18	16
Minimum	48	67.6
Maximum	360	416
Mean	136.5	169.3
Median	100	130
SD	92.15	114.3
SE of Mean	21.14	26.21

Sample 1 vs Sample 2 Two-Sample t-Test

H0: Mean of Sample 1 = Mean of Sample 2

		t-Test	Lower C.Val	Upper C.Val	
Method	DF	Value	t (0.025)	t (0.975)	P-Value
Pooled (Equal Variance)	36	-0.974	-2.028	2.028	0.336
Welch-Satterthwaite (Unequal Varian	34.5	-0.974	-2.032	2.032	0.337

Pooled SD: 103.798

Conclusion with Alpha = 0.050

Student t (Pooled): Do Not Reject H0, Conclude Sample 1 = Sample 2

Welch-Satterthwaite: Do Not Reject H0, Conclude Sample 1 = Sample 2

Test of Equality of Variances

Variance of Sample 1	8492
Variance of Sample 2	13056

Numerator DF	Denominator DF	F-Test Value	P-Value
18	18	1.538	0.370

Conclusion with Alpha = 0.05

Two variances appear to be equal

Wilcoxon-Mann-Whitney Sample 1 vs Sample 2 Comparison Test for Uncensor Full Data Sets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.2 12/22/2024 2:15:46 PM
From File	2024_ProUCL_Input_Spec.Cond_TDS_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0.000
Selected Null Hypothesis	Sample 1 Mean/Median = Sample 2 Mean/Median (Two Sided Alternative)
Alternative Hypothesis	Sample 1 Mean/Median <> Sample 2 Mean/Median

Sample 1 Data: TDS (mg/L)

Sample 2 Data: TDS from SC(SC*0.65) (mg/L)

Raw Statistics

	Sample 1	Sample 2
Number of Valid Observations	19	19
Number of Distinct Observations	18	16
Minimum	48	67.6
Maximum	360	416
Mean	136.5	169.3
Median	100	130
SD	92.15	114.3
SE of Mean	21.14	26.21

Wilcoxon-Mann-Whitney (WMW) Test

H0: Mean/Median of Sample 1 = Mean/Median of Sample 2

Sample 1 Rank Sum W-Stat	335
WMW U-Stat	145
Mean (U)	180.5
SD(U) - Adj ties	34.24
Lower U-Stat Critical Value (0.025)	114
Upper U-Stat Critical Value (0.975)	247
Standardized WMW U-Stat	-1.037
Approximate P-Value	0.3

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Sample 1 = Sample 2

Appendix F

NJDEP Water Quality Data Exchange Selected Site Data

NJDEP Ambient Water Quality Data Exchange Chemical Results

Near SWMP Station 6

Run At: 03/14/2024 05:39 pm

Organization	Location	Date	Depth	Ft/m	Media	Characteristic	Form	Fraction	Remark	Result	Units
NJDEP_BFBM	FIBI012	7/12/2010			Other	FIBI Rating				Good	None
NJDEP_BFBM	FIBI012	7/12/2010			Water	Dissolved oxygen (DO)				8.79	mg/l
NJDEP_BFBM	FIBI012	7/12/2010			Water	pH				7.01	None
NJDEP_BFBM	FIBI012	7/12/2010			Water	Specific conductance				198	mS/cm
NJDEP_BFBM	FIBI012	7/12/2010			Water	Temperature, water				20.04	deg C
NJDEP_BFBM	FIBI012	6/21/2017			Air	Barometric pressure				753	mmHg
NJDEP_BFBM	FIBI012	6/21/2017			Air	Temperature, air				23.7	deg C
NJDEP_BFBM	FIBI012	6/21/2017			Other	FIBI Rating				Fair	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Fish Index of Biotic Integrity				45.78	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Per. Abun. Cold & Nontolerant Coolwater Sp. (adj)				23.35	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Per. Abun. Dominant 3 Taxa (not Blacknose Dace)				27.01	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Percent Abundance Cyprinidae (adj)				19.81	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Percent Richness Benthic Insectivores				26.49	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Percent Richness Generalist Feeders				76.58	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Percent Richness of Rheophilic Species (adj)				60.07	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Per. Rich. of Lithophilic Spawners (minus w. suck)				57.95	None
NJDEP_BFBM	FIBI012	6/21/2017			Other	Tolerance Index				74.94	None
NJDEP_BFBM	FIBI012	6/21/2017			Water	Dissolved oxygen (DO)				8.48	mg/l
NJDEP_BFBM	FIBI012	6/21/2017			Water	Dissolved oxygen saturation				93.5	%
NJDEP_BFBM	FIBI012	6/21/2017			Water	Flow				13.88	cfs
NJDEP_BFBM	FIBI012	6/21/2017			Water	Inorganic nitrogen (nitrate and nitrite)	as N	Total		0.0816	mg/l
NJDEP_BFBM	FIBI012	6/21/2017			Water	Kjeldahl nitrogen		Total		0.277	mg/l
NJDEP_BFBM	FIBI012	6/21/2017			Water	Phosphate-phosphorus	as P	Total		0.0317	mg/l
NJDEP_BFBM	FIBI012	6/21/2017			Water	Specific conductance				198.6	uS/cm
NJDEP_BFBM	FIBI012	6/21/2017			Water	Temperature, water				20.1	deg C

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NJDEP Ambient Water Quality Data Exchange Chemical Results

Near SWMP Station 7

Run At: 03/14/2024 05:51 pm

Organization	Location	Date	Depth	Ft/m	Media	Characteristic	Form	Fraction	Remark	Result	Units
NJDEP_BFBM	BA50	8/29/2012			Air	Weather comments (text)				No rain day of sample, rain day before sample	None
NJDEP_BFBM	BA50	8/29/2012			Water	Escherichia coli		Total		172.5	#/100ml
NJDEP_BFBM	BA50	8/29/2012			Water	Fecal Coliform		Total		540	#/100ml
NJDEP_BFBM	BA50	8/29/2012			Water	Temperature, water				20.5	deg C
NJDEP_BFBM	BA50	9/5/2012			Air	Weather comments (text)				Rain day before & day of Sample	None
NJDEP_BFBM	BA50	9/5/2012			Water	Escherichia coli		Total		1732.9	#/100ml
NJDEP_BFBM	BA50	9/5/2012			Water	Fecal Coliform		Total		1600	#/100ml
NJDEP_BFBM	BA50	9/5/2012			Water	Temperature, water				23.9	deg C
NJDEP_BFBM	BA50	9/12/2012			Air	Weather comments (text)				No rain day of sample or day before sample	None
NJDEP_BFBM	BA50	9/12/2012			Water	Escherichia coli		Total		52.9	#/100ml
NJDEP_BFBM	BA50	9/12/2012			Water	Fecal Coliform		Total		49	#/100ml
NJDEP_BFBM	BA50	9/12/2012			Water	Temperature, water				18.5	deg C
NJDEP_BFBM	BA50	9/19/2012			Air	Weather comments (text)				Rain day before & day of Sample	None
NJDEP_BFBM	BA50	9/19/2012			Water	Escherichia coli		Total		727	#/100ml
NJDEP_BFBM	BA50	9/19/2012			Water	Fecal Coliform		Total		920	#/100ml
NJDEP_BFBM	BA50	9/19/2012			Water	Temperature, water				20.1	deg C
NJDEP_BFBM	BA50	9/26/2012			Air	Weather comments (text)				Rain day of sample, no rain day before	None
NJDEP_BFBM	BA50	9/26/2012			Water	Escherichia coli		Total		48.8	#/100ml
NJDEP_BFBM	BA50	9/26/2012			Water	Fecal Coliform		Total		23	#/100ml
NJDEP_BFBM	BA50	9/26/2012			Water	Temperature, water				17.1	deg C

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NJDEP Ambient Water Quality Data Exchange Chemical Results

Near SWMP Station 8

Run At: 03/14/2024 06:03 pm

Organization	Location	Date	Depth	Ft/m	Media	Characteristic	Form	Fraction	Remark	Result	Units
NJDEP_BFBM	BA48	8/29/2012			Air	Weather comments (text)				No rain day of sample, rain day before sample	None
NJDEP_BFBM	BA48	8/29/2012			Water	Escherichia coli		Total		5.2	#/100ml
NJDEP_BFBM	BA48	8/29/2012			Water	Temperature, water				23.8	deg C
NJDEP_BFBM	BA48	9/5/2012			Air	Weather comments (text)				Rain day before & day of Sample	None
NJDEP_BFBM	BA48	9/5/2012			Water	Escherichia coli		Total		56.3	#/100ml
NJDEP_BFBM	BA48	9/5/2012			Water	Temperature, water				23.3	deg C
NJDEP_BFBM	BA48	9/12/2012			Air	Weather comments (text)				No rain day of sample or day before sample	None
NJDEP_BFBM	BA48	9/12/2012			Water	Escherichia coli		Total		11	#/100ml
NJDEP_BFBM	BA48	9/12/2012			Water	Temperature, water				21.7	deg C
NJDEP_BFBM	BA48	9/19/2012			Air	Weather comments (text)				Rain day before & day of Sample	None
NJDEP_BFBM	BA48	9/19/2012			Water	Escherichia coli		Total		34.1	#/100ml
NJDEP_BFBM	BA48	9/19/2012			Water	Temperature, water				21.2	deg C
NJDEP_BFBM	BA48	9/26/2012			Air	Weather comments (text)				Rain day of sample, no rain day before	None
NJDEP_BFBM	BA48	9/26/2012			Water	Escherichia coli		Total		8.6	#/100ml
NJDEP_BFBM	BA48	9/26/2012			Water	Temperature, water				19.7	deg C

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NJDEP Ambient Water Quality Data Exchange Chemical Results

Near SWMP Station 10

Run At: 03/15/2024 09:43 am

Organization	Location	Date	Depth	Ft/m	Media	Characteristic	Form	Fraction	Remark	Result	Units
NJDEP_BFBM	FIBI081	7/20/2009			Other	FIBI Rating				Good	None
NJDEP_BFBM	FIBI081	7/20/2009			Water	Dissolved oxygen (DO)				7.95	mg/l
NJDEP_BFBM	FIBI081	7/20/2009			Water	pH				7.8	None
NJDEP_BFBM	FIBI081	7/20/2009			Water	Specific conductance				253	mS/cm
NJDEP_BFBM	FIBI081	7/20/2009			Water	Temperature, water				20.26	deg C
NJDEP_BFBM	FIBI081	7/2/2012			Air	Barometric pressure				749	mmHg
NJDEP_BFBM	FIBI081	7/2/2012			Air	Temperature, air				31.6	deg C
NJDEP_BFBM	FIBI081	7/2/2012			Water	Dissolved oxygen (DO)				7.71	mg/l
NJDEP_BFBM	FIBI081	7/2/2012			Water	Dissolved oxygen saturation				89.3	%
NJDEP_BFBM	FIBI081	7/2/2012			Water	pH				6.88	None
NJDEP_BFBM	FIBI081	7/2/2012			Water	Specific conductance				228	uS/cm
NJDEP_BFBM	FIBI081	7/2/2012			Water	Temperature, water				21.87	deg C
NJDEP_BFBM	FIBI081	6/21/2017			Water	Escherichia coli		Total		157.6	#/100ml
NJDEP_BFBM	FIBI081	6/21/2017			Water	Temperature, water				21.3	deg C
NJDEP_BFBM	FIBI081	6/26/2017			Water	Escherichia coli		Total		224.7	#/100ml
NJDEP_BFBM	FIBI081	6/26/2017			Water	Temperature, water				22.7	deg C
NJDEP_BFBM	FIBI081	7/5/2017			Water	Escherichia coli		Total		344.8	#/100ml
NJDEP_BFBM	FIBI081	7/5/2017			Water	Temperature, water				23.7	deg C
NJDEP_BFBM	FIBI081	7/10/2017			Water	Escherichia coli		Total		579.4	#/100ml
NJDEP_BFBM	FIBI081	7/10/2017			Water	Temperature, water				24	deg C
NJDEP_BFBM	FIBI081	7/19/2017			Water	Escherichia coli		Total		55.4	#/100ml
NJDEP_BFBM	FIBI081	7/19/2017			Water	Temperature, water				25.2	deg C
NJDEP_BFBM	FIBI081	8/21/2017			Air	Barometric pressure				761	mmHg
NJDEP_BFBM	FIBI081	8/21/2017			Air	Temperature, air				23	deg C
NJDEP_BFBM	FIBI081	8/21/2017			Other	FIBI Rating				Fair	None
NJDEP_BFBM	FIBI081	8/21/2017			Water	Dissolved oxygen (DO)				8.43	mg/l
NJDEP_BFBM	FIBI081	8/21/2017			Water	Dissolved oxygen saturation				96.1	%
NJDEP_BFBM	FIBI081	8/21/2017			Water	Flow				17.73	cfs
NJDEP_BFBM	FIBI081	8/21/2017			Water	Inorganic nitrogen (nitrate and nitrite)	as N	Total		0.165	mg/l
NJDEP_BFBM	FIBI081	8/21/2017			Water	Kjeldahl nitrogen		Total		0.215	mg/l
NJDEP_BFBM	FIBI081	8/21/2017			Water	pH				7.77	None
NJDEP_BFBM	FIBI081	8/21/2017			Water	Phosphate-phosphorus	as P	Total		0.0271	mg/l
NJDEP_BFBM	FIBI081	8/21/2017			Water	Specific conductance				251.9	uS/cm
NJDEP_BFBM	FIBI081	8/21/2017			Water	Temperature, water				21.78	deg C
NJDEP_BFBM	FIBI081	8/14/2018			Water	Escherichia coli		Total		131.4	#/100ml
NJDEP_BFBM	FIBI081	8/14/2018			Water	Temperature, water				23.5	deg C
NJDEP_BFBM	FIBI081	8/21/2018			Water	Escherichia coli		Total		88	#/100ml
NJDEP_BFBM	FIBI081	8/21/2018			Water	Temperature, water				22.6	deg C
NJDEP_BFBM	FIBI081	8/28/2018			Water	Escherichia coli		Total		140.1	#/100ml
NJDEP_BFBM	FIBI081	8/28/2018			Water	Temperature, water				24.5	deg C
NJDEP_BFBM	FIBI081	9/4/2018			Water	Escherichia coli		Total		53.7	#/100ml
NJDEP_BFBM	FIBI081	9/4/2018			Water	Temperature, water				24.7	deg C
NJDEP_BFBM	FIBI081	9/11/2018			Water	Escherichia coli		Total		143.9	#/100ml
NJDEP_BFBM	FIBI081	9/11/2018			Water	Temperature, water				20.1	deg C

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