

Office of

**AUBURN WATER DISTRICT**

**Office Telephone # 784-6469**

The regular monthly meeting of the Trustees of the Auburn Water District will be held at the office of the Auburn Water District, 268 Court Street, on **Wednesday, September 16, 2015 at 4:00 P.M.**

**AGENDA**

1. Approve Minutes of Regular Meeting of August 19, 2015.
2. Financial Report Update - *Greg Leighton*.
3. Ratify Payment of Bills
4. Open session
5. Activity Report - Mike Broadbent
6. New Business
  - Water Main Break on Pine/Goff/School St.
  - Tentative 2016 Projects
  - Lake Auburn Water Quality
  - University of Maine Research
7. Old Business
  - North Auburn Dam Emergency Spillway Project
  - Sixth Street Water Main Replacement
  - Update on efforts to collect past-due bills
  - Quickbooks Update
  - Auburn City Council Water Trustee Appointment
  - Policy Workgroups
8. Executive Session per 1 M.R.S.A. § 405 (6) (E) to discuss
  - Update on water drainage issue
9. Executive Session per 1 M.R.S.A. § 405 (6) (D) to discuss
  - Updates on personnel Issues
10. Adjourn Regular Meeting.

Upcoming: - Trustee Meeting, October 21

# Memo

**To:** Water & Sewerage District Trustees  
**From:** Sid Hazelton, P.E., Acting Superintendent  
**CC:** Files  
**Date:** 9/10/2015  
**Re:** Accounts Payable Check Register



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The Accounts Payable Check Register is not included in the trustee packets due to an issue with the NDS server.

If the issue is resolved in time, the check register will be e-mailed separately prior to the Trustee meetings. If not, we hope to have a paper copy available at the meetings.

I apologize for the inconvenience.

August 19, 2015

The regular monthly meeting of the Trustees of the Auburn Water District was held at the office of the Auburn Water District on Wednesday, August 19, 2015 at 4:00pm.

Members present: Robert Cavanagh, Preston Chapman, Tizz Crowley (Mayor's Representative/Treasurer), K. C. Geiger (President), Lee Upton and Rick Whiting. Also present: Sid Hazelton, Acting Superintendent and Michael Broadbent, Assistant Water Superintendent.

On motion of Preston Chapman, seconded by Tizz Crowley, it was unanimously voted: **To approve the minutes of the Regular Meeting of July 22, 2015.**

**FINANCIAL REPORT UPDATE** – The financial report was presented by Sid Hazelton.

#### **RATIFY PAYMENT OF BILLS**

On motion of Preston Chapman, seconded by Lee Upton, it was unanimously voted: **To ratify the payment of bills in the amount of \$231,455.38 as shown on the printout dated July 11, 2015-August 14, 2015.**

**OPEN SESSION** - Raymond Fortier, Sewer District Trustee was in attendance.

#### **GROUNDWATER EXPLORATION PRESENTATION BY WESTON SAMPSON ENGINEERS Jeff McClure & Kevin McKinnon**

The ideal source would have to provide 2.5-3 MGD. The task was to look for significant sand and gravel deposits. There are three options : vertical well, angled well or radial collector well. The radial collector well would provide the most yield from a particular sight and would require less costly maintenance. Different factors and variables must be considered when making a decision on how to proceed. Sid Hazelton told the Trustees that the report was available if any of them would like to read it.

**ACTIVITY REPORT** : The July Activity Report was presented by Michael Broadbent.

The District has performed some new water service taps and an extension for Hammond Tractor on Minot Ave. The District is making preparations for the work to be done at the North Auburn Dam and Sixth Street.

#### **NEW BUSINESS**

**COLLECTION OF PAST DUE BILLS** - The District is stepping up its efforts to collect delinquent accounts. The District's current practice is more lenient than the Public Utilities Commission's guidelines. The District will be changing the process and procedures which will become part of the District's modified Terms and Conditions. It was thought that the restoration of service fee may be too low. The District will now require payment of the restoration fee at the time of the service and no longer add the fee to the customer's bill. A note will be added on the customers' bill to let them know about the District's collection process.

**MEMO FROM CITY OF AUBURN – EXPECTATIONS OF BOARDS** – Sid Hazelton responded explaining that the Districts and LAWPC do not receive funding from the City and should not have been included on the list. Sid Hazelton will send a formal letter.

**LAKE AUBURN UPDATE** - The Lake water quality remains high, turbidity numbers remain low and algae is under control.

**BIO MEDICAL TOURISM FACILITY** - This will be a "5 Star" facility which will provide housing for

the people from China who will be seeking medical treatment in our local hospitals.

**FLUORIDE TANKS** –The tanks were guaranteed not to change color. Mike Broadbent will follow up with the manufacturer to see what they will do about this issue.

### **OLD BUSINESS**

**PROJECTS** – The Poland Spring Booster Station is near completion. The District will be installing a spillway for the overflow. The extension for Hammond Tractor on Minot Ave. and the Transportation Center project are works in progress.

**POLICY WORKGROUPS** - The workgroup has recommended some changes in the compensation sections of the Personnel Policy Handbook. The changes will be hi-lighted in the policy for review by Sid Hazelton and will then be brought to the Board for final approval.

**MAINE POWER OPTIONS/NEW CONTRACT** - The District has signed a three –year contract for a little over \$.06/kwh.

**MEASURING OF THE LAKE** - The event is scheduled for Wednesday, August 26<sup>th</sup> with tours starting at 3:00pm.

**TRAINING – THE ART OF HUMAN RELATIONS** - The 6-week session has been completed. The training was very well presented.

**LEAD AND COPPER TESTING** – Mary Jane Dillingham was able to get permission to take a larger number of comprehensive samples in the hopes of avoiding the more stringent testing.

### **EXECUTIVE SESSION PER 1 M.R.S.A. § 405 (6) (E) TO DISCUSS UPDATE ON A WATER DRAINAGE ISSUE -**

On motion of Tizz Crowley, seconded by Rick Whiting, it was unanimously voted: **To move into Executive Session per 1 M.R.S.A. § 405 (6) (E) to discuss a water drainage issue.**

The meeting came out of Executive Session.

### **EXECUTIVE SESSION PER 1 M.R.S.A § 405 (6) (D) TO DISCUSS OPTIONS FOR HEALTH OTIONS FOR HEALTH INSURANCE 2016 AND UPDATE ON PERSONNEL ISSUES.**

The meeting came out of Executive Session.

The meeting was adjourned.

# Memo

**To:** Water & Sewerage District Trustees  
**From:** Sid Hazelton, P.E., Acting Superintendent  
**CC:** Files  
**Date:** 9/9/2015  
**Re:** Discussion of September Agenda Items

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## Water Main Break on Pine/Goff/School St Update

The Auburn Police Department and AWD staff looked at local surveillance video, and contacted local trucking companies in an attempt to identify the truck that caused the hydrant damage and subsequent water main breaks on August 25. Unfortunately, these attempts were unsuccessful. Although they will continue their investigation, at this time it is unlikely that we will be able to recoup our losses.

## North Auburn Dam Emergency Spillway Project

Water District Personnel recently completed the construction of an emergency spillway at the North Auburn Dam. This spillway will protect the dam from overflowing and causing downstream erosion up to a 100 year storm. The project was paid for through LAWPC funds.

## Fluoride Tanks Update

A letter has been sent to Snyder tanks requesting their attention to the discoloring of the newly installed Fluoride tanks. We need their assurance that the tanks will perform as specified.

## Update on efforts to collect past-due bills

We have revised our Terms and Conditions, and they were approved by the Public Utilities Commission effective 9/7/2015.

With this step behind us, we will move forward with our plan to step up efforts to collect past-due bills.

Starting our next billing cycle, disconnection notices will be sent for accounts that are 30 days past due. This change will be highlighted in bold red print on the bill. The actual disconnection date will be 14 days from mailing the notice. A one-time courtesy reminder door hanger will be placed one week after the disconnection notice is mailed, along with a label that indicates that this is the last time a door hanger will be used.

### Quickbooks Update

We have purchased the Quickbooks software billing module, and we hope to have it installed on all billing computers this week. This will enable us to bill all non-metered customers. We will start with service bills, and then add accounts payable. This software will allow us to streamline our accounting by tracking all accounts electronically, and improve our query capability. We anticipate doing all Quickbook training in-house.

### Cascades Odor Issue Update

Our experiment of metering nitrogen rich leachate from the LAWPCA Compost Facility into the effluent at the Lewiston Junction Pump Station has proven to be effective at reducing odors from the Cascades Mill. We have shared our findings with the Mill, and will work with them over the next few months to come up with a program that will work for the long-term.

### Lake Auburn Water Quality

Turbidity at the Lake is still at historical low levels; averaging below 0.5 for the year. Secci disk readings at the deep hole average around 8 meters, which is very good. Algae counts are low and water clarity is high. Phosphorus levels are back to normal (<10ppb). Dissolved oxygen levels at the lake are good as well.

### University of Maine Research

Heather Doolittle, Civil Engineering Student at the University of Maine, spent the summer retrieving and analyzing Lake Auburn sediments and studied the relationship between iron, aluminum, and phosphorus, and the Lakes' vulnerability to internal phosphorus loading under anoxic conditions.

She is presenting her findings at the University on September 10<sup>th</sup>. If a video of the presentation is made, it may be available to show at the meeting. Depending upon level of interest, Heather may be available to present at a future Trustee meeting.

### Executive Session

There will be an executive session for both boards of trustees to discuss personnel issues.

**AUBURN WATER DISTRICT  
OPERATING STATEMENT -TRUSTEES' REPORT  
EIGHT MONTHS ENDED AUGUST 31, 2015**

	August	2015	Y-T-D AUGUST 2015		
	YTD - 2014	BUDGET	ACTUAL	BUDGET	VARIANCE
<b><u>REVENUES:</u></b>					
Water Sales	\$1,514,911	\$2,347,431	\$1,560,903	\$1,564,954	(\$4,051)
Rent income	37,520	61,018	36,572	40,679	(4,106)
Interest Income	8,360	14,593	22,283	9,729	12,555
Mdse. & Jobbing	26,691	35,347	59,753	23,565	36,189
Hydrant Rental	409,744	611,494	407,663	407,663	0
Private Fire Prot.	200,142	300,089	201,673	200,059	1,614
Misc. Op. Revenue	50,423	73,179	60,230	48,786	11,444
<b>TOTAL REVENUES</b>	<b>2,247,791</b>	<b>3,443,151</b>	<b>2,349,078</b>	<b>2,295,434</b>	<b>53,644</b>
			<b>68.22%</b>	<b>66.67%</b>	< Standard
<b><u>EXPENSES:</u></b>					
Payroll	461,413	715,184	468,766	476,789	(8,024)
Treatment:					
UV Treatment Plant	175,575	283,505	163,269	189,003	(25,734)
Chloramine Facility	3,169	5,590	3,648	3,727	(79)
Laboratory	35,966	55,890	26,441	37,260	(10,819)
Trans & Dist Maint:					
Maint of Mains	31,529	66,582	47,079	44,388	2,691
Dist System	65,735	89,069	58,882	59,379	(498)
Other	12,895	22,111	16,624	14,741	1,884
Administration	336,081	547,610	392,985	365,073	27,912
Vehicles	42,135	69,977	50,355	46,651	3,704
Gull Management	55,434	86,727	51,713	57,818	(6,105)
Lake Auburn Watershed	149,589	157,385	111,154	104,923	6,231
<b>SUB-TOTAL</b>	<b>1,369,521</b>	<b>2,099,630</b>	<b>1,390,916</b>	<b>1,399,753</b>	<b>(8,837)</b>
			<b>66.25%</b>	<b>66.67%</b>	< Standard
Interest	127,182	188,851	127,409	125,901	1,508
<b>TOTAL EXPENSES</b>	<b>1,496,703</b>	<b>2,288,481</b>	<b>1,518,325</b>	<b>1,525,654</b>	<b>(7,329)</b>
Bonds - Principal Payments	111,487	773,402	152,683	515,601	(362,918)
<b>SURPLUS FROM OPERATIONS</b>	<b>639,601</b>	<b>381,268</b>	<b>678,070</b>	<b>254,179</b>	<b>423,891</b>

**AUBURN WATER DISTRICT  
BALANCE SHEET  
PERIOD ENDING - AUGUST 31, 2015**

	<u>8/31/2015</u>	<u>12/31/2014</u>	<u>8/31/2015</u>	<u>12/31/2014</u>
<b>Property, Plant and Equipment:</b>				
Plant in Service	34,941,162.93	34,810,951.32		
Less: Accumulated Depreciation	(9,637,779.61)	(9,260,121.61)	10,653,024.71	10,037,167.16
	<u>25,303,383.32</u>	<u>25,550,829.71</u>	<u>446,686.65</u>	<u>615,690.58</u>
Construction Work in Progress	512,737.75	57,871.76	11,099,711.36	10,652,857.74
<b>Net Utility Plant</b>	<u>25,816,121.07</u>	<u>25,608,701.47</u>	9,513,385.58	9,666,067.61
<b>Current Assets:</b>				
Cash & Working Funds	1,219,067.05	964,920.22		
Temporary Cash Investments	113,242.52	113,117.33		
Accounts Receivable - Net	374,877.72	538,055.03	172,412.53	282,987.09
Prepayments	29,786.06	9,395.58	10,401.39	11,085.00
Other Current Assets	0.00	0.00	56,168.50	35,402.52
<b>Total Current Assets</b>	<u>1,736,973.35</u>	<u>1,625,488.16</u>	<u>316,810.46</u>	<u>404,754.34</u>
<b>Deferred Debits:</b>				
Unamortized Debt Issuance	78,631.62	84,155.70	0.00	0.00
Other Deferred Debits	110,693.08	136,041.55	70,147.00	70,147.00
<b>Total Deferred Debits</b>	<u>189,324.70</u>	<u>220,197.25</u>	6,742,364.72	6,660,560.19
<b>Total Assets</b>	<u>27,742,419.12</u>	<u>27,454,386.88</u>	<u>27,742,419.12</u>	<u>27,454,386.88</u>
<b>Capitalization:</b>				
Retained Earnings				
Current Year Earnings				
<b>Bonds</b>				
<b>Total Capitalization</b>				
<b>Current Liabilities:</b>				
Accounts Payable				
Customer Deposits				
Accrued Interest				
Miscellaneous Liabilities				
<b>Total Current Liabilities</b>				
<b>Other Deferred Credits</b>				
<b>Operating Reserves</b>				
<b>Contributions in Aid</b>				
<b>Total Equity Capital and Liabilities</b>				

# AUBURN WATER DISTRICT

## MONTHLY ACTIVITY REPORT

### August 2015

### MAINS

Location	Ck'd	Comments	Leak Check					Misc.	New
			PT/Cl <sub>2</sub>	Leak	On Owner	OK			
356 Park Av	1	Cut out 6" main - not cement lined						1	
Minot Av - Hammond Tractor	1	New private main							1
356 Park Av	1	Repair trench - wash out						1	
Pine St, School St, Grant St	1	3 Leaks caused by hit hydrant		1					
Washington St	1	Water main break		1					
<b>Monthly Totals</b>	5		0	2	0	0		2	1
<b>2014 Monthly Totals</b>	4		0	1	0	0		1	2
<b>YTD Totals</b>	33		1	15	0	1		11	5
<b>2014 YTD Totals</b>	12		1	9	0	4		3	4

### GATES

Location	Ck'd	Comments	Adjust	Leak	New	Misc.
Broad St	1	Work on gates	1			
Broad St	1	Raise gate boxes	1			
Seventh St & Loring Av	1	Work on gates	1			
Riverside Dr & S Main St	1	Work on gates	1			
Park Av	1	Work on gates	1			
<b>Monthly Totals</b>	5		5	0	0	0
<b>2014 Monthly Totals</b>	4		4	0	0	0
<b>YTD Totals</b>	15		9	2	1	3
<b>2014 YTD Totals</b>	15		13	0	0	2

## HYDRANTS

Location	Ck'd	Comments	Broken	Cap	Misc.	New	Frozen
Industrial Park, Hotel Rd	1	Flush hydrants			1		
<b>Monthly Totals</b>	1		0	0	1	0	0
<b>2014 Monthly Totals</b>	0		0	0	0	0	0
<b>YTD Totals</b>	27		16	1	4	0	6
<b>2014 YTD Totals</b>	11		6	0	3	1	1

## NEW SERVICES

Location	No.	Comments	No Meter	Meter	Meter Size
192 Center St - AutoZone	1	New		1	1"
100 Minot Av - Mechanics Bank	1	New		1	1"
Valview Dr - vacant lots 1 & 2	1	2 new service taps	1		
<b>Monthly Totals</b>	3		1	2	
<b>2014 Monthly Totals</b>	0		0	0	
<b>YTD Totals</b>	10		4	6	
<b>2014 YTD Totals</b>	6		2	4	





## LABORATORY

Month	Dist. Sys. Tests	Temp (°C)		Avg. NaOH gal/MG	Avg. Cl mg/l	Avg. FI mg/l	Avg. Turb. (ntu)	SWTR Tests
		Air	Water					
January	51	NA	2.8	15.20	2.68	0.57	0.53	31
February	47	NA	2.7	16.60	2.62	0.65	0.31	28
March	51	NA	3.1	16.80	2.54	0.52	0.24	31
April	55	NA	4.9	16.02	2.51	O/L	0.53	30
May	47	NA	12.9	15.50	2.56	0.66	0.66	31
June	50	NA	19.2	15.00	2.60	0.69	0.51	30
July	50	NA	23.2	16.00	2.74	0.70	0.31	31
August	47	NA	24.8	16.00	2.87	0.64	0.41	31
September								
October								
November								
December								
YTD Avg				15.89	2.64	0.63	0.44	
2014 Avg				19.20	2.43	0.73	0.79	
YTD Totals	398							243
2014 YTD	367							242

## LAKE AUBURN

Month	No. Patrols	Withdrawals *			Elevations **					
		AWD	LWD	Total	1st	High	Yr.	Low	Yr.	2014
January	Daily	2.43	3.87	6.30	260.51	261.40	1974	257.20	2002	260.52
February	Daily	2.63	3.59	6.22	260.81	261.70	1996	257.10	2002	260.81
March	Daily	2.73	3.71	6.44	260.60	261.41	2010	257.40	2002	260.65
April	Daily	2.77	3.38	6.15	260.39	262.40	1953	258.20	2002	260.83
May	Daily	3.02	3.68	6.70	260.82	261.51	2012	258.78	2007	261.12
June	Daily	2.97	3.76	6.73	260.29	260.61	1984	259.49	2007	261.42
July	Daily	3.15	4.85	8.00	260.30	261.70	2013	260.34	2010	260.78
August	Daily	2.96	3.93	6.89	260.00	261.10	1981	258.00	1999	260.85
September										
October										
November										
December										
Avg. Daily	Daily	2.83	3.85	6.68						
YTD Totals	0	22.66	30.77	53.43						
2014 YTD Totals		21.52	33.66	55.18						

\* Average Daily Withdrawals MGD \*\* Elevation Above Sea Level

## WEATHER\*

Month	Precipitation					Temperature			
	Snowfall (in.)	Total (in)	Heating Degree Days	Normal Precip	Days of Precip.	Max. (°F)	Min. (°F)	Avg. (°F)	Dep. from Norm
January	47.6	3.62	1504	3.26	11	46	-13	17	-2.5
February	28.6	1.65	1550	2.55	9	33	-18	10	-12.9
March	8.6	1.43	1191	3.64	10	51	-7	26	-6.5
April	4.3	2.83	708	3.78	10	69	17	41	-2.7
May	0.0	0.72	120	3.9	6	87	32	60	4.6
June	0.0	5.59	177	3.96	11	84	37	60	-4.4
July	0.0	2.12	35	3.43	9	89	46	67	-3.1
August	0.0	3.83	12	3.25	10	91	48	69	0.3
September									
October									
November									
December									
<b>YTD Totals</b>	<b>89.10</b>	<b>21.79</b>							
<b>2014 YTD Totals</b>	<b>55.20</b>	<b>37.24</b>							

\* From www.wunderground.com

## DIG SAFE

Month	Total	Contractors	MDOT	AHD	School Dept.	Lewiston Water	Fairpoint	AWD	CMP	ASD	GAS	MTA
January	36	20	0	0	0	0	0	4	12	0	0	0
February	32	5	0	0	0	1	1	16	7	0	2	0
March	58	29	0	1	0	0	0	16	10	0	2	0
April	103	54	3	13	0	0	2	3	13	6	8	1
May	154	82	19	30	1	0	1	2	5	0	14	0
June	148	80	0	15	0	0	0	4	36	6	6	1
July	140	77	2	41	0	0	0	6	4	0	9	1
August	134	74	0	21	0	0	1	18	10	4	6	0
September												
October												
November												
December												
<b>YTD Totals</b>	<b>805</b>	<b>421</b>	<b>24</b>	<b>121</b>	<b>1</b>	<b>1</b>	<b>5</b>	<b>69</b>	<b>97</b>	<b>16</b>	<b>47</b>	<b>3</b>
<b>2014 Totals</b>	<b>934</b>	<b>463</b>	<b>10</b>	<b>200</b>	<b>10</b>	<b>4</b>	<b>16</b>	<b>43</b>	<b>65</b>	<b>6</b>	<b>111</b>	<b>6</b>

## DUTY FOREMAN CALLS

(Overtime)

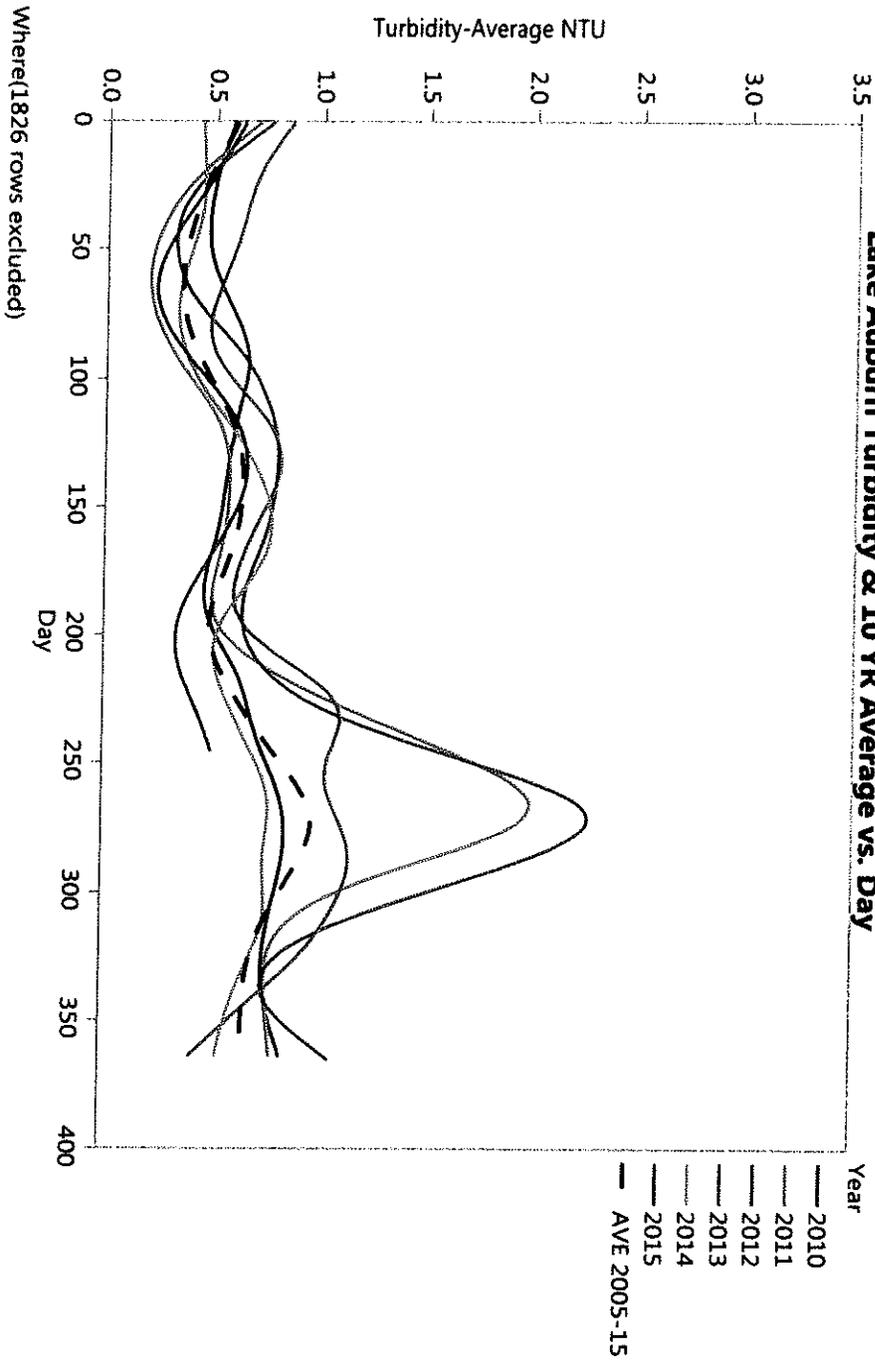
Districts	Total	High/Low Pressure	Water Quality	Alarms	Sewer Service	Leak	Misc.	Locates	Hydrants	Meter	Fire Calls
Sewerage District	2			0	1	0	1	0	0	0	0
Water District	7	0	0	0		0	7	0	0	0	0
<b>Monthly Totals</b>	9	0	0	0	1	0	8	0	0	0	0
<b>2014 Monthly Totals</b>	16	0	0	5	2	1	7	1	0	0	0
<b>YTD Totals</b>	77	1	3	14	5	11	38	3	0	0	2
<b>2014 YTD Totals</b>	112	1	17	25	12	9	33	10	1	0	4

## OTHER ACTIVITIES

1. Cut trees at North Auburn Dam
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

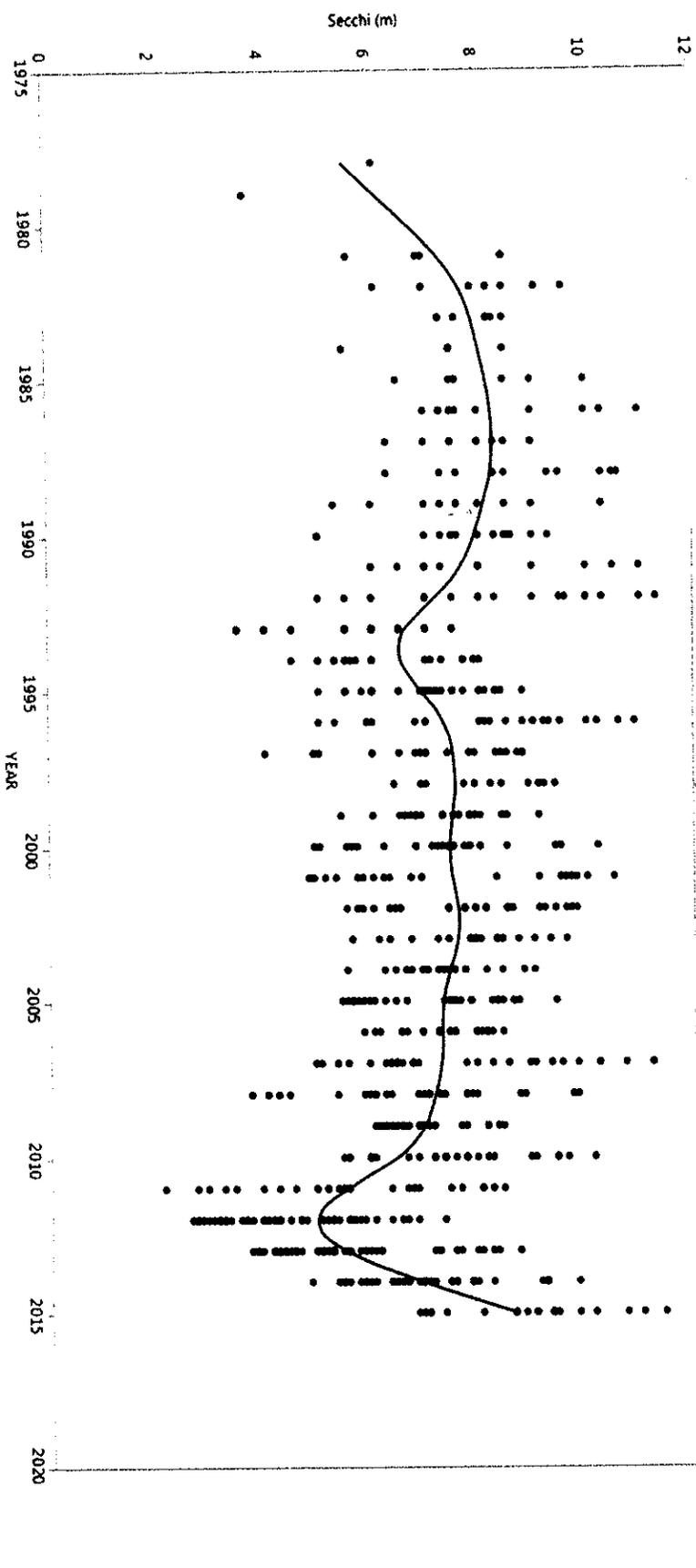
# Graph Builder

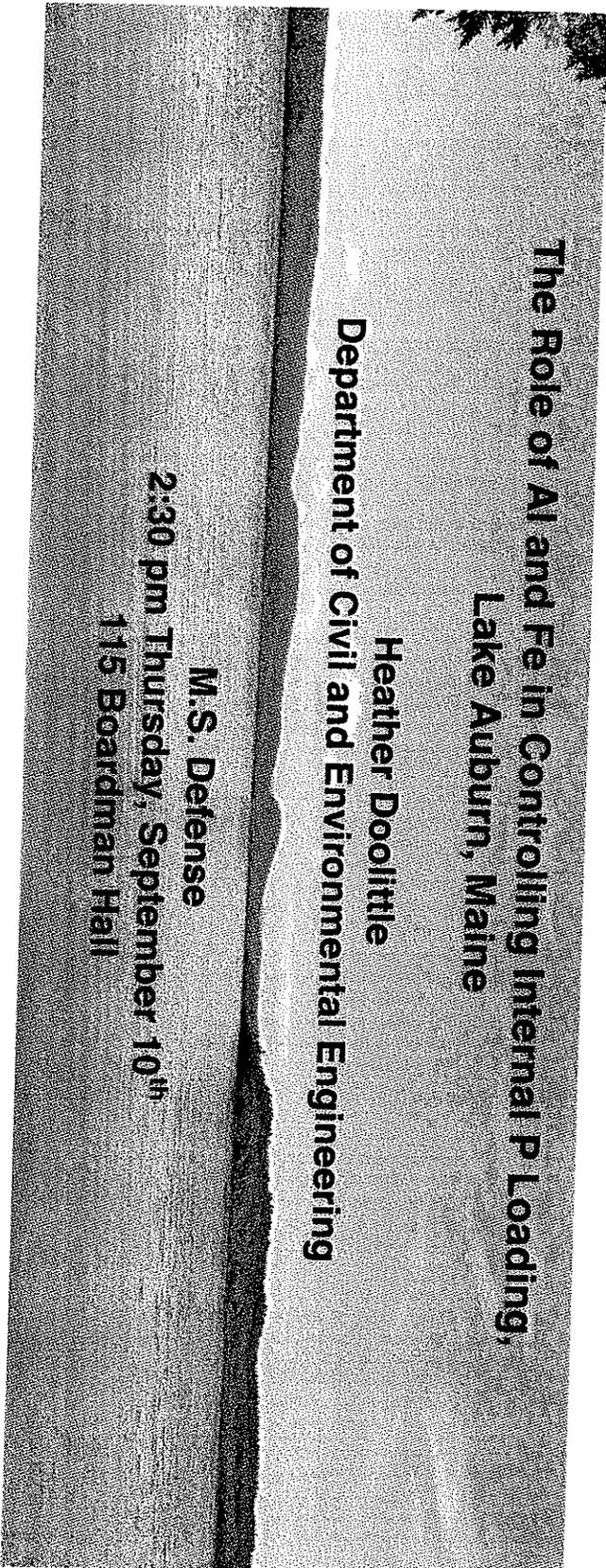
## Lake Auburn Turbidity & 10 YR Average vs. Day



Where(1826 rows excluded)

Lake Auburn Secchi at Deep Hole Station 8





**The Role of Al and Fe in Controlling Internal P Loading,  
Lake Auburn, Maine**

**Heather Doolittle  
Department of Civil and Environmental Engineering**

**M.S. Defense  
2:30 pm Thursday, September 10<sup>th</sup>  
115 Boardman Hall**

Lake Auburn, Maine is a historically oligotrophic lake serving as the primary drinking water source to a population of 40,000. While the local water district is currently exempt from filtration by the EPA, a recent decline in water quality has caused concern. The decline in water quality was linked to internal phosphorus loading from the sediment. Results show that Lake Auburn sediments are high in reducible Fe hydroxide and relatively low in Al hydroxide. Analyses of longer sediment cores (~60 cm) identified concentrated Fe and P in the surficial sediment (0-2 cm). Previous research has shown sediments with molar Al: reducible Fe ratios < 3 and Al: reducible Fe-bound P < 25 to act as a source of P under anoxic conditions. Lake Auburn sediment exhibits molar Al: reducible-Fe ratios between 0.2 and 1.7 and molar Al: reducible Fe-bound P ratios between 2.0 and 14.5, indicating a risk for internal P loading in years with widespread hypolimnetic anoxia. An investigation of water chemistry sampled in transect along Lake Auburn tributaries showed that Al removal in upstream lakes and wetlands paired with seasonal Fe export from upstream wetlands is likely impacting sediment chemistry, resulting in the lakes vulnerability to internal P loading and eutrophication.

# The Controls on Hypolimnetic Sediment Phosphorus Release in a New England Lake: Climate, Sediment Quality, and Changing Land Use

Department of Civil and Environmental Engineering, Headlee Department, and Amherst Center for Environmental Engineering, University of Maine, Orono, ME; School of Earth and Climate Sciences, University of Maine, Orono, ME

## Abstract

## Results

Lake Auburn is located in Auburn, Maine and serves as the public water supply to over 50,000 people (Figures 1 and 3). The EPA has awarded it an exemption from filtration due to historically high water quality. Since 2011, Lake Auburn has experienced a decrease in water quality evidenced by elevated epilimnetic phosphorus (P) concentrations, widespread hypolimnetic anoxia (Figure 1), and algal blooms, including toxic species of blue-green algae. The increased P in the water column has been linked to high concentrations of reducible iron in the lake sediments, which release P under anoxic conditions. Studies have shown lakes with molar Al: (reducible-Fe) ratios < 3 to act as a source of P during anoxia.<sup>2,3</sup>

Tributary wetlands, created by dam impalement and road construction, are acting as substantial sources of Fe to the lake sediments, perhaps resulting in Lake Auburn's vulnerability to decreased water quality during hypolimnetic anoxia. Summer hypolimnetic anoxia (< 2 ppm DO) from 2001 to 2012, years not shown did not occur during the study period. Adapted from Smith (2013).

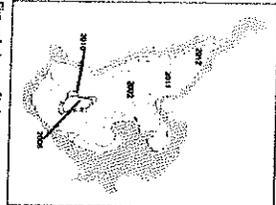


Figure 1: A map of Lake Auburn showing the maximum extent of summer hypolimnetic anoxia (< 2 ppm DO) from 2001 to 2012, years not shown did not occur during the study period. Adapted from Smith (2013).

## Methods

Sediment was sampled at 0, 10, and 20 cm depths using a hopper corer at 11 locations in Lake Auburn and from two upstream lakes (Figure 2). Sediment was placed on dry ice in the field and kept frozen until analysis. Water samples were taken from Lake Auburn and upstream tributaries for temperature, pH, ANC, and conductivity. Sediment samples were analyzed for metals (total, dissolved, and organically bound).

Figure 2: Sampling sediment from Lake Auburn using a hopper corer.



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Sediment P speciation was determined by performing a series of sequential chemical extractions from Premier et al. (1994), outlined below. Extracted soil phosphorus (P) and Fe concentrations on a Thermo Electron ICP-AES 6500. P and Fe fraction was further analyzed for reactive P (P<sub>i</sub> inorganic) and NaOH reactive P (P<sub>r</sub>, organic) using molybdate blue colorimetric methods.

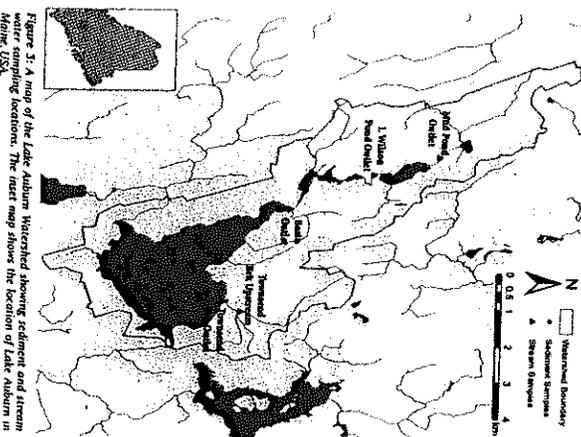
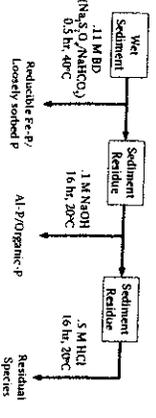


Figure 3: A map of the Lake Auburn watershed showing sediment and stream water sampling locations. The inset map shows the location of Lake Auburn in Maine, USA.

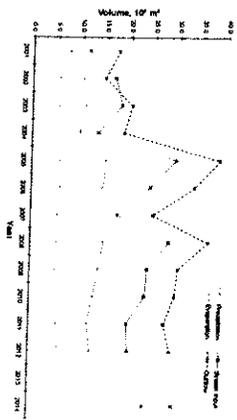


Figure 4: Total yearly volumes of inputs and outputs for Lake Auburn. Data prior to 2012 were obtained from CDMS Smith (2013). Data for 2012 (Stream inputs from the Basin and Townsend Brook comprise approximately two thirds of total input to Lake Auburn.)

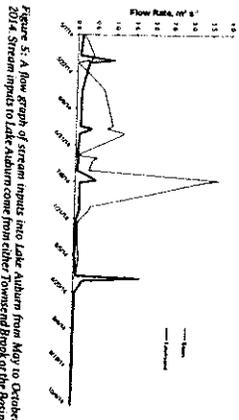


Figure 5: A flow graph of stream inputs to Lake Auburn from May to October 2014. Stream inputs to Lake Auburn come from either Townsend Brook or the Basin.

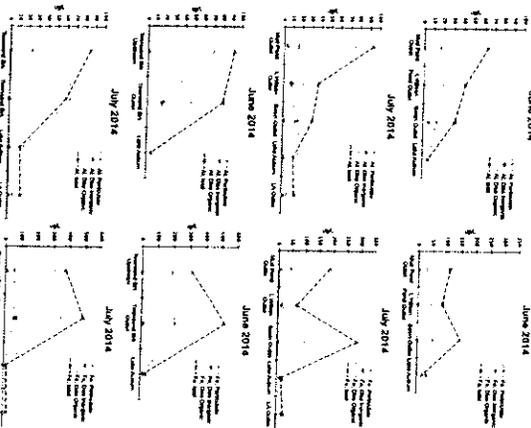


Figure 6: Tracers showing changes in suspended metal concentrations and speciation with proximity to Lake Auburn. Iron and aluminum concentrations and Basin Outlet are both capturing flow out of wetland. Townsend Brook Outlet Lake Auburn. Sample locations are shown in Figure 3.

## Summary

- The majority of inputs to the lake are from stream flow through the Basin and Townsend Brook wetlands (Figures 4 and 5).
- Wetland tributaries are causing an increased flux of Fe into the lake (Figure 6).
- Lake Auburn sediments contain high concentrations of reducible Fe relative to Al making the lake vulnerable to internal P cycling on years that hypolimnetic anoxia develops (Figure 7).
- A long-term solution the removal of these wetlands could decrease Fe loads into the lake and balance the Al:Fe ratio in the sediment, preventing internal P cycling (Table 1). This process could be complemented with Al treatment of the lake (i.e. Alum).
- A 30 cm core will be extracted from Lake Auburn in winter 2015. <sup>210</sup>Pb dating of this core will show possible changes in Fe accumulation rates overtime, capturing the creation of the tributary wetlands approximately 100 years ago.

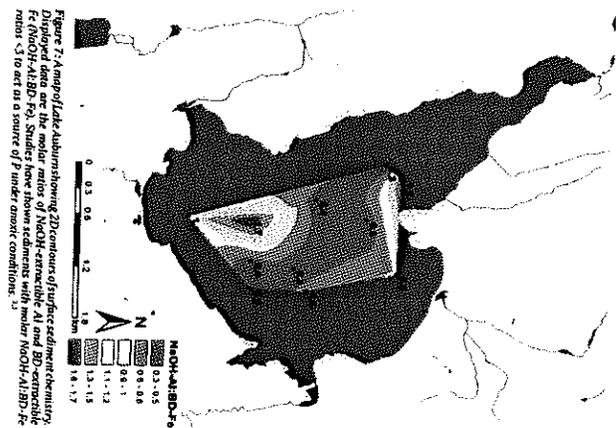


Figure 7: A map of Lake Auburn showing 20 centimeters of surface sediment chemistry. Data were obtained from CDMS Smith (2013). The shaded area represents the maximum extent of summer hypolimnetic anoxia (< 2 ppm DO) from 2001 to 2012, years not shown did not occur during the study period. Adapted from Smith (2013).

## 2014 Iron Mass Budget For Lake Auburn

Inputs	Present, kg	With Wetlands Removed, kg
Basin Stream	4489	1416
Townsend Brook	1673	1155
<b>Outputs</b>	<b>493</b>	<b>493</b>
<b>Mass Retained in Lake</b>	<b>5669</b>	<b>2077</b>

Table 1: A mass iron budget for Lake Auburn over 2014. The high flux of Fe relative to Al, caused by tributary wetland inputs, is not completely removed by assuming the water chemistry immediately upstream of the wetlands flowed directly into the lake.

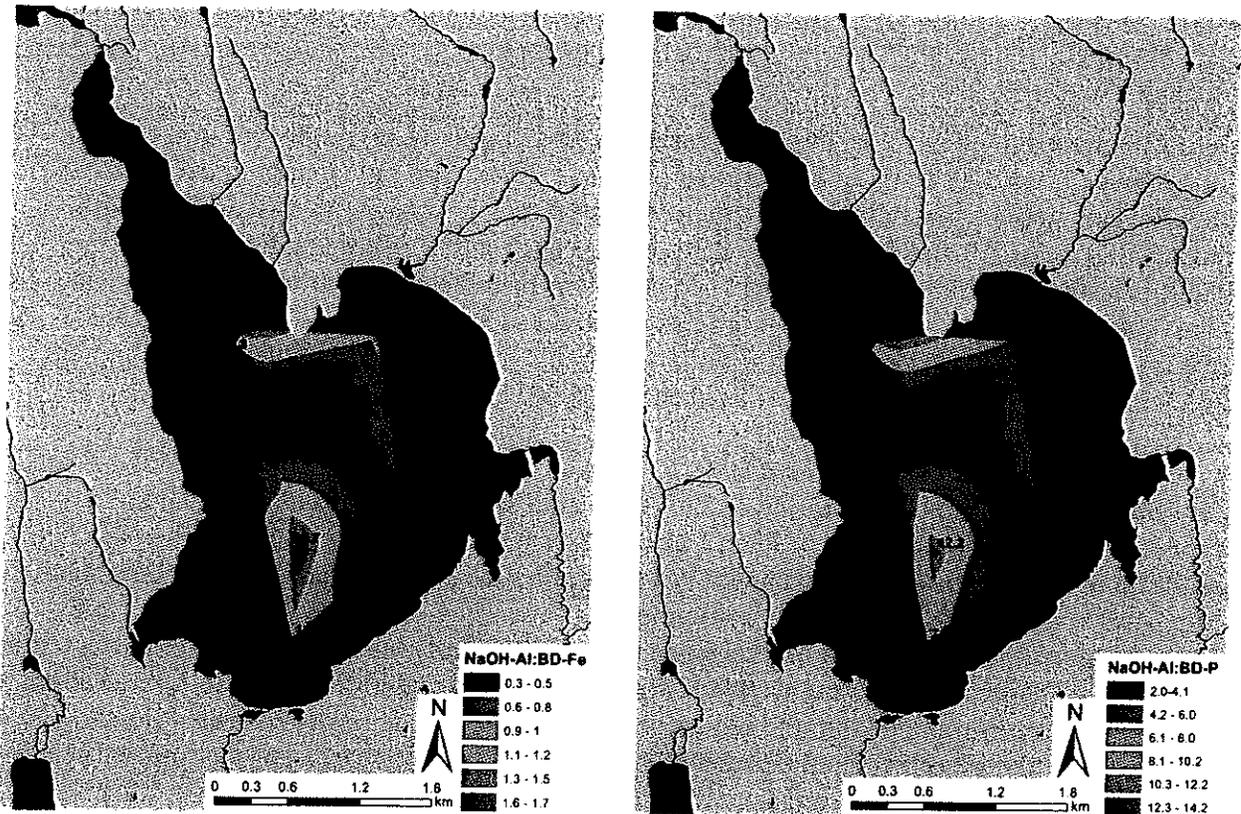
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Summary of Lake Auburn Research  
April 6, 2015

Lake Auburn sediment has very low concentrations of aluminum (Al) relative to iron (Fe) and phosphorus (P) with Al:Fe ratios ranging from 0.3 to 1.7 and Al:P ratios ranging from 2.0 to 14.5. Several studies, some of which include Maine lakes, have shown lakes sediments with molar Al:Fe ratios  $< 3$  and Al:P ratios  $< 25$  to be susceptible to P release under anoxic conditions. We sampled sediment from 11 locations in Lake Auburn. Our analyses show that Lake Auburn sediment is well below both the threshold of 3 for Al:Fe and 25 for Al:P (see figures), indicating that Lake Auburn may be vulnerable to internal P loading during summers with widespread hypolimnetic anoxia, as occurred in 2011 and 2012.

A survey of sediments from upstream lakes in the watershed (Mud Pond and Little Wilson Pond) showed that these lakes have more favorable Al:Fe and Al:P ratios with values  $>3$  and  $>25$ , respectively. High concentration of Fe in Lake Auburn sediment may be linked to the presence the Basin and Townsend Brook wetlands. Water samples taken at several locations stretching from Mud Pond to Lake Auburn and from upstream Townsend Brook to Lake Auburn have shown an increase concentration of total Fe in both wetland systems (see Figure 6 in poster). It is possible that the presence of these wetlands are causing an increased flux of Fe to Lake Auburn, which becomes incorporated into the sediments, making the lake at risk to internal P loading. However, it is also possible that the presence of these wetlands decreases nutrient inputs (N and P) to the lake and, as such, it is important that the role these wetlands play in lake productivity is further evaluated.

We are currently analyzing two 60 cm sediment cores that were extracted from Lake Auburn in March 2015. These cores are being dated using radioactive isotopes ( $^{210}\text{Pb}$ ) and chemically analyzed to determine if there have been changes in sediment chemistry over the last several hundred years. We hope to determine any differences in sedimentation to Lake Auburn as land use within the watershed changed from agricultural to forested and if the emplacement of the dam, which created the Basin wetlands, has had a significant impact on sediment Al:Fe in the lake.



Contour maps of Lake Auburn surficial sediments showing the Al:Fe ratios (left) and Al:P ratios (right). Both maps highlight the low concentration of aluminum relative to iron and phosphorus in the sediment.