

Filename: Effects of screens on AD of TP in samplers

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# Screen Effects on TP in AD samplers

## Technical Memo

To  
Wasatch Front Water Quality Council  
Salt Lake City, UT

By  
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### Justification

There is much concern by DWQ Utah Lake Science Panel (ULSP) on the amount of nutrients accumulating on Utah Lake from atmospheric deposition (AD). Presently, the ULSP is considering using only screened sampler data from Barrus et al. (2020) raw data after removal of insect or debris contaminated samples to calculate AD loads. However, Barrus et al. (2021) and Richards (2020) reported that screened samplers significantly reduced TP deposition. Accurate estimates of AD of nutrients will not be possible if the effects of screens on AD are not accounted for. This cursory analysis addresses this concern.

### Methods

Raw data from Seth Barrus Excel file titled, “AD\_Results\_Barrus”, sheet name: “CombinedStats per m2” were analyzed. Table II on that sheet provided 48 sampler data from Central Davis High and Orem paired screened and unscreened (NADP) samplers (Table 1).

*Table 1. II. Comparison between NADP and SDSD Sample Tables (No filter - NADP, Filter - SDSD): Total Phosphorus (mg/m2) from Barrus 2020 Excel spreadsheet.*

Date	Central Davis High	Central Davis NADP	Orem	Orem NADP
6/25/20	1.9736	4.4820	2.0095	22.9642
7/2/20	2.6770	3.0465	2.6660	7.0593

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7/10/20	0.8675	3.3352	0.6988	9.4431
7/17/20	N/A	N/A	2.4678	5.4925
7/23/20	2.7951	N/A	4.9859	4.5119
7/30/20	N/A	N/A	0.9500	23.7307
8/10/20	2.4922	6.2892	1.0434	66.5338
8/21/20	5.0232	7.9270	2.3631	232.5352
8/28/20	42.2723	41.6804	3.5383	49.7937
9/4/20	N/A	N/A	2.4220	5.2501
9/11/20	N/A	5.6627	59.9064	83.9371
9/18/20	19.0458	4.0492	1.2663	4.2267
9/25/20	2.1758	3.3842	2.1909	4.0811
10/2/20	2.9420	4.3022	1.6954	8.2823
10/9/20	1.0739	3.6930	2.1695	3.4091
10/15/20	4.0970	4.0859	2.5183	3.6299
10/23/20	1.7816	11.1853	1.2217	3.7653
10/29/20	1.5314	4.7025	34.4981	1.6064
11/12/20	N/A	N/A	23.8514	42.5714
11/19/20	N/A	N/A	3.1592	5.3603
11/25/20	7.1850	15.9369	1.5063	10.5526
12/3/20	6.9812	1.1643	2.3049	8.6842
12/10/20	0.9690	0.6500	1.5589	2.5119
12/16/20	1.2232	1.8235	1.2048	4.3610

The following table (Table 2) is reordered with Bug/Debris added from Barrus 2020 sheet name: “Overall”.

Table 2. Reordered Table 1 with bug/debris samples added from sheet “Overall” Barrus spreadsheet.

Date	Screened	Unscreened	Location	Bugs/Debris
8/21/20	5.0232	7.9270	Central Davis High	3
10/23/20	1.7816	11.1853	Central Davis High	7
10/23/20	1.2217	3.7653	Orem	13
8/21/20	2.3631	232.5352	Orem	50
11/12/20	23.8514	42.5714	Orem	debris
10/15/20	4.0970	4.0859	Central Davis High	y
10/15/20	2.5183	3.6299	Orem	y
10/29/20	1.5314	4.7025	Central Davis High	y debris
6/25/20	1.9736	4.4820	Central Davis High	
7/2/20	2.6770	3.0465	Central Davis High	
7/10/20	0.8675	3.3352	Central Davis High	

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7/17/20	N/A	N/A	<b>Central Davis High</b>
7/23/20	2.7951	N/A	<b>Central Davis High</b>
7/30/20	N/A	N/A	<b>Central Davis High</b>
8/10/20	2.4922	6.2892	<b>Central Davis High</b>
8/28/20	15.9369	41.6804	<b>Central Davis High</b>
9/4/20	N/A	N/A	<b>Central Davis High</b>
9/11/20	N/A	5.6627	<b>Central Davis High</b>
9/18/20	19.0458	4.0492	<b>Central Davis High</b>
9/25/20	2.1758	3.3842	<b>Central Davis High</b>
10/2/20	2.9420	4.3022	<b>Central Davis High</b>
10/9/20	1.0739	3.6930	<b>Central Davis High</b>
11/12/20	N/A	N/A	<b>Central Davis High</b>
11/19/20	N/A	N/A	<b>Central Davis High</b>
11/25/20	7.1850	15.9369	<b>Central Davis High</b>
12/3/20	6.9812	1.1643	<b>Central Davis High</b>
12/10/20	4.5119	0.6500	<b>Central Davis High</b>
12/16/20	23.7307	1.8235	<b>Central Davis High</b>
6/25/20	2.0095	22.9642	<b>Orem</b>
7/2/20	2.6660	7.0593	<b>Orem</b>
7/10/20	0.6988	9.4431	<b>Orem</b>
7/17/20	2.4678	5.4925	<b>Orem</b>
7/23/20	4.9859	4.5119	<b>Orem</b>
7/30/20	0.9500	23.7307	<b>Orem</b>
8/10/20	1.0434	66.5338	<b>Orem</b>
8/28/20	3.5383	49.7937	<b>Orem</b>
9/4/20	2.4220	5.2501	<b>Orem</b>
9/11/20	59.9064	83.9371	<b>Orem</b>
9/18/20	1.2663	4.2267	<b>Orem</b>
9/25/20	2.1909	4.0811	<b>Orem</b>
10/2/20	1.6954	8.2823	<b>Orem</b>
10/9/20	2.1695	3.4091	<b>Orem</b>
10/29/20	34.4981	1.6064	<b>Orem</b>
11/19/20	3.1592	5.3603	<b>Orem</b>
11/25/20	1.5063	10.5526	<b>Orem</b>
12/3/20	2.3049	8.6842	<b>Orem</b>

<b>12/10/20</b>	1.5589	2.5119	<b>Orem</b>
<b>12/16/20</b>	1.2048	4.3610	<b>Orem</b>

There were eight bug/debris ‘contaminated’ samples that I removed from further analysis. I then calculated Difference = unscreened – screened and descriptive statistics.

## Results

The difference between paired screened and unscreened data was calculated (Table 3).

Table 3. Difference between screened and unscreened TP concentrations mg/m2.

date	screened	unscreened	site	Difference
6/25/20	1.9736	4.482	Central Davis High	2.51
7/2/20	2.677	3.0465	Central Davis High	0.37
7/10/20	0.8675	3.3352	Central Davis High	2.47
7/17/20	0.05	0.05	Central Davis High	0.00
7/23/20	2.7951	0.05	Central Davis High	-2.75
7/30/20	0.05	0.05	Central Davis High	0.00
8/10/20	2.4922	6.2892	Central Davis High	3.80
8/28/20	4.9859	41.6804	Central Davis High	36.69
9/4/20	0.05	0.05	Central Davis High	0.00
9/11/20	0.05	5.6627	Central Davis High	5.61
9/18/20	19.0458	4.0492	Central Davis High	-15.00
9/25/20	2.1758	3.3842	Central Davis High	1.21
10/2/20	2.942	4.3022	Central Davis High	1.36
10/9/20	1.0739	3.693	Central Davis High	2.62
11/12/20	0.05	0.05	Central Davis High	0.00
11/19/20	0.05	0.05	Central Davis High	0.00
11/25/20	7.185	15.9369	Central Davis High	8.75
12/3/20	6.9812	1.1643	Central Davis High	-5.82
12/10/20	3.5383	0.65	Central Davis High	-2.89
12/16/20	0.05	1.8235	Central Davis High	1.77
6/25/20	2.0095	22.9642	Orem	20.95
7/2/20	2.666	7.0593	Orem	4.39
7/10/20	0.6988	9.4431	Orem	8.74
7/17/20	2.4678	5.4925	Orem	3.02
7/23/20	4.9859	4.5119	Orem	-0.47
7/30/20	0.95	23.7307	Orem	22.78

8/10/20	1.0434	66.5338	Orem	65.49
8/28/20	3.5383	49.7937	Orem	46.26
9/4/20	2.422	5.2501	Orem	2.83
9/11/20	59.9064	83.9371	Orem	24.03
9/18/20	1.2663	4.2267	Orem	2.96
9/25/20	2.1909	4.0811	Orem	1.89
10/2/20	1.6954	8.2823	Orem	6.59
10/9/20	2.1695	3.4091	Orem	1.24
10/29/20	34.4981	1.6064	Orem	-32.89
11/19/20	3.1592	5.3603	Orem	2.20
11/25/20	1.5063	10.5526	Orem	9.05
12/3/20	2.3049	8.6842	Orem	6.38
12/10/20	1.5589	2.5119	Orem	0.95
12/16/20	1.2048	4.361	Orem	3.16

The mean difference in TP (mg/m<sup>2</sup>) between screened and unscreened side by side paired samples was 6.02 mg/m<sup>2</sup> and the proportion difference (mean unscreened/mean screened) was 2.26 mg/m<sup>2</sup> from samples with bugs/debris removed (Table 4). This shows that screens had a very large effect on reducing the amount of AD that went into a sampler. Reasons are speculative, for example screens accumulated AD, wind blew AD off screens, etc.

Table 4. Descriptive statistics of screened and unscreened TP mg/m<sup>2</sup>/week.

stats	screened	unscreened
mean	<b>4.78</b>	<b>10.8</b>
sd	<b>10.7</b>	<b>18.3</b>
p50	<b>2.17</b>	<b>4.33</b>
p25	<b>.997</b>	<b>2.17</b>
p75	<b>3.05</b>	<b>8.48</b>
max	<b>59.9</b>	<b>83.9</b>
min	<b>.05</b>	<b>.05</b>
range	<b>59.9</b>	<b>83.9</b>

stats	Difference
mean	6.01
sd	15.8
p50	2.49
p25	0
p75	6.48

max	65.5
min	-32.9
range	98.4

## Conclusion

AD samplers with screens had a very significant negative effect on TP deposition measurements and can significantly bias AD nutrient load estimation on Utah Lake.

## Recommendation

Do not use screened data only, because screens reduced TP by about 56%, which is consistent with Barrus et al. 2021 publication and my initial analyses, Richards 2020. I recommend using both screened and unscreened data after adjusting screened data to account for screen effect and after removing contaminated samples to estimate nutrient loads more accurately to Utah Lake from AD.

## Literature Cited

Barrus, S. M. et al. 2021. Nutrient Atmospheric Deposition Sampling and Analysis Improvements: Utah Lake Impacts. Hydrology.

Richards, D.C. 2020. Nutrient Atmospheric Deposition on Utah Lake and Great Salt Lake Locations 2020, including Effects of Sampler Type: Statistical Analyses and Results. Report to Wasatch Front Water Quality Council, Salt Lake City. OreoHelix Ecological, Vineyard, UT.