Appendix 9. Laboratory Comparison between StablCal and multiple lots of Polymer Turbidity Standard using natural sediment and water (from the Neosho River at Neosho Rapids, Kansas, U.S. Geological Survey station number 07182390) at the Kansas Water Science Center Laboratory, Lawrence, Kansas on September 15, 2017

Comparison Description

Station name: Kansas Water Science Center laboratory, Lawrence, Kansas.

Equipment: Two Yellow Springs Instrument (YSI) EXO water-quality monitors, one equipped with two YSI EXO turbidity sensors was calibrated in polymer standard and one equipped with two YSI EXO turbidity sensors, one calibrated in StablCal standard and one calibrated in polymer standard were deployed in a laboratory turbidity testing apparatus for comparison between the standards. (See “Performance Evaluation Tests,” “Laboratory Tests,” p. 7 of main report, for a full description of laboratory methods.) The Hach model 2100AN laboratory turbidimeter with a flow-through cell was used as a reference to measure the turbidity in the apparatus bucket every 15 minutes before adding more sediment. No datum corrections were applied to either dataset.

Testing material and water: Sediment and water from Neosho River at Neosho Rapids, Kansas (USGS station number 07182390).

Calibration standard used: One sensor was calibrated with Hach StablCal turbidity standard and three sensors calibrated with YSI polymer standard.

Laboratory comparison date: September 15, 2017.

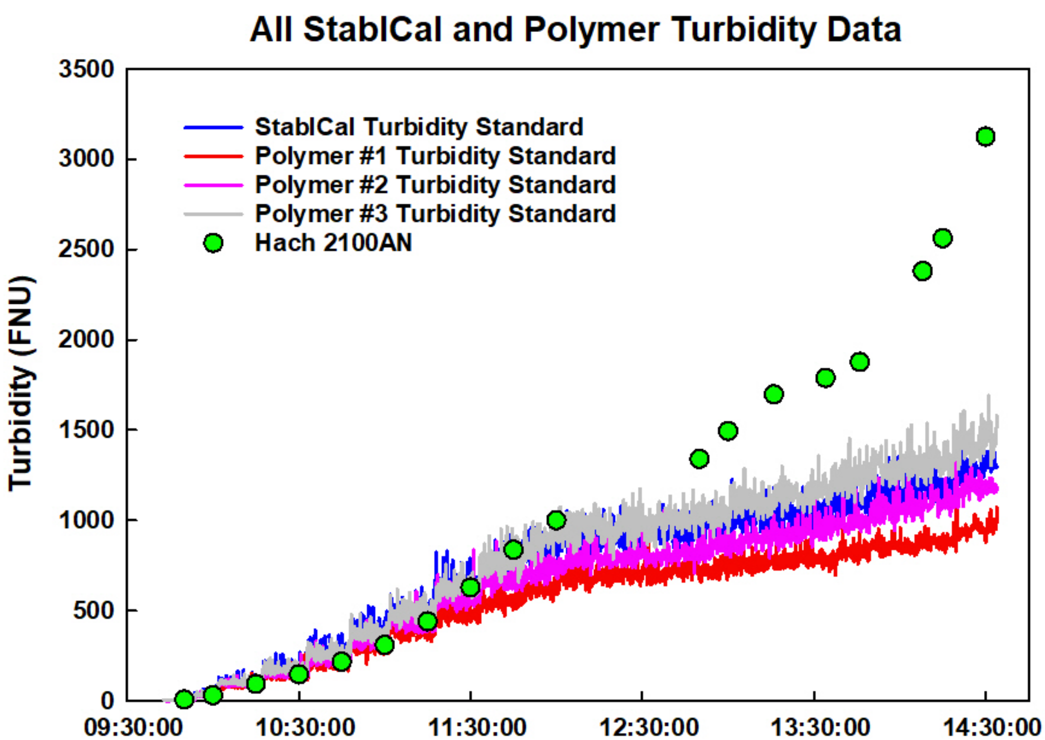
Datasets

All data were collected using U.S. Geological Survey [USGS] protocols (U.S. Geological Survey, variously dated) and are published in King (2021). Data were edited to remove periods where material was added to the testing apparatus, leaving the steady-state data for analysis.

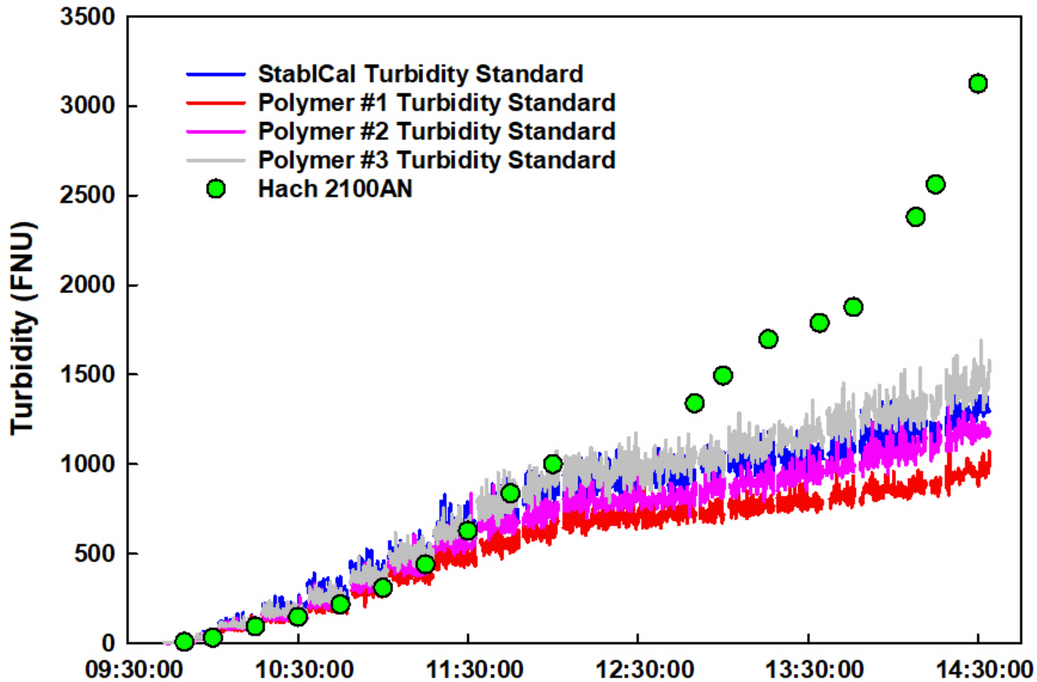
Polymer Standard Identification

	124 FNU Lot Number	1,010 FNU Lot Number
Polymer #1	17H798860	17H797418
Polymer #2	17E796816	17E794976
Polymer #3	17H799343	17H799341

Time Series



StablCal and Polymer Turbidity Data without steps



Statistical Analyses - StablCal and Polymer #1 Data

Slope comparison

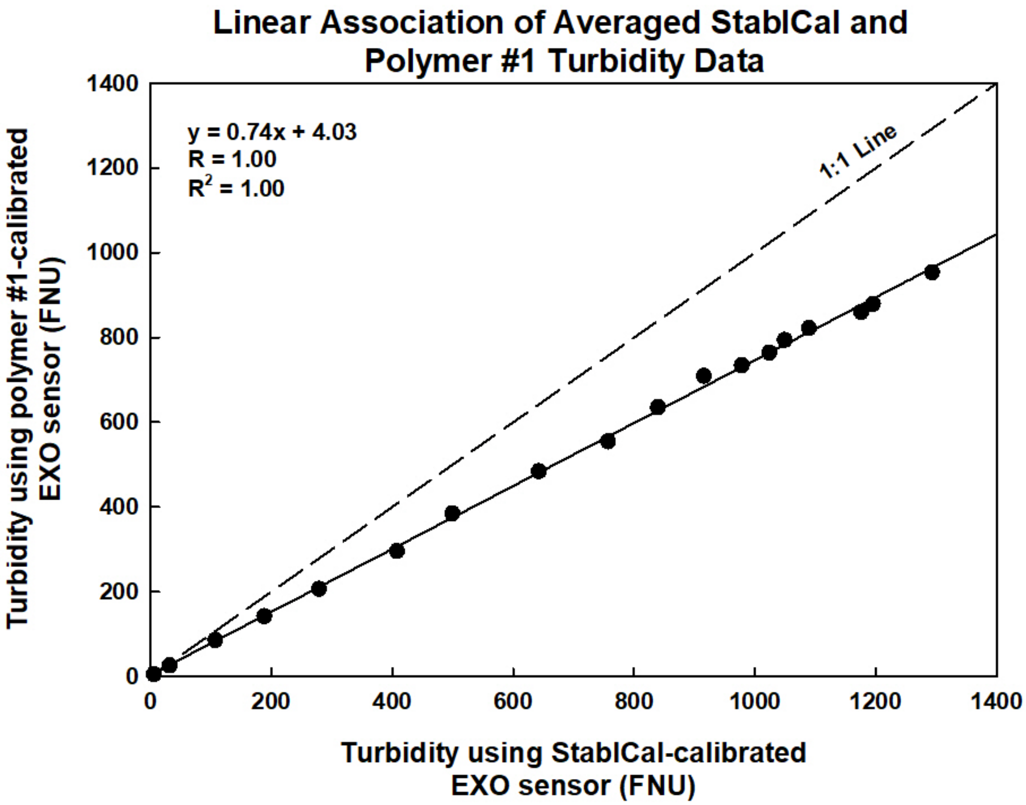
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using StablCal turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #1 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

$$y = 0.74x + 4.03$$

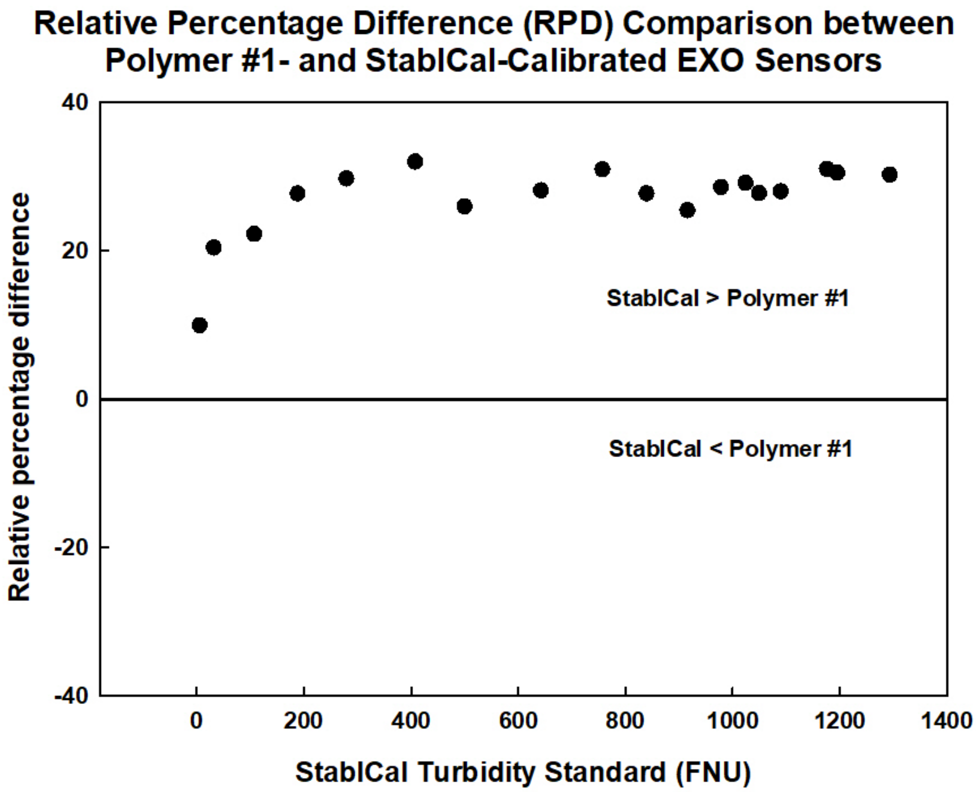
where

y = turbidity measured with polymer #1-calibrated EXO sensor (FNU)

x = turbidity measured with StablCal-calibrated EXO sensor (FNU).



Linear Association of Averaged StablCal and
Polymer #1 Turbidity Data
y = 0.74x + 4.03
R = 1.00
R² = 1.00
1:1 Line
Turbidity using polymer #1-calibrated
EXO sensor (FNU)
Turbidity using StablCal-calibrated
EXO sensor (FNU)
0
200
400
600
800
1000
1200
1400



Paired t-test for StablCal and Polymer #1 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Passed (P = 0.210)

Paired t-test:

Treatment Name	N	Missing	Mean	Std Dev	SEM
StablCal	18	0	693.261	433.707	102.226
Polymer #1	18	0	518.694	322.145	75.930
Difference	18	0	174.568	112.230	26.453

t = 6.599 with 17 degrees of freedom.

95 percent two-tailed confidence interval for difference of means: 118.757 to 230.378

Two-tailed P-value = 0.00000451

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant change (P = <0.001)

One-tailed P-value = 0.00000226

The sample mean of treatment StablCal exceeds the sample mean of treatment Polymer 1 by an amount that is greater than would be expected by chance, rejecting the hypothesis that the population mean of treatment Polymer 1 is greater than or equal to the population mean of treatment StablCal. (P = <0.001)

Power of performed two-tailed test with alpha = 0.050: 1.000

Power of performed one-tailed test with alpha = 0.050: 1.000

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 10 to 31 percent (median: 28 percent; mean: 27 percent). The data passed the Shapiro-Wilk test for normality (P=0.210); therefore, a paired t-test was performed. The difference between mean values for the StablCal- and polymer #1-calibrated EXO sensors was statistically significant ($P<0.05$).

Statistical Analyses - StablCal and Polymer #2 Data

Slope comparison

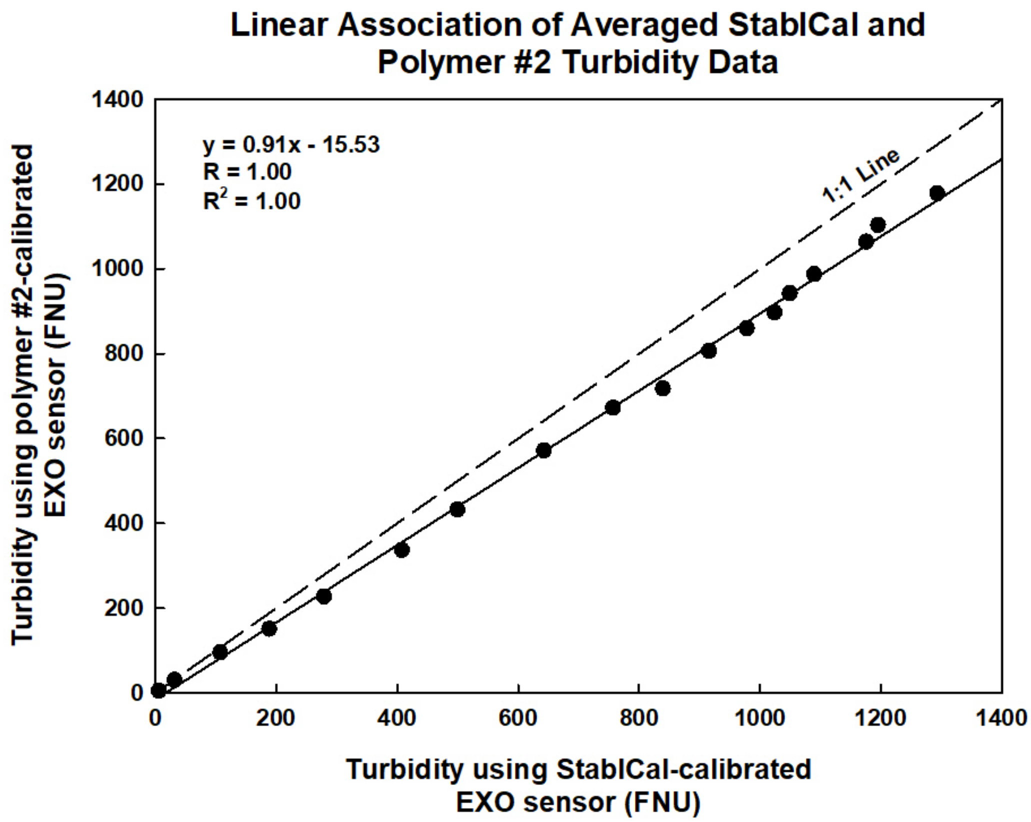
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using StablCal turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #2 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

$$y = 0.91x - 15.53$$

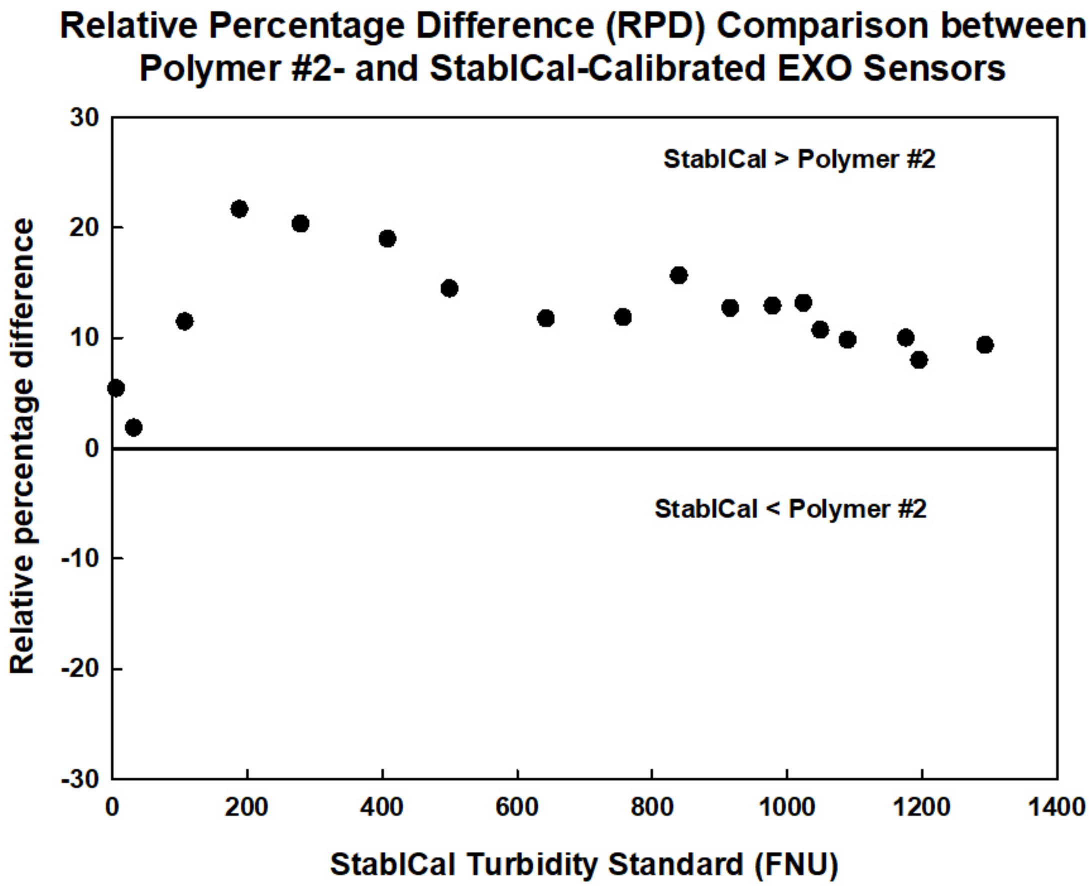
where

y = turbidity measured with polymer #2-calibrated EXO sensor (FNU)

x = turbidity measured with StablCal-calibrated EXO sensor (FNU).



Linear Association of Averaged StablCal and Polymer #2 Turbidity Data
y = 0.91x - 15.53
R = 1.00
R² = 1.00
1:1 Line
Turbidity using polymer #2-calibrated EXO sensor (FNU)
Turbidity using StablCal-calibrated EXO sensor (FNU)
0
200
400
600
800
1000
1200
1400



Wilcoxon Signed-Rank Test for StablCal and Polymer #2 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
StablCal	18	0	798.318	256.133	1059.430
Polymer #2	18	0	694.922	208.319	953.792

W= -171.000 T+ = 0.000 T-= -171.000

Z-Statistic (based on positive ranks) = -3.724

P(est.) = <0.001 P(exact)= <0.001

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  StablCal and Polymer #2
V = 171, p-value = 7.629e-06
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
  56.29124 103.39649
sample estimates:
(pseudo)median
      81.56359
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 2 to 22 percent (median: 12 percent; mean: 12 percent). The data did not pass the Shapiro-Wilk test for normality (P<0.05); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the StablCal- and polymer #2-calibrated EXO sensors was statistically significant (P<0.05).

Statistical Analyses - StablCal and Polymer #3 Data

Slope comparison

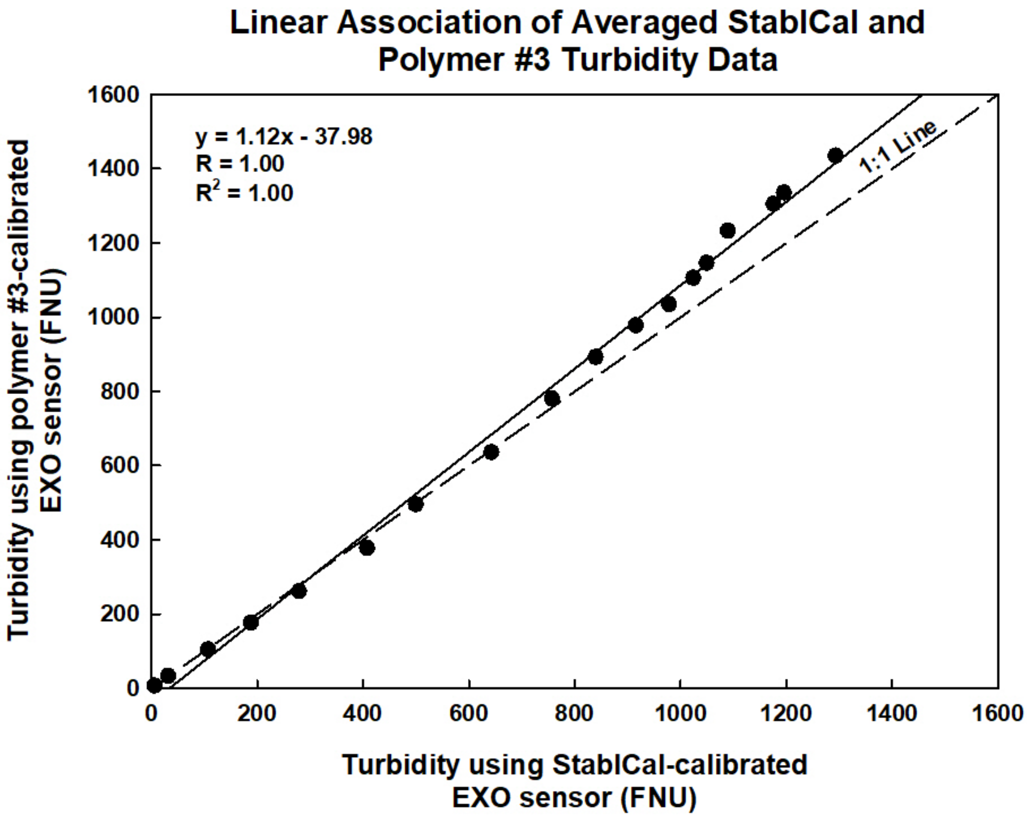
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using StablCal turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #3 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

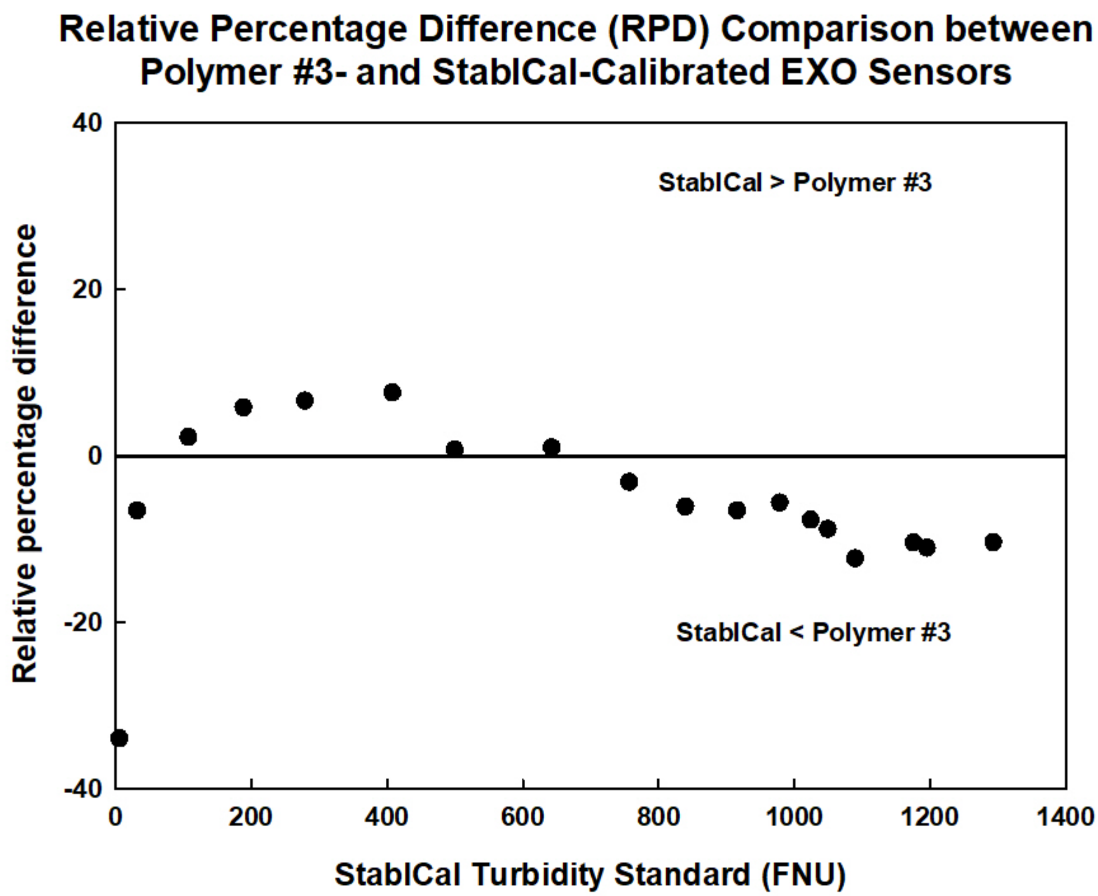
$$y = 1.12x - 37.98$$

where

y = turbidity measured with polymer #3-calibrated EXO sensor (FNU)

x = turbidity measured with StablCal-calibrated EXO sensor (FNU).


Linear Association of Averaged StablCal and
Polymer #3 Turbidity Data
y = 1.12x - 37.98
R = 1.00
R2 = 1.00
1:1 Line
Turbidity using polymer #3-calibrated
EXO sensor (FNU)
Turbidity using StablCal-calibrated
EXO sensor (FNU)
0
200
400
600
800
1000
1200
1400
1600



Wilcoxon Signed-Rank Test for StablCal and Polymer #3 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
StablCal	18	0	798.318	256.133	1059.430
Polymer #3	18	0	836.913	240.106	1167.834

W= 103.000 T+ = 137.000 T-= -34.000

Z-Statistic (based on positive ranks) = 2.243

P(est.) = 0.026 P(exact)= 0.024

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = 0.024).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  StablCal and Polymer #3
V = 34, p-value = 0.02367
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
 -72.71047 -10.24142
sample estimates:
(pseudo)median
     -47.20638
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 1 to 34 percent (median: 7 percent; mean: 8 percent). The data did not pass the Shapiro-Wilk test for normality (P<0.05); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the StablCal- and polymer #3-calibrated EXO sensors was statistically significant (P<0.05).

Statistical Analyses - Polymer #1 and Polymer #2 Data

Slope comparison

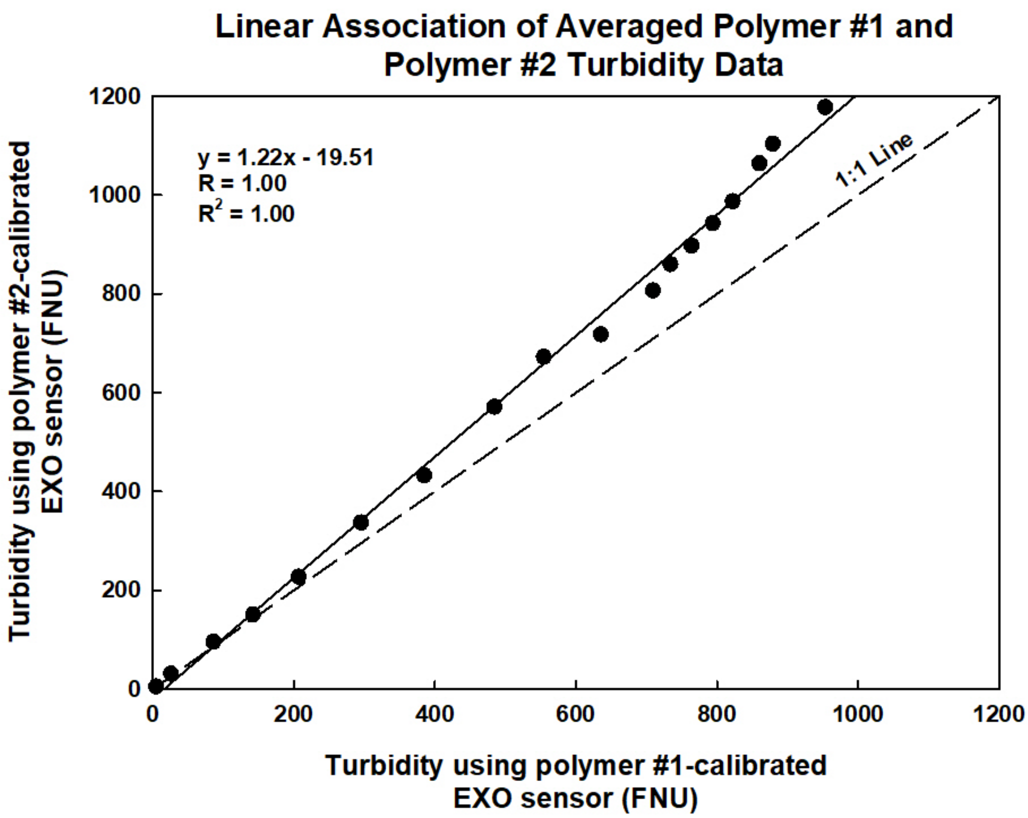
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #1 turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #2 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

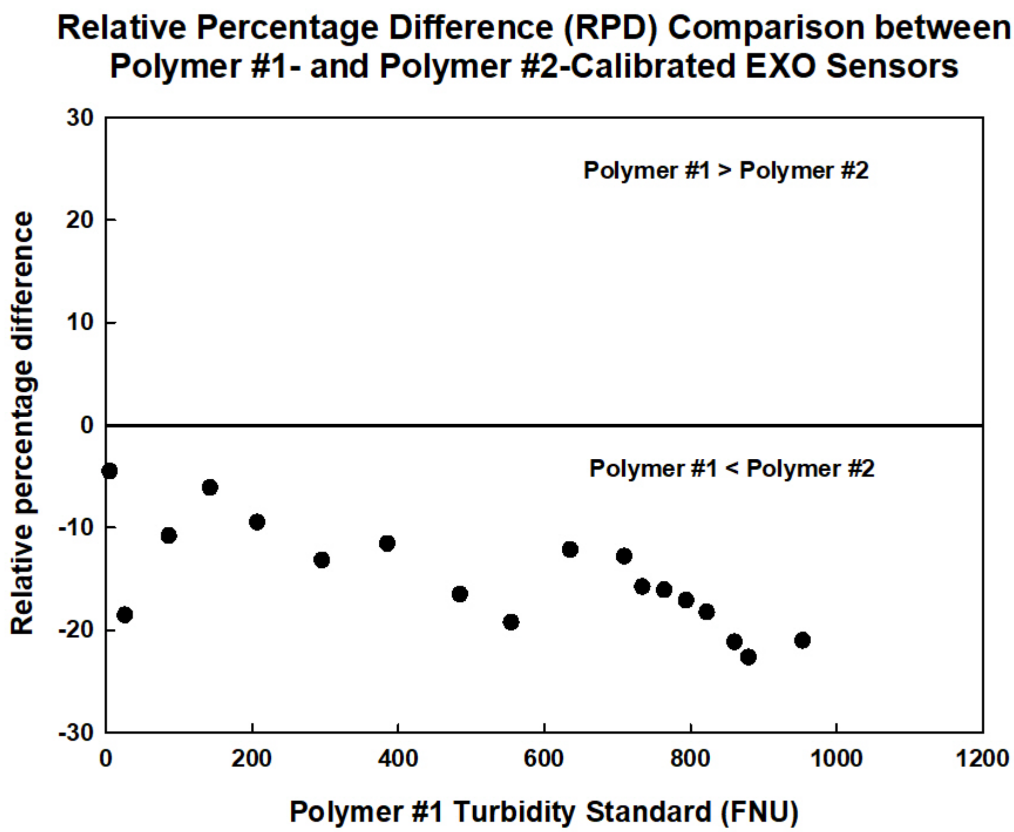
$$y = 1.22x - 19.51$$

where

y = turbidity measured with polymer #2-calibrated EXO sensor (FNU)

x = turbidity measured with polymer #1-calibrated EXO sensor (FNU).


Linear Association of Averaged Polymer #1 and Polymer #2 Turbidity Data
y = 1.22x - 19.51
R = 1.00
R2 = 1.00
1:1 Line
Turbidity using polymer #2-calibrated EXO sensor (FNU)
Turbidity using polymer #1-calibrated EXO sensor (FNU)
0
200
400
600
800
1000
1200



Paired t-test for Polymer #1 and Polymer #2 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Passed (P = 0.154)

Paired t-test:

Treatment Name	**N**	**Missing**	**Mean**	**Std Dev**	**SEM**
Polymer #1	18	0	518.694	322.145	75.930
Polymer #2	18	0	615.488	395.099	93.126
Difference	18	0	-96.794	76.079	17.932

t = -5.398 with 17 degrees of freedom.

95 percent two-tailed confidence interval for difference of means: -134.627 to -58.961

Two-tailed P-value = 0.0000481

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant change (P = <0.001)

One-tailed P-value = 0.0000240

The sample mean of treatment Polymer 2 exceeds the sample mean of treatment Polymer 1 by an amount that is greater than would be expected by chance, rejecting the hypothesis that the population mean of treatment Polymer 1 is greater than or equal to the population mean of treatment Polymer 2. (P = <0.001)

Power of performed two-tailed test with alpha = 0.050: 0.999

Power of performed one-tailed test with alpha = 0.050: 1.000

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 5 to 23 percent (median: 16 percent; mean: 15 percent). The data passed the Shapiro-Wilk test for normality (P=0.154); therefore, a paired t-test was performed. The difference between mean values for the polymer #1- and polymer #2-calibrated EXO sensors was statistically significant (P<0.05).

Statistical Analyses - Polymer #1 and Polymer #3 Data

Slope comparison

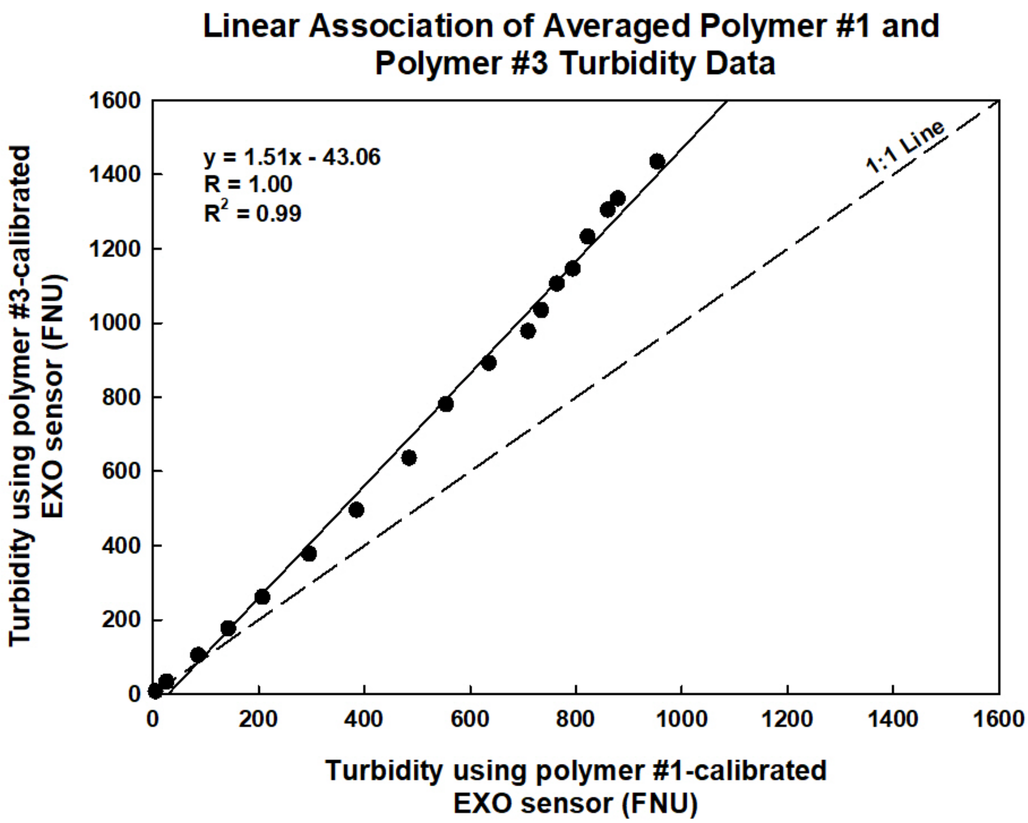
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #1 turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #3 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

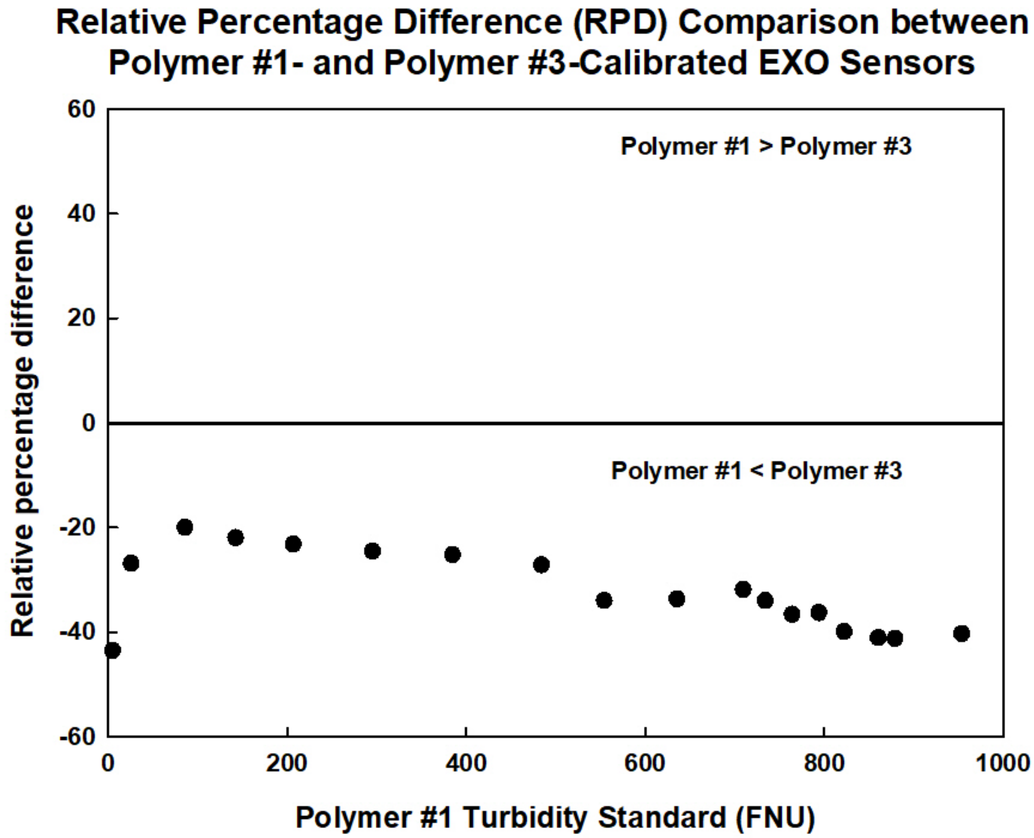
$$y = 1.51x - 43.06$$

where

y = turbidity measured with polymer #3-calibrated EXO sensor (FNU)

x = turbidity measured with polymer #1-calibrated EXO sensor (FNU).


Linear Association of Averaged Polymer #1 and Polymer #3 Turbidity Data
y = 1.51x - 43.06
R = 1.00
R2 = 0.99
1:1 Line
Turbidity using polymer #3-calibrated EXO sensor (FNU)
Turbidity using polymer #1-calibrated EXO sensor (FNU)
0
200
400
600
800
1000
1200
1400
1600



Paired t-test for Polymer #1 and Polymer #3 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Passed (P = 0.106)

Paired t-test:

Treatment Name	N	Missing	Mean	Std Dev	SEM
Polymer #1	18	0	518.694	322.145	75.930
Polymer #3	18	0	741.210	488.337	115.102
Difference	18	0	-222.516	168.601	39.740

t = -5.599 with 17 degrees of freedom.

95 percent two-tailed confidence interval for difference of means: -306.359 to -138.673

Two-tailed P-value = 0.0000319

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant change (P = <0.001)

One-tailed P-value = 0.0000160

The sample mean of treatment Polymer 3 exceeds the sample mean of treatment Polymer 1 by an amount that is greater than would be expected by chance, rejecting the hypothesis that the population mean of treatment Polymer 1 is greater than or equal to the population mean of treatment Polymer 3. (P = <0.001)

Power of performed two-tailed test with alpha = 0.050: 1.000

Power of performed one-tailed test with alpha = 0.050: 1.000

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 23 to 43 percent (median: 34 percent; mean: 32 percent). The data passed the Shapiro-Wilk test for normality (P=0.106); therefore, a paired t-test was performed. The difference between mean values for the polymer #1- and polymer #3-calibrated EXO sensors was statistically significant (P<0.05).

Statistical Analyses - Polymer #2 and Polymer #3 Data

Slope comparison

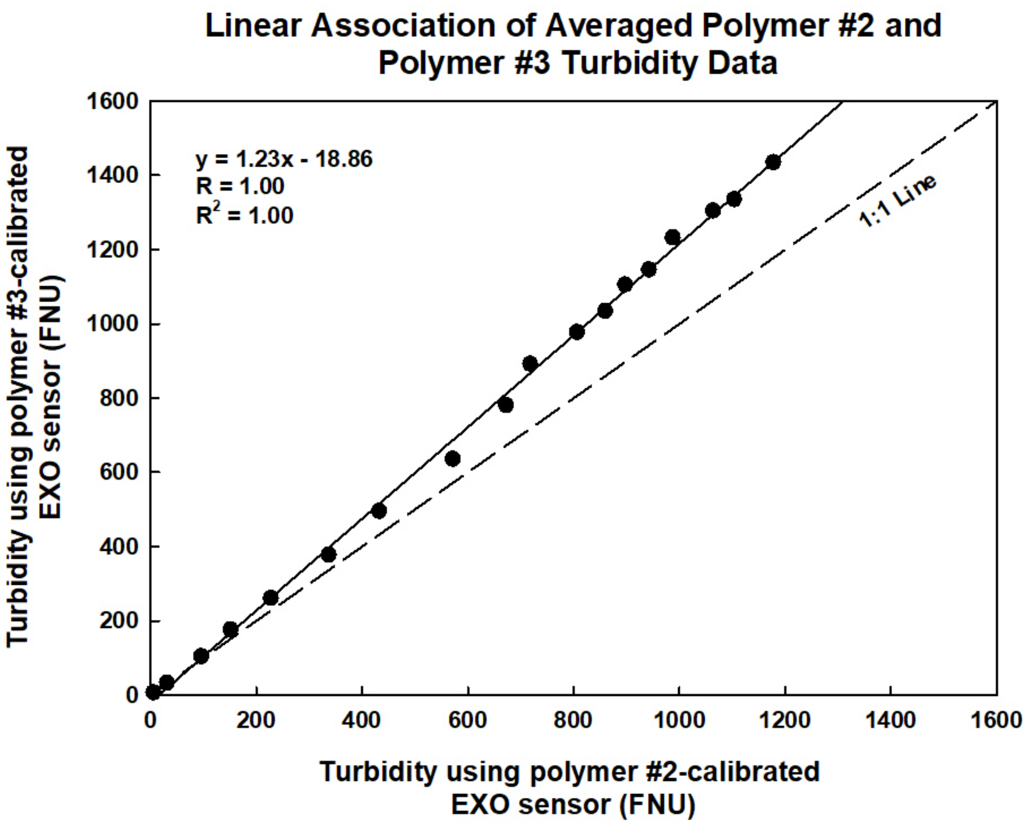
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #2 turbidity standard and one YSI EXO turbidity sensor calibrated by using polymer #3 turbidity standard at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

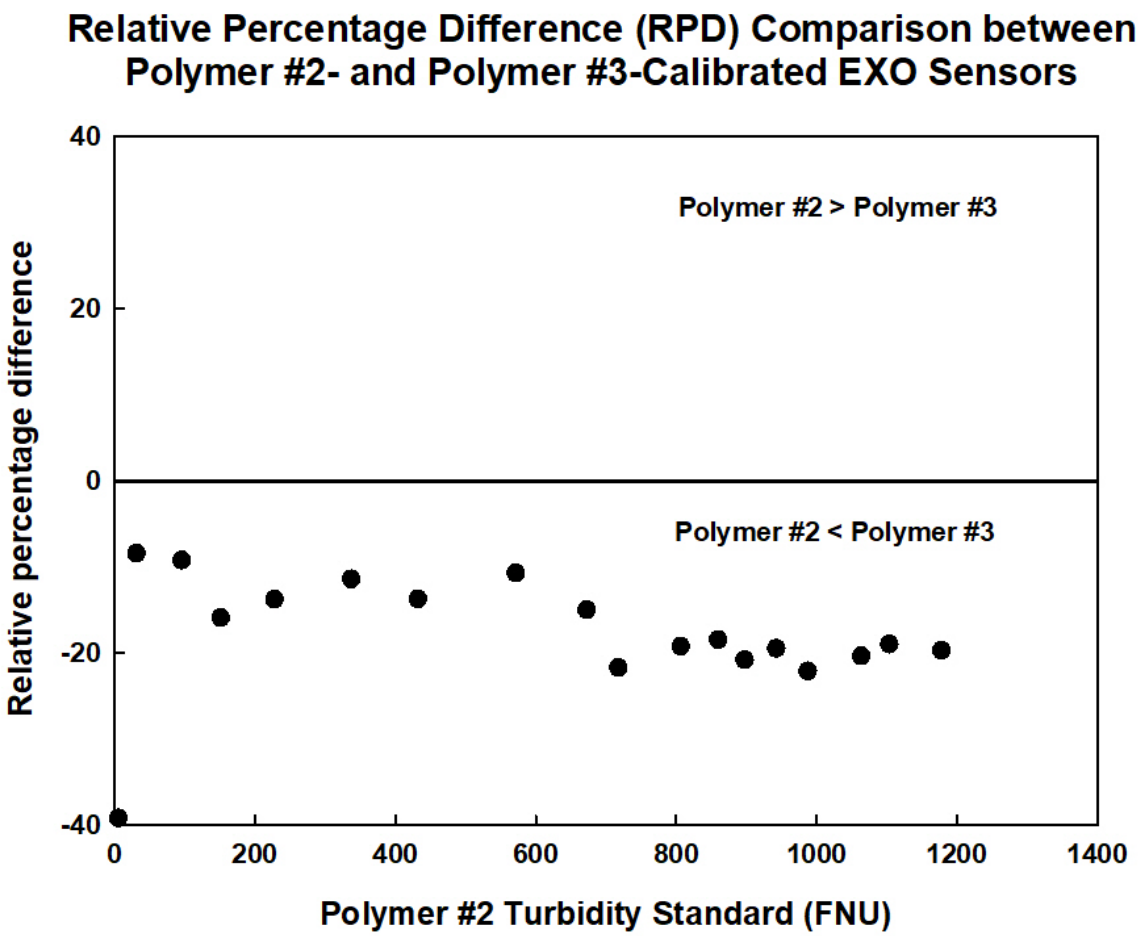
$$y = 1.23x - 18.86$$

where

y = turbidity measured with polymer #3-calibrated EXO sensor (FNU)

x = turbidity measured with polymer #2-calibrated EXO sensor (FNU).


Linear Association of Averaged Polymer #2 and Polymer #3 Turbidity Data
y = 1.23x - 18.86
R = 1.00
R2 = 1.00
1:1 Line
Turbidity using polymer #3-calibrated EXO sensor (FNU)
Turbidity using polymer #2-calibrated EXO sensor (FNU)
0
200
400
600
800
1000
1200
1400
1600



Wilcoxon Signed-Rank Test for Polymer #2 and Polymer #3 Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
Polymer #2	18	0	694.922	208.319	953.792
Polymer #3	18	0	836.913	240.106	1167.834

W= 171.000 T+ = 171.000 T-= -0.000

Z-Statistic (based on positive ranks) = 3.724

P(est.) = <0.001 P(exact)= <0.001

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  Polymer #3 and Polymer #2
V = 171, p-value = 7.629e-06
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
  71.31904 177.17004
sample estimates:
(pseudo)median
      123.9418
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 1.00). Relative percentage difference ranged from 8 to 39 percent (median: 19 percent; mean: 18 percent). The data did not pass the Shapiro-Wilk test for normality (P<0.05); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the polymer #2- and polymer #3-calibrated EXO sensors was statistically significant (P<0.05).

Statistical Analyses - StablCal and Hach 2100AN Data

Slope comparison

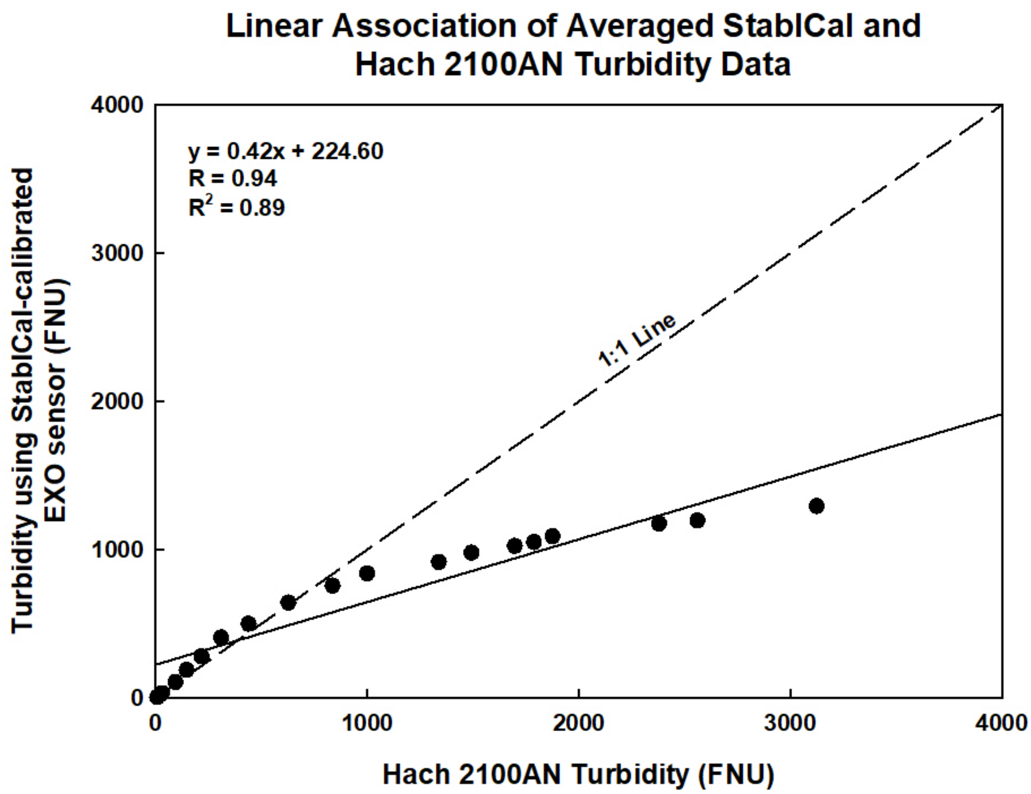
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using StablCal turbidity standard and the Hach 2100AN laboratory turbidimeter at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

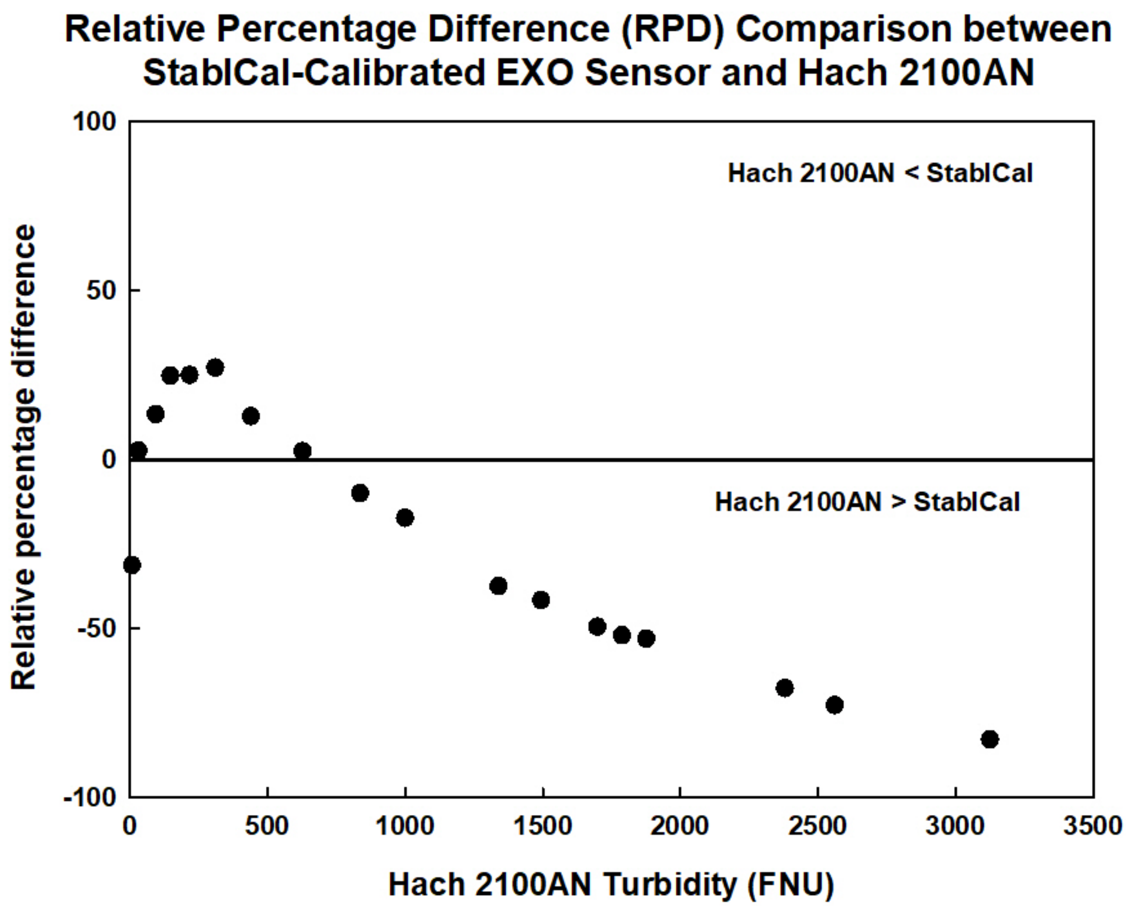
$$y = 0.42x + 224.60$$

where

y = turbidity measured with StablCal-calibrated EXO sensor (FNU)

x = turbidity measured with Hach 2100AN turbidimeter (FNU).


Linear Association of Averaged StablCal and
Hach 2100AN Turbidity Data
y = 0.42x + 224.60
R = 0.94
R2 = 0.89
1:1 Line
Turbidity using StablCal-calibrated
EXO sensor (FNU)
Hach 2100AN Turbidity (FNU)
0
1000
2000
3000
4000



Wilcoxon Signed-Rank Test for StablCal and Hach 2100AN Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
Hach 2100AN	18	0	918.000	199.375	1810.000
StablCal	18	0	798.318	256.133	1059.430

W= -101.000 T+ = 35.000 T-= -136.000

Z-Statistic (based on positive ranks) = -2.199

P(est.) = 0.029 P(exact)= 0.027

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = 0.027).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  Hach 2100AN and StablCal
V = 136, p-value = 0.02685
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
  31.15153 681.77867
sample estimates:
(pseudo)median
       339.324
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 0.94). Relative percentage difference ranged from 2 to 83 percent (median: 29 percent; mean: 35 percent). The data did not pass the Shapiro-Wilk test for normality ($P<0.05$); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the StablCal-calibrated EXO sensor and Hach 2100AN was statistically significant ($P<0.05$).

Statistical Analyses - Polymer #1 and Hach 2100AN Data

Slope comparison

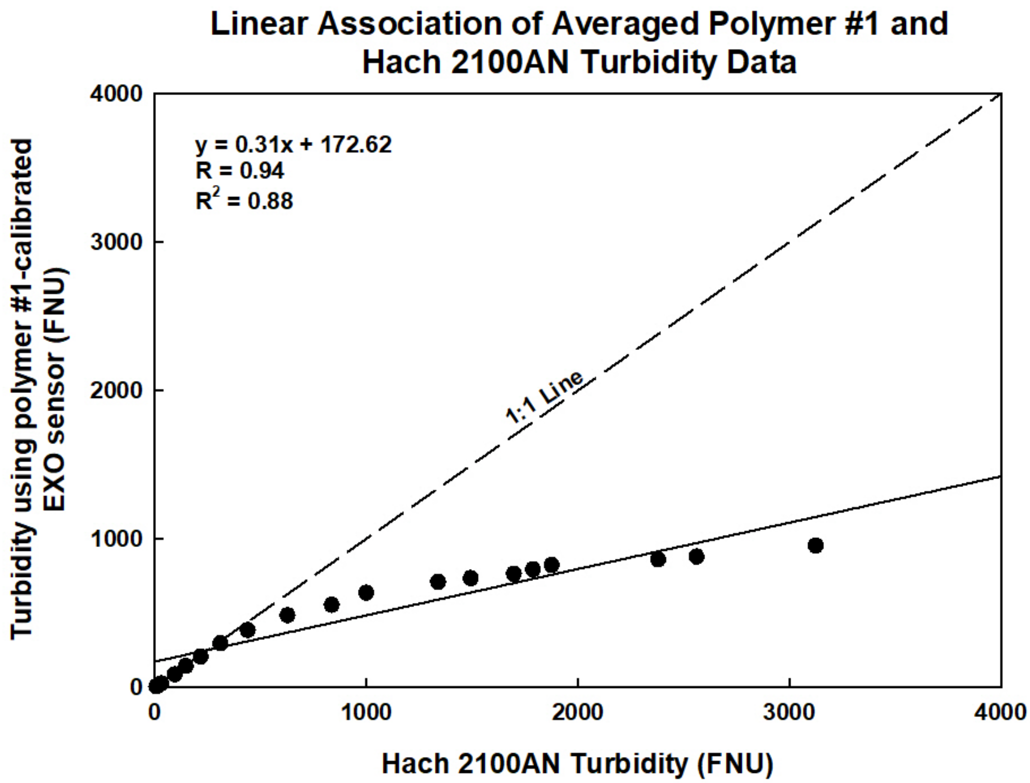
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #1 turbidity standard and the Hach 2100AN laboratory turbidimeter at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

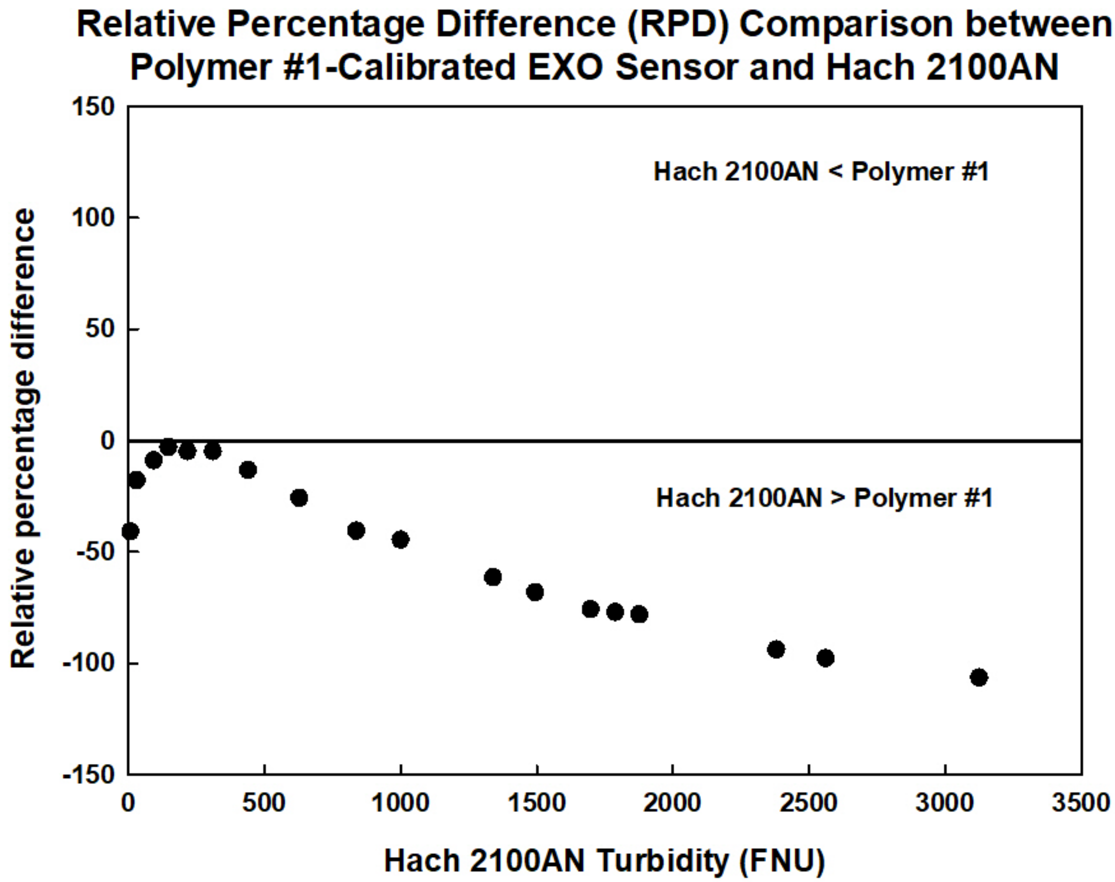
$$y = 0.31x + 172.62$$

where

y = turbidity measured with polymer #1-calibrated EXO sensor (FNU)

x = turbidity measured with Hach 2100AN turbidimeter (FNU).


Linear Association of Averaged Polymer #1 and
Hach 2100AN Turbidity Data
y = 0.31x + 172.62
R = 0.94
R2 = 0.88
1:1 Line
Turbidity using polymer #1-calibrated EXO sensor (FNU)
Hach 2100AN Turbidity (FNU)
0
1000
2000
3000
4000



Wilcoxon Signed-Rank Test for Polymer #1 and Hach 2100AN Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
Hach 2100AN	18	0	918.000	199.375	1810.000
Polymer #1	18	0	594.855	190.654	801.112

W= -171.000 T+ = 0.000 T-= -171.000

Z-Statistic (based on positive ranks) = -3.724

P(est.) = <0.001 P(exact)= <0.001

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  Hach and Polymer #1
V = 171, p-value = 7.629e-06
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
 146.4998 912.8363
sample estimates:
(pseudo)median
      504.3682
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 0.94). Relative percentage difference ranged from 3 to 106 percent (median: 43 percent; mean: 48 percent). The data did not pass the Shapiro-Wilk test for normality ($P<0.05$); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the polymer #1-calibrated EXO sensor and Hach 2100AN was statistically significant ($P<0.05$).

Statistical Analyses - Polymer #2 and Hach 2100AN Data

Slope comparison

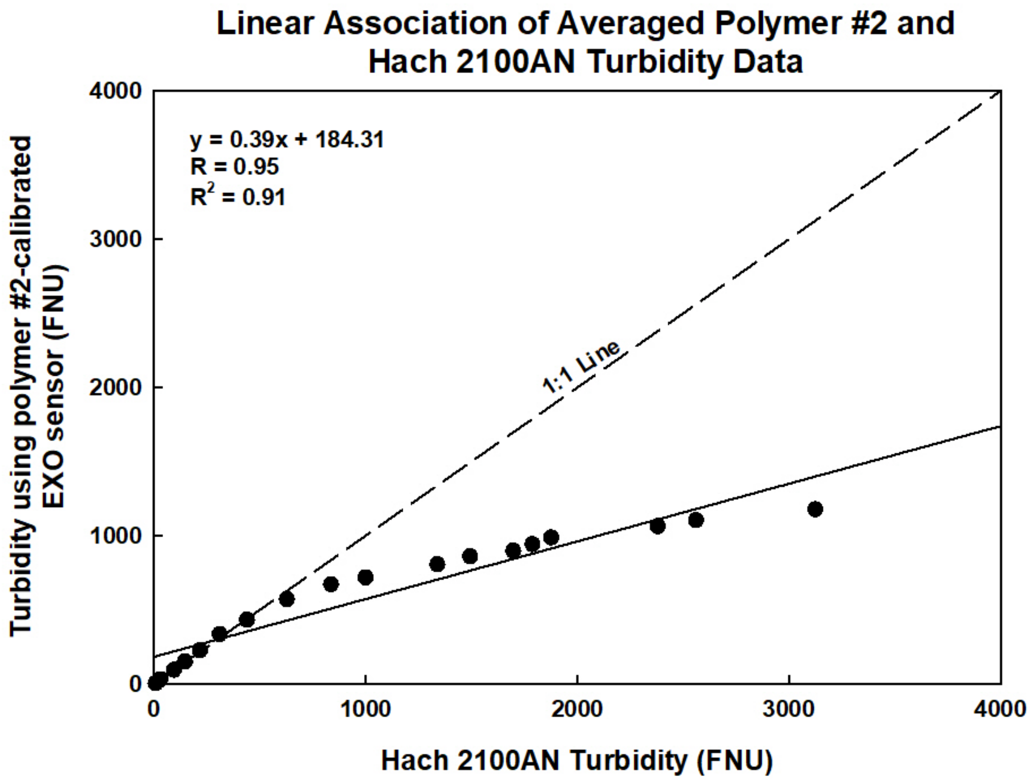
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #2 turbidity standard and the Hach 2100AN laboratory turbidimeter at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 15, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

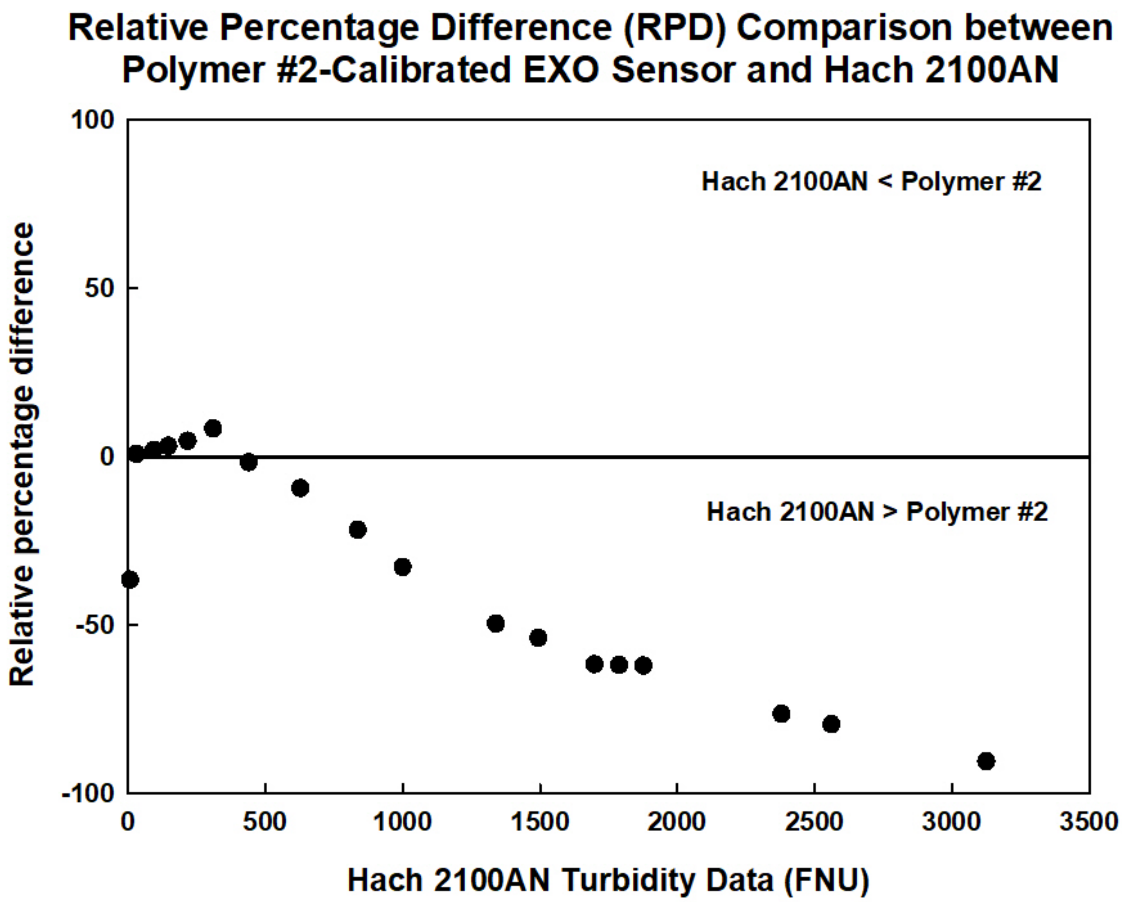
$$y = 0.39x + 184.31$$

where

y = turbidity measured with polymer #2-calibrated EXO sensor (FNU)

x = turbidity measured with Hach 2100AN turbidimeter (FNU).


Linear Association of Averaged Polymer #2 and
Hach 2100AN Turbidity Data
y = 0.39x + 184.31
R = 0.95
R2 = 0.91
1:1 Line
Turbidity using polymer #2-calibrated EXO sensor (FNU)
Hach 2100AN Turbidity (FNU)
0
1000
2000
3000
4000



Wilcoxon Signed-Rank Test for Polymer #2 and Hach 2100AN Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	N	Missing	Median	25%	75%
Hach 2100AN	18	0	918.000	199.375	1810.000
Polymer #2	18	0	694.922	208.319	953.792

W= -131.000 T+ = 20.000 T-= -151.000

Z-Statistic (based on positive ranks) = -2.853

P(est.) = 0.005 P(exact)= 0.003

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = 0.003).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  Hach and Polymer #2
V = 151, p-value = 0.002808
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
  82.41961 761.44871
sample estimates:
(pseudo)median
      422.6851
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 0.95). Relative percentage difference ranged from 1 to 91 percent (median: 35 percent; mean: 36 percent). The data did not pass the Shapiro-Wilk test for normality ($P<0.05$); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the polymer #2-calibrated EXO sensor and Hach 2100AN was statistically significant ($P<0.05$).

Statistical Analyses - Polymer #3 and Hach 2100AN Data

Slope comparison

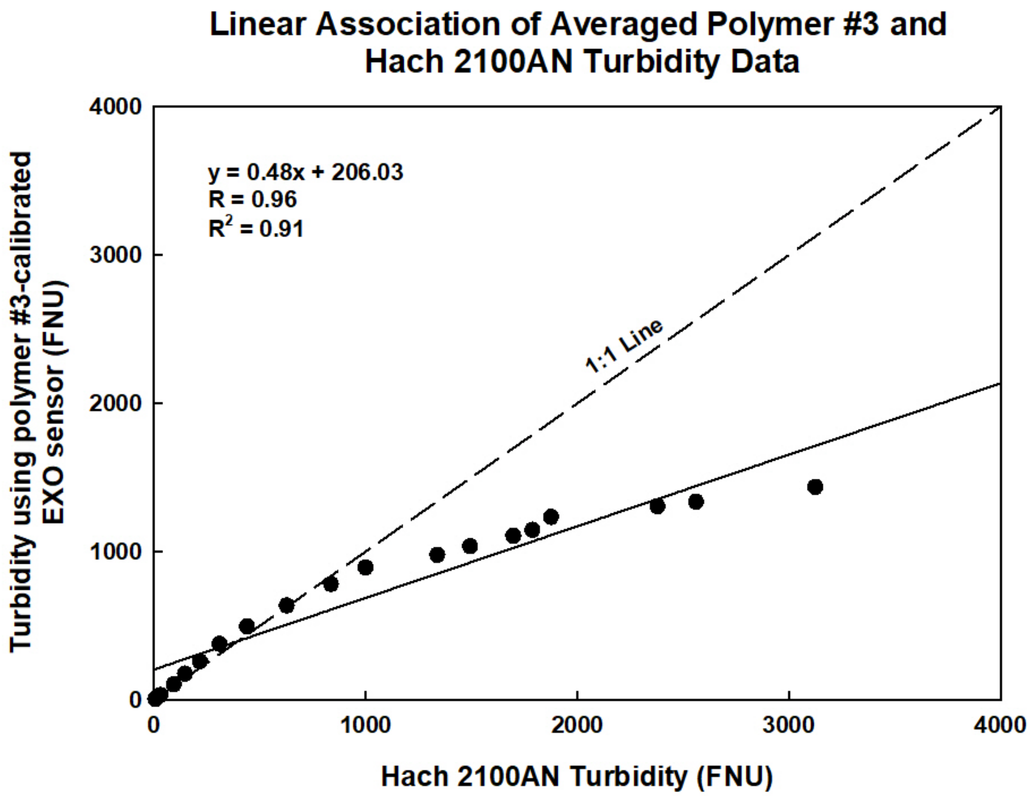
The following is a summary of final regression analysis for sensor-measured turbidity from one YSI EXO turbidity sensor calibrated by using polymer #3 turbidity standard and the Hach 2100AN laboratory turbidimeter at the Kansas Water Science Center laboratory, Lawrence, Kansas, on September 7, 2017; the data used in the final regressions were averages of turbidity for each step, each of which had a duration of approximately 15 minutes once the sensor had stabilized:

$$y = 0.48x + 206.03$$

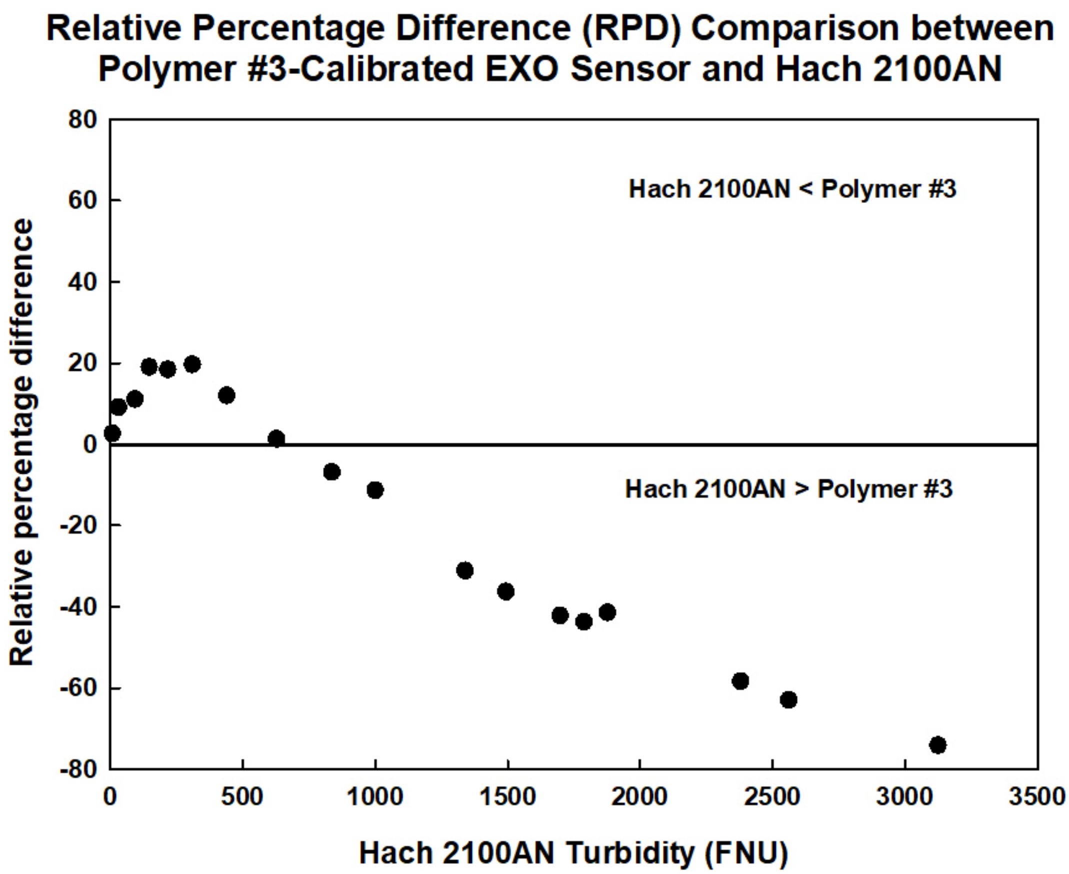
where

y = turbidity measured with polymer #3-calibrated EXO sensor (FNU)

x = turbidity measured with Hach 2100AN turbidimeter (FNU).



Linear Association of Averaged Polymer #3 and
Hach 2100AN Turbidity Data
y = 0.48x + 206.03
R = 0.96
R2 = 0.91
1:1 Line
Turbidity using polymer #3-calibrated
EXO sensor (FNU)
Hach 2100AN Turbidity (FNU)
0
1000
2000
3000
4000



Wilcoxon Signed-Rank Test for Polymer #3 and Hach 2100AN Data

SigmaPlot Statistical Output:

Normality Test (Shapiro-Wilk): Failed (P < 0.050)

Group	**N**	**Missing**	**Median**	**25%**	**75%**
Hach 2100AN	18	0	918.000	199.375	1810.000
Polymer #3	18	0	836.913	240.106	1167.834

W= -95.000 T+ = 38.000 T-= -133.000

Z-Statistic (based on positive ranks) = -2.069

P(est.) = 0.041 P(exact)= 0.038

The change that occurred with the treatment is greater than would be expected by chance; there is a statistically significant difference (P = 0.038).

R Statistical Output:

```
Wilcoxon Signed-Rank test with continuity correction

data:  Hach and Polymer
V = 133, p-value = 0.03849
alternative hypothesis: true location shift is not equal to 0
95 percent confidence interval:
  19.52073 608.48928
sample estimates:
(pseudo)median
      294.1747
```

Summary of Results

There is a strong linear association between measurements made with the two sensors (R = 0.96). Relative percentage difference ranged from 1 to 74 percent (median: 19 percent; mean: 28 percent). The data did not pass the Shapiro-Wilk test for normality (P<0.05); therefore, a Wilcoxon signed-rank test was performed. The difference between median values for the polymer #3-calibrated EXO sensor and Hach 2100AN was statistically significant (P<0.05).

Selected References

Cleveland, W.S., 1979, Robust locally weighted regression and smoothing scatterplots: Journal of the American Statistical Association, v. 74, no. 368, p. 829–836.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources—Hydrologic analysis and interpretation: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A3, 522 p. [Also available at https://doi.org/10.3133/twri04A3.]

King, L.R., 2021, Laboratory and field data for selected turbidity standard and sensor comparisons, October 2014 to September 2017: U.S. Geological Survey Data Release, https://doi.org/10.5066/P9EVSDHH.

U.S. Geological Survey, variously dated, The national field manual for the collection of water-quality data: U.S. Geological Survey Techniques and Methods, book 9, chaps A1–A10. [Also available at https://water.usgs.gov/owq/FieldManual/.]