The Sediment
of Bridges
Pond:
an analysis

Rob Seidenwurm
Environmental Science 102
Professors Dethier, Kegley, Art
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I. Acknowledgements:

I would like to thank Professor Dethier for his constant help in trying to understand whatever it was I was doing at the time. He also helped with some of the lab work and provided useful handouts and suggestions to which I could compare my data. Thank you, in addition, for your constant support and for blowing up the raft.

I would like to thank Sandy in the lab for helping with chemical procedure and for her help with the IC and the monster graphite furnace.

I would like to thank Tim Sullivan for doing his best on no sleep and giving his precious thesis time to help a couple of lost ES-102 students. He went beyond the call of duty as a TA.

Finally, I'd like to thank Kevin Weng, because of his help (be it symbiotic help) throughout. It was also very comforting to have him around to see that there was someone as lost and frustrated as I was at any given time.

hmm

II. Introduction:

The purpose of this project is to provide a thorough examination of the sediment in Bridges Pond. No tests had previously been performed on this sediment on record. The lab will give data representing 8 different samples and tested for percent water, percent loss on ignition, concentration of anions, and concentration of chromium.

The data for water samples in Bridges Pond done in an earlier lab this year show rather high concentrations of anions, possibly indicating a reason for the degradation of the pond. This lab will relate the pond water anion concentrations to the sediment anion concentrations. The lab will also examine the chromium concentrations in the sediment. Chromium, a trace metal, is often toxic unless kept to small quantities. An examination of the chromium levels will provide excellent insight for the health of the pond.

no need to say "will" – you've done it!

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III. Retrieving the samples

Materials: 1) inflatable raft complete with two paddles (provided by Professor Dethier)

   2) map of the pond (see map at the end of the paper)

   3) sediment scooper

   4) plastic bags

The samples were recovered on April 19th, 1990; Temperature was in the mid 60s and it was sunny. The process of collecting the samples was rather arduous. With the assistance of Kevin Weng, we embarked on the pond and recovered the samples through a process of first finding our spot on the map to take a sample from. The scooper was then readied and lowered into the water with the rope tied to it. When the scooper would hit the ground, it would clamp shut and the sediment would be trapped inside. The scooper was then hauled back up to the raft and dumped into a labeled plastic bag.   This process was then repeated for each of the eight selected sites.   The samples were then placed in the "cold room" in Bronfman until further lab tests would be performed.

There was active vegetation floating on the surface of some parts of the pond.   There was also some brown, dirt-like substance that floated in clumps and crumbled when touched. The pond did also have a rather foul odor. The sediment was vile. It was dark black and very fine and liquid. I would hypothesize that the grains were .063 mm or less. The sediment looked very much like oil. It

too, had a foul odor.   The sediments were fairly uniform when extracted except for the differences in vegetation.   Sediment samples 1 and 8 (see map) did not include vegetation while the other scoops came to the surface bearing alga-like plants.   Sediment samples 5 and 6 had especially large amounts of vegetation.

where?

(why all the blank space?)

IV. Percent Water

Materials: 1) 8 weighed /out/ watch glasses

                     2) Plastic Gloves

                     3) 2mm filtering device with catch basin

                     4) 1 smaller watch glass

                     5) DDW

                     6) A hood

                     7) An oven

                     8) a scale

The samples were taken to the lab and the following process was repeated for all 8 of them. The sample was dumped from the plastic bag into the top portion of the 2mm ~~filter~~ screen. While wearing plastic gloves, I pushed the sample repeatedly so as to push most of it through the filter. The vegetation found in many of the samples was removed and given to Kevin Weng for his project. Most of the sediment did in fact go through the filter, though not without repeated spatterings of the "muck" within the lab. Once a sufficient sample was through the filter, the top portion was removed and the sample left in the catch basin was placed onto a labeled, large watch glass. This was done by a process of scooping the sediment up with a smaller watch glass and letting it pour onto the larger glass. All the equipment was then thoroughly washed with DDW and the process repeated for the other samples. The plastic bags were, incidentally washed out so as to be reused (Largely by Professor Dethier).

The samples were then placed into the hood to be air dried for 24 hours. After 24 hours, the samples were weighed to determine wet weight. These samples were then observed. There was a great deal of variance in the sediments. There were generally three different descriptions. Sediments 1, 4, and 8 all consisted of a few large, dense looking clumps with a light gray color on the outside progressing to a darker gray in the middle. Sediments 2, 6 and 7 all consisted of granular, smaller clumps that were less dense looking than the aforementioned samples. These samples had a much more uniform color of medium gray. Sediments 3 and 5 were noticeable in that there was a lack of these two samples. This is in part due to not enough sample taken from the pond and in part due to not pushing the enough sediment through the filter. What there was of these two samples was very light gray and extremely cracked throughout. The samples were then placed into the oven at approximately 110 degrees Celsius for 24 hours.

Rob —
a table of these data would have been compact

Upon removing the samples from the oven, they were once again placed in the hood in order to cool down. They samples were much more uniform in color now, but their respective density appearances and clumping patterns had remained constant. The samples were then weighed to determine dry weight. The equation to determine percent water loss is as follows:

$$[(\text{Wet Weight} - \text{Dry Weight})/ (\text{Wet Weight})] \times 100.$$

This calculation was performed on each part of the data to produce the data in table 1 on the following page. The pattern that is evident within this data lies in the relationship between the observations made on the samples and water loss. Samples 1, 4 and

8 had the three highest percent water losses, samples 2, 6 and 7 the next three, and 3 and 5 had the lowest. It seems as if the clumpier and more dense the sediment sample is, the more water it contained.
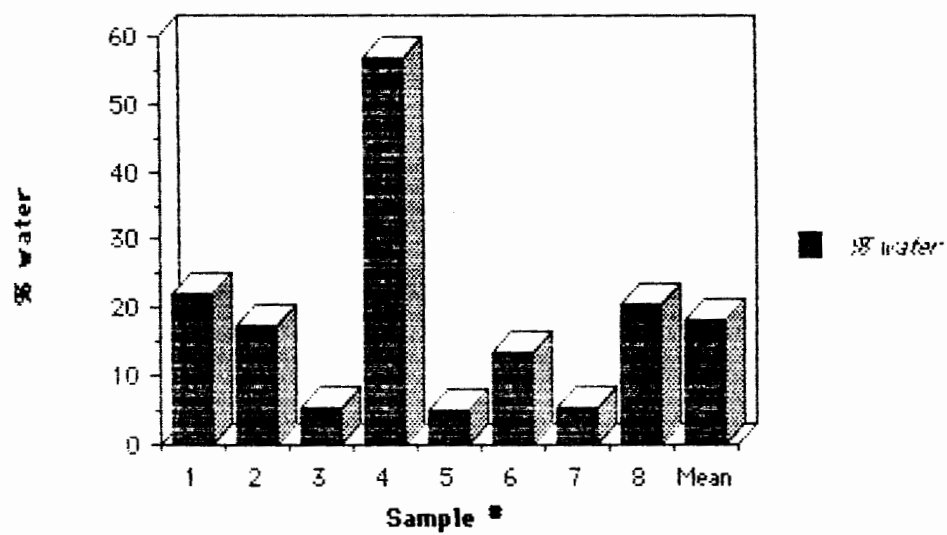
In addition, there is a relationship between the data and the area of the pond. The sediment with the greater water loss came from the northwest part of the pond, near the pipe inflow, while the middle of the pond tended to have the lowest measurements. (see map) It is inconclusive as to why this is so. Further studies would need to be done regarding the retention of water by sediments to gain further knowledge on this issue.

What should determine water loss?? Sediment texture, right? And what else?

Space?

	Sample #	Percent Water loss
1	1	21.9
2		
3	2	17.6
4		
5	3	5.4
6		
7	4	56.9
8		
9	5	5.0
10		
11	6	13.5
12		
13	7	5.5
14		
15	8	20.7
16		
17	Mean	18.3

Percentage of water loss

% water (y-axis)

60
50
40
30
20
10
0

Sample # (x-axis): 1 2 3 4 5 6 7 8 Mean

Legend: ■ % water

V. Loss on Ignition.

Materials: 1) 8 labeled and weighed crucibles

                  2) scale

                  3) metal scooper

                  4) ceramic lined ~~oven~~ furnace

                  5) Asbestos Gloves

                  6) Forceps

The samples were chopped up into smaller pieces with the scooper and a specified amount was weighed out in crucibles. In general, the amount was 5 g except in the cases of samples 3 and 5 in which the entire sample was placed into the crucible and still measured just over 1 g. These 8 crucibles were then placed into the oven using forceps to place them toward the back of the oven. The oven was heated to a temperature that ranged from 550 degrees to 1100 degrees F. This process ashed the sample and, in effect, burned off both the Carbon and Nitrogen. The samples were removed after 24 hours by using forceps and wearing asbestos gloves for protection from the extreme heat.

The samples one again showed differences in color. The samples that were previously mentioned as being clumped and light gray progressing to dark gray (samples 1, 4, and 8) had an orange tint to them. The remaining samples maintained a beige tint. All the samples were no very brittle upon touch with the scooper.

After 20 minutes or so of cooling, the samples were again weighed to determine percent loss on ignition. The calculation was performed using the following formula:

$$[(\text{weight before ashing} - \text{weight after ashing})/(\text{weight before ashing})] \times 100$$

The data can be found on Table 2 on the next page. There were also relationships in this data. There was an almost perfect inverse relationship between the water loss and the loss on ignition. For each sample, if the water loss was below the mean, the loss on ignition was above the mean and vice-versa. Hence, the same pattern in terms of pond location was discovered, with the lower loss of ignition data coming from the northwest area of the pond.

The question is then raised: Why should different areas have more Carbon and Nitrogen? In analyzing the data, the sum of water loss and loss on ignition is fairly constant. What must be noted is that the loss on ignition is based on what is left after the water is gone. For example, for sample 1, the loss of ignition is 23.6 % of the 78.9% of the sediment left after the water is removed. In essence the percent carbon in the original sample is not 23.6%, but 18.6%. Although there is some variance in the data, there does not appear to be great differences in this area. It should be noted, in addition, that areas 1 and 8 were the only samples in which vegetation was not found. This corresponded to a lower loss on ignition.
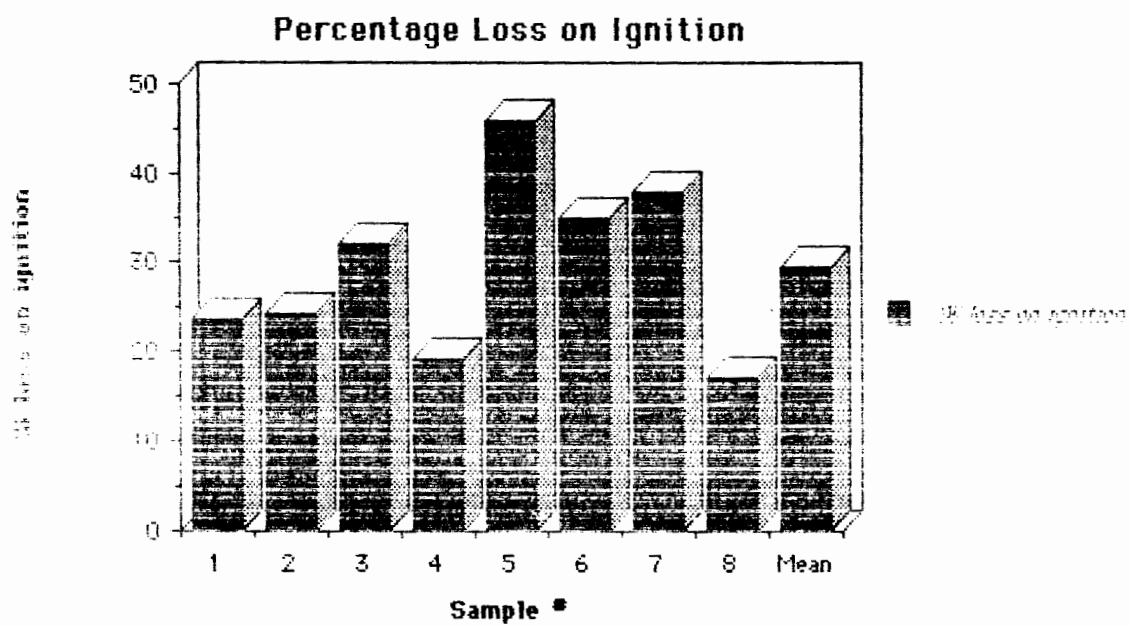
Other reasons that might account for less organics might include pond depth and exposure to sunlight. The deeper the pond at each specific point, the less chance is that there will be thriving vegetation. This might, in turn, correspond to a smaller O horizon.

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Less exposure to sunlight falls under this same category. If a specific area does not receive enough sunlight, less plantlife will exist. This again might correspond to the less rich O layer.

Sample #	Percent Loss on ignition
1	21.9
2	17.6
3	5.4
4	56.9
5	5.0
6	13.5
7	5.5
8	20.7
Mean	18.3

is
No -- this is the same
as your previous table --
what happened??

Percentage Loss on Ignition

where are OM—
rich seds!

VI. Determining anion concentrations

Materials: 1) A 400 ml beaker

2) A scale

3) 6 labeled watch glasses

4) metal scooper

5) DDW

6) 6 labeled 100 ml Volumetric Flasks

7) filtration device μm ?

8) .45 microgram filter paper

9) Flasks with nozzle for air hose

10) Compressor Engine ɯɳɕɬɘɳ

11) 6 labeled plastic bottles

12) Ion Chromatograph

13) Plastic Gloves

14) vials for autosampler

15) 5 ml pipette

The six remaining samples that still had sediment were taken and 5.00 grams of each were carefully weighed out (except for sample #2, in which only 2.50 g were available. This idea will hold true for later steps in this procedure). Each sample was then placed in a 400 ml beaker with added DDW just under the 100 ml level, thus producing a 20:1 ratio (note: with sample 2, DDW was added to just under the 50 ml level). The sample was then chopped up to promote suspension of the sediment. When the sample was nearly completely suspended, it was transferred to a 100 ml volumetric

flask and filled to the line with DDW to obtain an exact ratio. This solution was then transferred into a prepared filtration device consisting of a container with filter paper at the base which then funnels to a flask with a nozzle for an air hose. The flask was then connected to an air hose which, in turn, was connected to an air compressor. When the compressor was turned on, the solution flowed through the device and into the flask. The filter paper did catch some of the solution as evidence by the paper's change in color.

The solution in the flask was then poured into plastic bottles and brought to the cold room in Bronfman for storage. It was then discovered, that the solutions were to be diluted further. Thus, 5 ml of each solution was pipetted into a 50 ml volumetric and then filled with DDW, thus producing another 10:1 dilution. The solutions were then brought to the ion chromatograph for analysis of the anions fluoride, chloride and sulfate. To load the samples into the IC, they were placed in individual plastic vials, capped, and placed into the autosampler. A data readout was then available. After dilution calculations, the data on Table 3 on the following page was produced. This data was put along side the data from the chemistry lab done on Bridges pond by ES 102 this year. Data from this lab is, however from the pond water and not available for fluoride.

Information as to where these ions is not exactly easy to trace. Fluorides are generally not very abundant. There was no real pattern across the pond for the fluoride levels. Data for fluoride comparison was not available, however, a relatively polluted portion of the Mississippi River was tested for anion levels in 1964-5 and

can't be true

found to have a concentration of fluoride of .3 micrograms per liter[1]. These were, it should be noted, water samples and thus it is difficult to compare to sediment samples.

Chlorides and sulfates are generally more abundant. The same data from the Mississippi showed a chloride level of 24 micrograms _wrong units_ per liter and a sulfate level of 51 micrograms per liter.[2] The chloride levels are more often effected by "human activities."[3] Road salts or salt factories would certainly be a cause of higher chloride levels. In general, the more human intervention, the higher these levels are. Sulfates are common in pyrite ores, which are often given off with the burning of coal and the burning of fuels.[4] It is not surprising, then, that both chlorides and sulfates are present in significant quantities in this sediment. After all, there is road salt being piped into the pond and there is certainly a great deal of human activity around the pond. Both of <u>these ideas</u> would elevate the chloride, _ideas can't elevate_ while the sulfate levels, which exist in even more frequent _why_ quantities, seem to have come from the railroad. The railroad would seem to produce large quantities of pyrite ash that could very easily settle on the base of the pond. Sulfates also come from the presence of organics.— _more likely_

The chloride and sulfate levels also have comparison data from the previous Bridges Pond lab. The problem with this data is that all the measurements were taken from the water. The measurements of

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[1] Hem, John D. <u>Study and Interpretation of the Chemical Characteristics of Natural Water.</u>-Third Edition., p.9
[2] Ibid
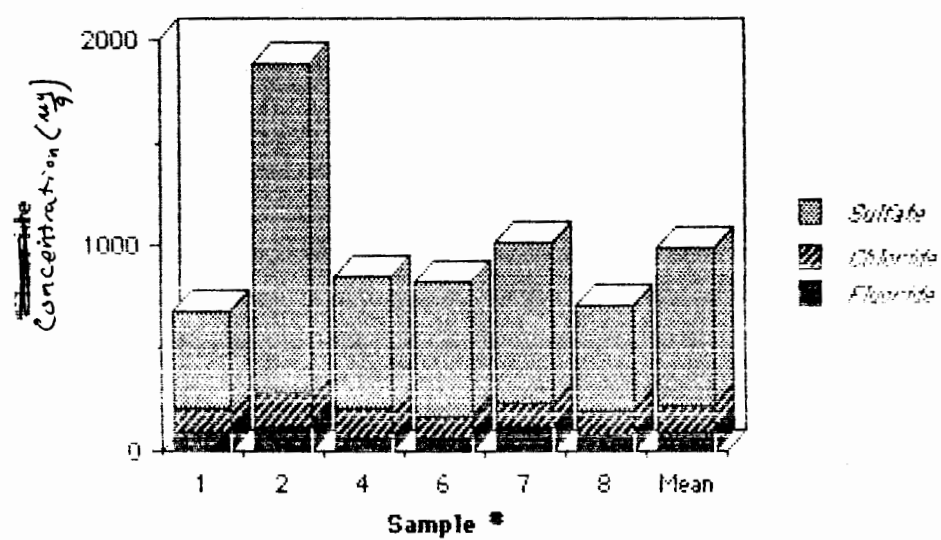[3] Ibid, p.119
[4] Ibid, p.112

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sediments are generally much larger because these sediments, especially in low-energy ponds, tend to hold ions to a greater degree. Once again, it is surprising to see the tremendous lack of correlation between the two sets of data. It seems as if the sulfate concentrations for the water samples are lower at the higher sediment points. There is really no correlation between the chloride levels either. Thus it is difficult to try to produce any relationship between concentrations in water and in sediment.

Concentration of anions in mior

	Sample #	measured in $\frac{mg}{g}$ (ppm)			measured in $\frac{mg}{L}$ (ppm)	
		Fluoride	Chloride	Sulfate	Cl for water	Sulf for water
1						
2	1	90.0	110.0	490.0	42.6	7.1
3						
4	2	120.0	170.0	1600.0	42.2	0.4
5						
6	3				30.0	0.4
7						
8	4	70.0	130.0	650.0	41.9	10.4
9						
10	5				27.0	11.7
11						
12	6	60.0	110.0	650.0	22.7	12.4
13						
14	7	110.0	120.0	790.0	20.8	10.6
15						
16	8	80.0	110.0	520.0	40.0	9.7
17						
18	Mean	88.3	125.0	783.0	33.4	7.8

what about NO_3 ??

I can't read the
units and, therefore
the table — does this
table include a calculation?
What sort?

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Comparison of anion concentration

Figure: Bar chart titled "Comparison of anion concentration" with y-axis "concentration (µg/g)" ranging 0 to 2000, and x-axis "Sample #" with categories 1, 2, 4, 6, 7, 8, Mean. Legend: Sulfate, Chloride, Fluoride.

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VII. Determining Chromium Concentrations

Materials: 1) safety goggles

2) plastic gloves

3) scale

4) 100 ml volumetric flasks

5) Concentrated Hydrochloric Acid

6) Heating plate

7) DDW

8) Plastic Bottles

9) Atomic Spectroscope with graphite furnace

10) small plastic vials

11) standards of Potassium dichromate

12) matrix modifier

[handwritten: this should be in a appendix since it takes up so much space.]

[handwritten: ? next to item 8]

Note: The dissolution of ash process was performed by Kevin Weng, however I observed some of this process. *[handwritten: does this mean 0.35g ?]*

The ash samples were taken and ..35 g of 3 samples were weighed out and placed into a 100 ml volumetric flask. Only 3 samples (#s 3, 4 and 5) were done because of lack of time. The dissolution process was quite lengthy. While wearing goggles and plastic gloves, 5 ml of concentrated hydrochloric acid was added. *[handwritten: samples were wetted with DDW first]* This solution was swirled and heated for approximately 30 minutes to stimulate dissolution of the ash. The flask was then diluted with DDW to 100 ml. 30 ml of this solution was then transferred into another 100 ml volumetric and then diluted to 100 ml with more

DDW. This solution was then transferred into a plastic bottle and stored in the cold room until run on the AA.

The sample was to be run on the graphite furnace part of the AA. The sample was placed into small (approximately 1 ml) plastic vials along separate vials of the matrix modifier and DDW and then placed into the sample "wheel" which could hold up to 36 different vials. The graphite furnace worked with a robotic arm sucking up 5 microliters of the sample along with the matrix modifier and DDW and placing them in the graphite chamber. The sample was then heated through 7 different steps, through use of a chromium lamp in the AA. These temperatures were, respectively: 110 C; 240 C; 1650 C; 20 C; 2500 C; 2650 C; 20 C. At 2500 C the computer analyzed the absorbance of light coming through the furnace and then translated this number into a concentration in micrograms per Liter based on a standard determined earlier.

Once this number was obtained, it had to be translated into micrograms per gram in the sediment. To do this, the dilutions and other aspects had to be taken into account. The number was determined by first dividing by 10 because we had but 100 ml, not 1L. Then the number was multiplied by 100 ml/ 30 ml because only 30 ml of the 100 ml dilution was taken. The units were now in micrograms. To obtain micrograms/ gram, one needs to divide by the weight of the ash in the sample, or .35 g. Finally this number was multiplied by (1- percent loss on ignition) to take into account the part of the sediment that was ashed off and thus not included in the sample. The data, which follows on the next page on table 4, is in micrograms of chromium per gram of sample.

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Getting this data was an accomplishment in itself. The average of 15 micrograms per gram (parts per million) is, I believe, fairly firm data. Since only three samples were tested, it seems needless to try to look for patterns across the pond. Instead, it would be beneficial to look at the comparison data. The abundance of chromium in the earth's upper crust is approximately .14 micrograms per gram.[1] This is truly relevant data, and it is also relevant that the sample from Bridges Pond is approximately 100 times the abundance in the upper crust. Thus it seems that there is an overabundance of chromium in the pond that could be aiding the degradation of the pond and its fish. This chromium in this concentration would no doubt be extremely harmful to fish as well as to humans in the form of potential drinking water. The question of where the chromium is coming from is also a good one. I would hypothesize some accumulation due to the many years of the railroad going by and pumping pollutants into the air. In addition, the tremendous amount of litter surrounding the pond might have leached some trace metals such as chromium into the sediment of the pond.

What is not evident, however, is whether or not some there is additional leaching of this chromium into the water of the pond. United States Environmental Protection Agency's 1976 report stated that the "Maximum permissible concentration of 50 micrograms per liter [parts per billion] total chromium has been included in United

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[1] Elder, John F. Metal Biogeochemistry in Surface-Water Systems- A Review of Principles and Concepts, 1988, p.2

States' mandatory drinking water standards."[1]   Thus if the chromium content in Bridges Pond water is anywhere near the concentration in the sediment, it is a violation of the EPA law and is potentially dangerous for drinking.   The water in the pond should be tested using the aforementioned procedure to determine if actual damage does exist.

how could you tell – do you mean high concentrations ?

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[1] Hem, p.138

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	Sample #	Chromium Conc. in $\mu g/g$
1		
2	1	
3		
4	2	
5		
6	3	16.3
7		
8	4	16.7
9		
10	5	11.7
11		
12	6	
13		
14	7	
15		
16	8	
17		
18	Mean	14.9

Chromium Concentrations

Y-axis: Concentration ($\frac{\mu g}{g}$)

Legend: Chromium

X-axis labels: 3, 4, 5, Mean

X-axis title: Sample #

Y-axis scale: 0, 5, 10, 15, 20

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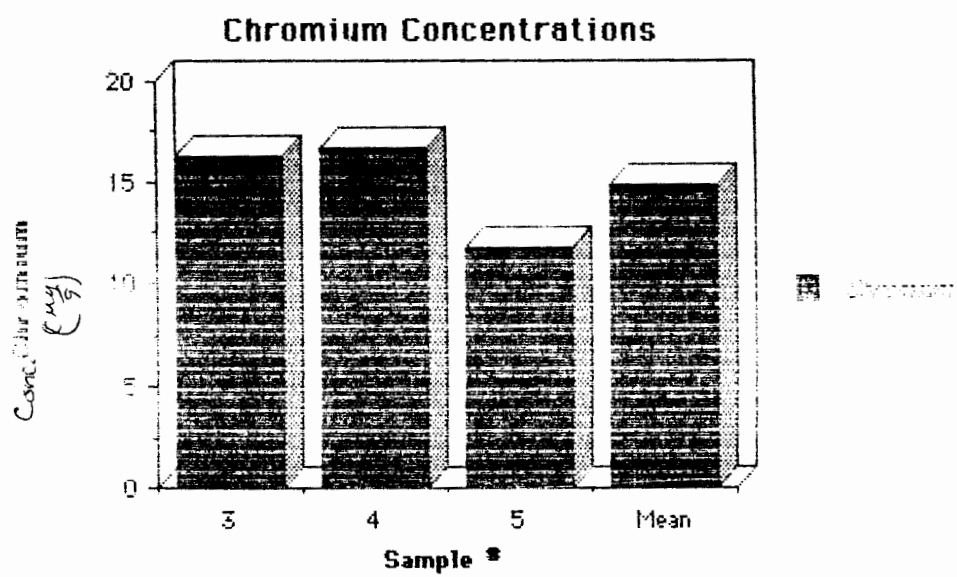
VIII. Conclusion

In conclusion, it seems as if Bridges Pond has an overabundance of chromium in its sediment based on the direct comparison to the relative abundance in the earth's outer crust. What can be done about this, as well as the direct problems associated with it, is unknown. If we can assume that the chromium levels are high in the water as well, then it is evident that chromium has led to the delineation of Bridges Pond. However, the relationship between sediment concentrations and water concentrations is not known, as is evident by the anion data. It would seem that the anion data is high is well, but with no direct comparison available, this cannot be assumed. Thus, if the actual source of pollution of Bridges Pond really does come from trace metals such as chromium, a complete analysis of the water must be taken and related to water quality standards. Then, and only then, once we have found the problems of the pond, we can work toward fixing them.

what?

didn't I give you comparison data for this very purpose

Rob — There's some good information here, but you took 29 pages to say what you could have in 15. Why all the blank space? I am confused by your data and unplied calculations, all the more so because these are new data and I want to understand what they mean. Look at this again and see if you can follow your logic. Your bar graphs are fine ... but why not look for obvious correlations using all your data. Maybe LOI is a good predictor for SO_4? So I'm disappointed by this writeup, but not by the data...... 29

IX. Bibliography

Elder, John F. <u>Metal Biogeochemistry in Surface-Water Systems- A Review of Principles and Concepts.</u> United States Government Printing Office, 1988.

Hem, John D. <u>Study and Interpretation of the Chemical Characteristics of   Natural Water- Third Edition.</u>

X. Appendix

Sample #	% water	% loss on ig.	Fluoride $\left(\frac{\mu g}{g}\right)$	Chloride $\left(\frac{\mu g}{g}\right)$	Sulfate $\left(\frac{\mu g}{g}\right)$	Chromium $\left(\frac{\mu g}{g}\right)$
1	21.9	23.6	90	110	490	
2	17.6	24.0	120	170	1600	
3	5.4	32.1				16.3
4	56.9	19.1	70	130	650	16.7
5	5.0	45.9				11.7
6	13.5	35.0	60	110	650	
7	5.5	37.8	110	120	790	
8	20.7	17.0	80	110	520	
Mean	18.3	29.3	88	125	783	14.9

Samples taken from P-1 through P-8

Scale, in Feet
0   50   100

E

S

W

IN-1
IN-2
IN-3
IN-5
IN-7

P-1 / I-1
I-2 / P-2
P-3 / I-3
P-4 / I-4
P-5 / I-5
P-6 / I-6
P-7 / I-7
I-8 / P-8

100 ft
100 ft
150 ft
150 ft
200 ft
200 ft
200 ft
100 ft

32