



1414 West Hamilton Avenue  
P.O. Box 8  
Eau Claire, WI 54702-0008

November 29, 2018

Cheryl Laatsch – Statewide FERC Coordinator  
WI Dept. of Natural Resources  
N7725 Hwy 28  
Horicon, WI 53032

Nick Utrup  
U.S. Fish and Wildlife Service  
Wisconsin/Minnesota Ecological Services Field Office  
4101 American Boulevard East  
Bloomington, MN 55425

**Subject: 2018 Water Quality Monitoring Report  
Big Falls (P-2390-01), Thornapple (P-2475) & Turtle-Flambeau (P-2390-02)**

Dear Ms. Laatsch and Mr. Utrup:

Enclosed is the 2018 Water Quality Sampling Report for Big Falls and Thornapple flowages. The samples were taken in April, July and August from the deepest point of each reservoir immediately upstream of the boat restraining barrier. The report includes results for the past five years.

Annual water quality monitoring for the Turtle Flambeau Flowage is conducted by the Citizens Lake Monitoring Program and the results are published on the WDNR's website. The link is: <https://dnr.wi.gov/lakes/clmn/Stations.aspx?location=26>. Should citizen monitoring be discontinued in the future, NSPW shall provide replacement services as stipulated in the 2008 Water Quality Certification for Big Falls Hydro.

Should you have any questions concerning this report, you may contact me at (715) 737-1353 or at [matthew.j.miller@xcelenergy.com](mailto:matthew.j.miller@xcelenergy.com). **Please provide any comments you may have by December 30, 2018.**

Sincerely,

A handwritten signature in cursive script that reads 'Matthew J. Miller'.

Matthew J. Miller  
Hydro License Compliance Consultant

Enclosure

c: General Project Files

**2018 Water Quality Monitoring Report for Big Falls Flowage  
(P-2390-01) and Thornapple Flowage (P-2475)**

Northern States Power Company –WI

An Xcel Energy Company

November 2018

## **APPENDIX A**

**2018 Water Quality Lab Analysis For Big Falls  
and Thornapple Flowages**



Minneapolis Testing Laboratory  
1518 Chestnut Ave N  
Minneapolis, MN 55043  
Certification # MN-027-053-197  
WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/18/2018 10:32

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface		MDE0104-01	Water	05/08/2018 11:18	05/10/2018 12:40
Big Falls Flowage Bottom		MDE0104-02	Water	05/08/2018 11:23	05/10/2018 12:40



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 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/18/2018 10:32

**Big Falls Flowage Surface**  
**MDE0104-01 (Water) - Chain of Custody Number: 238399**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	<b>0.0290</b>	0.00500	0.0160	mg/L		1	BDE0344	5/16/18 8:58	5/17/18 14:16	EPA 365.1	HRD

**Wet Chemistry**



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Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/18/2018 10:32

**Big Falls Flowage Bottom**

MDE0104-02 (Water) - Chain of Custody Number: 238399

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	<b>0.0300</b>	0.00500	0.0160	mg/L		1	BDE0344	5/16/18 8:58	5/17/18 14:17	EPA 365.1	HRD

**Wet Chemistry**



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Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/18/2018 10:33

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface		MDE0105-01	Water	05/08/2018 14:11	05/10/2018 12:40
Thornapple Flowage Bottom		MDE0105-02	Water	05/08/2018 14:07	05/10/2018 12:40



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Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/18/2018 10:33

**Thornapple Flowage Surface**

**MDE0105-01 (Water) - Chain of Custody Number: 238399**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0220	0.00500	0.0160	mg/L		1	BDE0344	5/16/18 8:58	5/17/18 14:17	EPA 365.1	HRD

**Wet Chemistry**





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Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/18/2018 10:33

**Thornapple Flowage Bottom**

**MDE0105-02 (Water) - Chain of Custody Number: 238399**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0240	0.00500	0.0160	mg/L		1	BDE0344	5/16/18 8:58	5/17/18 14:18	EPA 365.1	HRD

**Wet Chemistry**

**NORTHERN LAKE SERVICE, INC.**  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 05/29/18 Page 1 of 1

**Client:** Xcel Energy  
 Attn: Matt Miller  
 1414 W. Hamilton Ave  
 P.O. Box 8  
 Eau Claire, WI 54702

**NLS Project:** 299191  
**NLS Customer:** 96708  
 Phone: 715 737 1353

**Project:** Big Falls - Thornapple

**Big Falls Flowage** NLS ID: 1054755

COC: 215850:1 Matrix: SW  
 Collected: 05/08/18 11:15 Received: 05/10/18

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					05/24/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					05/11/18	NA	721026460

**Thornapple Flowage** NLS ID: 1054756

COC: 215850:2 Matrix: SW  
 Collected: 05/08/18 14:12 Received: 05/10/18

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					05/24/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					05/11/18	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

ND = Not Detected (< LOD)    LOD = Limit of Detection    LOQ = Limit of Quantitation    NA = Not Applicable  
 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President

Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 299191

Big Falls - Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1054755	Big Falls Flowage	7.8	0.51	8.3	0.15	0.71
1054756	Thornapple Flowage	2.5	0.99	3.2	0.12	0.46

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.



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Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/02/2018 12:45

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface		MDG0334-01	Water	07/24/2018 10:07	07/27/2018 7:15
Big Falls Flowage Bottom		MDG0334-02	Water	07/24/2018 10:14	07/27/2018 7:15



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Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/02/2018 12:45

**Big Falls Flowage Surface**

MDG0334-01 (Water) - Chain of Custody Number: 249753

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	0.0360	0.00200	0.00500	mg/L		1	BDH0021	8/1/18 10:09	8/2/18 11:00	EPA 365.1	HRD

**Wet Chemistry**



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 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/02/2018 12:45

**Big Falls Flowage Bottom**

MDG0334-02 (Water) - Chain of Custody Number: 249753

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	<b>0.0440</b>	0.00200	0.00500	mg/L		1	BDH0021	8/1/18 10:09	8/2/18 11:01	EPA 365.1	HRD

**Wet Chemistry**



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Certification # MN-027-053-197  
WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/02/2018 12:47

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface		MDG0335-01	Water	07/24/2018 11:30	07/27/2018 7:15
Thornapple Flowage Bottom		MDG0335-02	Water	07/24/2018 11:35	07/27/2018 7:15



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 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/02/2018 12:47

**Thornapple Flowage Surface**

**MDG0335-01 (Water) - Chain of Custody Number: 249753**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
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**Wet Chemistry**

<b>Phosphate, Total as P</b>	<b>0.0420</b>	0.00200	0.00500	mg/L		1	BDH0021	8/1/18 10:09	8/2/18 11:03	EPA 365.1	HRD
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 Certification # MN-027-053-197  
 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/02/2018 12:47

**Thornapple Flowage Bottom**

**MDG0335-02 (Water) - Chain of Custody Number: 249753**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	<b>0.0390</b>	0.00200	0.00500	mg/L		1	BDH0021	8/1/18 10:09	8/2/18 11:04	EPA 365.1	HRD

**Wet Chemistry**

NORTHERN LAKE SERVICE, INC.  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 08/02/18 Page 1 of 1

Client: Xcel Energy  
 Attn: Matt Miller  
 1414 W. Hamilton Ave  
 P.O. Box 8  
 Eau Claire, WI 54702

NLS Project: 304456  
 NLS Customer: 96708  
 Phone: 715 737 1353

Project: Big Falls-Thornapple

**Big Falls Flowage** NLS ID: 1070059

COC: 219703:1 Matrix: SW

Collected: 07/24/18 10:08 Received: 07/27/18

Notes: Noncompliance: Sample received at 13.3 degrees C, which is above WDNR protocol of 6 degrees C.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					07/31/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					07/27/18	NA	721026460

**Thornapple Flowage** NLS ID: 1070060

COC: 219703:2 Matrix: SW

Collected: 07/24/18 11:30 Received: 07/27/18

Notes: Noncompliance: Sample received at 13.3 degrees C, which is above WDNR protocol of 6 degrees C.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					07/31/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					07/27/18	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

ND = Not Detected (< LOD)    LOD = Limit of Detection    LOQ = Limit of Quantitation    NA = Not Applicable  
 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President

Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 304456

Big Falls-Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1070059	Big Falls Flowage	7.8	2	9.2	0.57	1.3
1070060	Thornapple Flowage	13	0.0*	13	0.0*	0.93

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.



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WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/17/2018 07:30

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface	M_T	MDI0001-01	Water	08/29/2018 10:54	09/04/2018 7:11
Big Falls Flowage Bottom	M_T	MDI0001-02	Water	08/29/2018 11:03	09/04/2018 7:11



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 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/17/2018 07:30

**Big Falls Flowage Surface**

MDI0001-01 (Water) - Chain of Custody Number: 238400

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	0.0360	0.00200	0.00667	mg/L		1	BDI0251	9/13/18 9:25	9/14/18 9:55	EPA 365.1	HRD

**Wet Chemistry**



Minneapolis Testing Laboratory  
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 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/17/2018 07:30

**Big Falls Flowage Bottom**

**MDI0001-02 (Water) - Chain of Custody Number: 238400**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Wet Chemistry</b>											
<b>Phosphate, Total as P</b>	0.0410	0.00200	0.00667	mg/L		1	BDI0251	9/13/18 9:25	9/14/18 9:58	EPA 365.1	HRD



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Minneapolis, MN 55043  
Certification # MN-027-053-197  
WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/17/2018 07:32

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface	M_T	MDI0002-01	Water	08/29/2018 9:10	09/04/2018 7:11
Thornapple Flowage Bottom	M_T	MDI0002-02	Water	08/29/2018 9:12	09/04/2018 7:11



Minneapolis Testing Laboratory  
 1518 Chestnut Ave N  
 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/17/2018 07:32

**Thornapple Flowage Surface**

**MDI0002-01 (Water) - Chain of Custody Number: 238400**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	<b>0.0330</b>	0.00200	0.00667	mg/L		1	BDI0251	9/13/18 9:25	9/14/18 9:59	EPA 365.1	HRD

**Wet Chemistry**





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 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150

Christine Keefe, Supervisor (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/17/2018 07:32

**Thornapple Flowage Bottom**

**MDI0002-02 (Water) - Chain of Custody Number: 238400**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					

**Wet Chemistry**

<b>Phosphate, Total as P</b>	<b>0.0340</b>	0.00200	0.00667	mg/L		1	BDI0251	9/13/18 9:25	9/14/18 10:00	EPA 365.1	HRD
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NORTHERN LAKE SERVICE, INC.  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 09/10/18 Page 1 of 1

Client: Xcel Energy  
 Attn: Matt Miller (reports)  
 1414 W. Hamilton Ave  
 P.O. Box 8  
 Eau Claire, WI 54702

NLS Project: 306959  
 NLS Customer: 96708  
 Phone: 715 737 1353

Project: Big Falls-Thornapple

**Big Falls Flowage** NLS ID: 1077360

COC: 220592:1 Matrix: SW  
 Collected: 08/29/18 10:54 Received: 08/31/18

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					09/06/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					08/31/18	NA	721026460

**Thornapple Flowage** NLS ID: 1077361

COC: 220592:2 Matrix: SW  
 Collected: 08/29/18 09:10 Received: 08/31/18

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					09/06/18	10200-H	721026460
Lab filtration for Chlorophyll	yes					08/31/18	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

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 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President

Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 306959

Big Falls-Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1077360	Big Falls Flowage	8.1	1.2	9.2	0.17	0.86
1077361	Thornapple Flowage	0.87	0.95	1.5	0.21	0.41

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.

## **APPENDIX B**

**Summary Of Total Phosphorous And Chlorophyll A  
Data For Big Falls And Thornapple Flowages  
2014 - 2018**

## Summary of Water Quality Data for Big Falls and Thornapple Flowages (2014-2018)

Date	<u>Big Falls Flowage</u>			<u>Thornapple Flowage</u>		
	Surface	Surface	Bottom	Surface	Surface	Bottom
	Total Phosphorus (mg/L P)	Chlorophyll-A (CCa) (ug/L)	Total Phosphorus (mg/L P)	Total Phosphorus (mg/L P)	Chlorophyll-A (CCa) (ug/L)	Total Phosphorus (mg/L P)
no sampling						
7/22/2014*	0.04	5.0	0.05	0.04	1.9	0.05
8/27/2014	0.03	3.6	0.10	0.04	14.0	<0.01
4/28/2015	0.02	1.3	0.03	0.03	1.7	0.02
7/21/2015	0.04	6.8	0.05	0.03	0.6	0.03
8/26/2015	0.03	4.1	0.03	0.03	2.4	0.03
5/3/2016	0.02	1.9	0.02	0.02	2.1	0.02
7/19/2016	0.03	2.0	0.06	0.03	0.6	0.03
8/30/2016	0.02	4.7	0.03	0.03	1.3	0.03
4/24/2017	0.02	3.6	0.03	0.02	2.5	0.03
7/24/2017	0.03	1.6	0.05	0.03	1.3	0.04
8/29/2017	0.02	3.1	0.06	0.03	1.1	0.03
<b>5/8/2018</b>	<b>0.03</b>	<b>7.8</b>	<b>0.03</b>	<b>0.02</b>	<b>2.5</b>	<b>0.02</b>
<b>7/24/2018</b>	<b>0.04</b>	<b>7.8</b>	<b>0.04</b>	<b>0.04</b>	<b>13.0</b>	<b>0.04</b>
<b>8/29/2018</b>	<b>0.04</b>	<b>8.1</b>	<b>0.04</b>	<b>0.03</b>	<b>0.9</b>	<b>0.03</b>
<i>Average (Ice-out sample)</i>	0.02	3.65	0.03	0.02	2.20	0.02
<i>Average (July sample)</i>	0.03	4.64	0.05	0.03	3.48	0.04
<i>Average (August sample)</i>	0.03	4.72	0.05	0.03	3.94	0.03

\* No spring sampling conducted due to high river flows

## **APPENDIX C**

**Summary Of Dissolved Oxygen and Temperature  
Data for Big Falls Flowage and Thornapple Flowage  
2014-2018**

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2014.**

Date: April 2014  
 Secchi Disk (ft.):  
 Depth of Bottom Sample (ft):  
 Weather Conditions:  
 Temperature (F):

Date: 7/22/2014  
 Secchi Disk (ft.): 3.5  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: mostly cloudy, NW wind 10-15  
 Temperature (F): 75

Date: 8/27/2014  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample: 36  
 Weather Conditions: mostly sunny, light winds  
 Temperature (F): 68

***Not Sampled Due To  
 High River Flows***

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	24.9	7.75	Surface	24.1	7.43
2.0	24.8	7.74	2.0	24.1	7.41
4.0	24.7	7.71	4.0	24.1	7.43
6.0	24.7	7.69	6.0	24.0	7.36
8.0	24.7	7.68	8.0	24.0	7.32
10.0	24.7	7.68	10.0	23.9	7.13
12.0	24.6	7.65	12.0	23.8	7.15
14.0	24.6	7.65	14.0	23.8	7.15
16.0	24.6	7.64	16.0	23.8	7.17
18.0	24.5	7.60	18.0	23.8	7.16
20.0	24.4	7.62	20.0	23.8	7.15
22.0	24.3	7.61	22.0	23.7	6.91
24.0	24.0	7.31	24.0	23.6	6.80
26.0	23.7	7.22	26.0	23.5	6.59
28.0	23.5	7.19	28.0	23.3	6.38
30.0	23.5	7.17	30.0	23.0	6.13
32.0	23.4	7.04	32.0	22.9	6.00
34.0	23.1	6.93	34.0	22.9	5.90
38.0	Bottom	Bottom	38.0	Bottom	Bottom

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2015.**

Date:	4/28/2015	Date:	7/21/2015	Date:	8/26/2015
Secchi Disk (ft.):	4.0	Secchi Disk (ft.):	4.0	Secchi Disk (ft.):	5.0
Depth of Bottom Sample (ft):	34	Depth of Bottom Sample (ft):	34	Depth of Bottom Sample:	36
Weather Conditions:	sunny, winds calm	Weather Conditions:	mostly sunny, NW winds @ 10	Weather Conditions:	mostly sunny, NW winds @ 5
Temperature (F):	57	Temperature (F):	68	Temperature (F):	60

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	13.4	10.75	Surface	24.3	7.52	Surface	18.1	7.84
2.0	12.0	10.83	2.0	24.3	7.51	2.0	18.0	7.82
4.0	11.9	10.81	4.0	24.1	7.37	4.0	17.7	7.81
6.0	11.7	10.77	6.0	24.0	7.39	6.0	17.6	7.83
8.0	11.6	10.75	8.0	23.9	7.40	8.0	17.0	8.24
10.0	11.6	10.72	10.0	23.9	7.38	10.0	16.6	8.40
12.0	11.6	10.71	12.0	23.9	7.35	12.0	16.6	8.42
14.0	11.5	10.69	14.0	23.9	7.32	14.0	16.4	8.42
16.0	11.5	10.69	16.0	23.8	7.30	16.0	16.3	8.47
18.0	11.4	10.66	18.0	23.8	7.27	18.0	16.3	8.47
20.0	11.3	10.64	20.0	23.8	7.26	20.0	16.3	8.51
22.0	11.2	10.60	22.0	23.8	7.26	22.0	16.3	8.52
24.0	11.1	10.57	24.0	23.8	7.26	24.0	16.3	8.54
26.0	11.1	10.57	26.0	23.8	7.25	26.0	16.2	8.57
28.0	11.0	10.59	28.0	23.8	7.25	28.0	16.1	8.55
30.0	11.0	10.56	30.0	23.8	7.21	30.0	16.1	8.59
32.0	10.8	10.45	32.0	23.8	7.20	32.0	16.0	8.56
34.0	10.7	10.4	34.0	23.8	7.03	34.0	16.0	8.58
36.0	Bottom	Bottom	36.0	Bottom	Bottom	36.0	16.0	8.55
						38.0	Bottom	Bottom



### Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2016.

Date: 5/3/2016  
 Secchi Disk (ft.): 4.5  
 Depth of Bottom Sample (ft): 35  
 Weather Conditions: hazy sun, wind west @ 10  
 Temperature (F): 55

Date: 7/19/2016  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): NA  
 Weather Conditions: Sunny, calm wind  
 Temperature (F): 74

Date: 8/30/2016  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample: 34  
 Weather Conditions: cloudy, calm wind  
 Temperature (F): 60

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	13.2	10.18	Surface			Surface	22.9	7.80
2	13.0	10.21	<b>No sampling - DO meter malfunctioned</b>			2	22.9	7.77
4	12.9	10.17		4	22.7	7.74		
6	12.8	10.15		6	22.7	7.73		
8	12.8	10.13		8	22.7	7.71		
10	12.8	10.12		10	22.7	7.71		
12	12.8	10.11		12	22.7	7.69		
14	12.8	10.11		14	22.6	7.66		
16	12.8	10.10		16	22.6	7.66		
18	12.8	10.10		18	22.6	7.64		
20	12.8	10.10		20	22.6	7.64		
22	12.8	10.08		22	22.6	7.60		
24	12.8	10.05		24	22.6	7.53		
26	12.7	10.03		26	22.5	7.46		
28	12.8	10.04	28	22.5	7.31			
30	12.7	10.03	30	22.5	7.29			
32	12.7	10.04	32	22.3	7.35			
34	12.7	10.0	34	22.0	7.35			
36	Bottom	Bottom	36	Bottom	Bottom			

## Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2017.

Date: 4/24/2017  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): 34  
 Weather Conditions: Overcast, south wind @ 15  
 Temperature (F): 55

Date: 7/24/2017  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: Partly cloudy, light winds  
 Temperature (F): 62

Date: 8/29/2017  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample: 34  
 Weather Conditions: Overcast, calm winds  
 Temperature (F): 58

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	11.6	11.09	Surface	24.5	6.27	Surface	18.7	8.25
2	11.4	11.06	2	24.1	6.23	2	18.7	8.23
4	11.3	11.05	4	24.1	6.23	4	18.5	8.20
6	11.3	11.02	6	24.1	6.25	6	18.5	8.18
8	11.3	11.00	8	24.1	6.26	8	18.4	8.17
10	11.3	10.98	10	24.0	6.26	10	18.4	8.13
12	11.3	10.98	12	24.0	6.26	12	18.4	8.09
14	11.2	10.97	14	24.0	6.25	14	18.4	8.08
16	11.2	10.96	16	24.0	6.24	16	18.4	8.08
18	11.2	10.95	18	23.9	6.25	18	18.4	8.07
20	11.2	10.95	20	23.9	6.27	20	18.4	8.07
22	11.2	10.94	22	23.8	6.26	22	18.4	8.07
24	11.2	10.94	24	23.7	6.28	24	18.4	8.05
26	11.2	10.93	26	23.7	6.28	26	18.4	8.04
28	11.1	10.92	28	23.7	6.25	28	18.3	8.01
30	11.1	10.90	30	23.7	6.27	30	18.3	8.01
32	11.1	10.89	32	23.7	6.25	32	18.3	8.01
34	11.1	10.87	34	23.7	6.22	34	18.2	7.84
36	Bottom	Bottom	36	23.7	6.13	36	Bottom	Bottom
			38	Bottom	Bottom			

## Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2018.

Date: 5/8/2018  
 Secchi Disk (ft.): 4.5  
 Depth of Bottom Sample (ft): 34  
 Weather Conditions: overcast, calm wind  
 Temperature (F): 73

Date: 7/24/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: mostly sunny, winds NW @ 5-10  
 Temperature (F): 72

Date: 8/29/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: partly sunny, winds N @ 5-10  
 Temperature (F): 59

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	17.6	9.88	Surface	24.0	8.35	Surface	21.6	7.33
2	16.6	10.00	2	23.7	8.34	2	21.6	7.31
4	16.6	9.97	4	23.4	8.22	4	21.6	7.30
6	16.4	9.96	6	23.3	8.20	6	21.6	7.29
8	16.2	9.92	8	23.3	8.16	8	21.6	7.27
10	16.2	9.92	10	23.3	8.15	10	21.5	7.23
12	16.2	9.92	12	23.3	8.14	12	21.5	7.24
14	16.2	9.92	14	23.1	7.95	14	21.4	7.27
16	16.2	9.91	16	23.0	7.94	16	21.4	7.28
18	16.2	9.91	18	23.0	7.90	18	21.4	7.26
20	16.2	9.90	20	23.0	7.77	20	21.4	7.22
22	16.2	9.90	22	22.7	7.74	22	21.4	7.22
24	16.2	9.89	24	22.5	7.60	24	21.4	7.23
26	16.2	9.91	26	22.5	7.57	26	21.4	7.23
28	16.2	9.90	28	22.4	7.51	28	21.4	7.24
30	16.2	9.90	30	22.3	7.47	30	21.4	7.21
32	16.2	9.89	32	22.2	7.29	32	21.4	7.15
34	16.1	9.91	34	22.2	7.24	34	21.4	6.92
36	Bottom	Bottom	36	22.2	7.18	36	21.3	6.7
			38	Bottom	Bottom		Bottom	Bottom

### Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2014.

Date:	April 2014	Date:	7/22/2014	Date:	8/27/2014
Secchi Disk (ft.):	4.0	Secchi Disk (ft.):	3.5	Secchi Disk (ft.):	5
Depth of Bottom Sample (ft):	20	Depth of Bottom Sample (ft):	20	Depth of Bottom Sample (ft)	20
Weather Conditions:	mostly cloudy, light winds	Weather Conditions:	mostly cloudy, sw wind @ 10	Weather Conditions:	mostly sunny
Temperature (F):	62	Temperature (F):	79	Temperature (F):	74

**Not Sampled Due To  
High River Flows**

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	25.4	6.90	Surface	23.9	7.81
2.0	25.1	6.86	2.0	23.1	7.83
4.0	24.8	6.84	4.0	22.8	7.41
6.0	24.7	6.80	6.0	22.8	7.42
8.0	24.1	6.72	8.0	22.7	7.41
10.0	24.0	6.69	10.0	22.3	7.07
12.0	24.0	6.67	12.0	22.2	6.90
14.0	24.0	6.65	14.0	22.2	6.77
16.0	23.9	6.63	16.0	22.1	6.67
18.0	23.9	6.60	18.0	21.8	6.58
20.0	23.9	6.59	20.0	21.8	6.59
22.0	Bottom	Bottom	22.0	Bottom	Bottom

### Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2015.

Date:	4/28/2015	Date:	7/21/2015	Date:	8/26/2015
Secchi Disk (ft.):	4.0	Secchi Disk (ft.):	5.5	Secchi Disk (ft.):	6.0
Depth of Bottom Sample (ft):	18	Depth of Bottom Sample (ft):	20	Depth of Bottom Sample (ft)	18
Weather Conditions:	sunny, calm winds	Weather Conditions:	sunny, NW winds @ 10	Weather Conditions:	mostly sunny, NW winds @ 5
Temperature (F):	63	Temperature (F):	78	Temperature (F):	66

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	13.8	10.52	Surface	24.3	6.77	Surface	20.4	8.22
2.0	10.9	10.41	2.0	23.8	6.69	2.0	19.4	8.23
4.0	10.6	10.42	4.0	23.8	6.66	4.0	18.8	8.20
6.0	10.3	10.31	6.0	23.4	6.61	6.0	18.5	8.07
8.0	10.3	10.28	8.0	22.9	6.55	8.0	18.4	7.99
10.0	10.0	10.14	10.0	22.8	6.52	10.0	18.3	7.90
12.0	9.9	10.09	12.0	22.8	6.48	12.0	18.3	7.89
14.0	9.9	10.11	14.0	22.8	6.48	14.0	18.3	7.87
16.0	9.9	10.10	16.0	22.7	6.47	16.0	18.3	7.88
18.0	9.9	10.08	18.0	22.7	6.46	18.0	18.2	7.80
20.0	Bottom	Bottom	20.0	22.7	6.44	20.0	Bottom	Bottom
			22.0	Bottom	Bottom			

### Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2016.

Date: 5/3/2016			Date: 7/19/2016			Date: 8/30/2016		
Secchi Disk (ft.): 4.5			Secchi Disk (ft.): 4.5			Secchi Disk (ft.): 4.5		
Depth of Bottom Sample (ft): 20			Depth of Bottom Sample (ft): NA			Depth of Bottom Sample (ft): 20		
Weather Conditions: overcast, wind west @ 15-20			Weather Conditions: mostly sunny, s wind @ 5-10			Weather Conditions: partly sunny, light winds		
Temperature (F): 65			Temperature (F): 79			Temperature (F): 80		
Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	11.0	10.65	<b>No Sampling - DO meter malfunctioned</b>			Surface	24.3	6.99
2.0	10.9	10.58				2.0	23.9	6.88
4.0	10.8	10.59				4.0	23.6	6.85
6.0	10.8	10.59				6.0	23.4	6.77
8.0	10.5	10.60				8.0	23.4	6.76
10.0	10.5	10.63				10.0	23.3	6.72
12.0	10.5	10.61				12.0	23.2	6.66
14.0	10.4	10.59				14.0	23.2	6.66
16.0	10.4	10.58				16.0	23.2	6.65
18.0	10.4	10.59				18.0	23.2	6.64
20.0	10.4	10.57				20.0	23.2	6.57
22.0	Bottom	Bottom	22.0	Bottom	Bottom			

### Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2017.

Date: 4/24/2017			Date: 7/24/2017			Date: 8/29/2017		
Secchi Disk (ft.): 4.0			Secchi Disk (ft.): 5.0			Secchi Disk (ft.): 6.0		
Depth of Bottom Sample (ft): 20			Depth of Bottom Sample (ft): 20			Depth of Bottom Sample (ft): 18		
Weather Conditions: overcast, windy			Weather Conditions: mostly sunny, light winds			Weather Conditions: cloudy, light winds		
Temperature (F): 60			Temperature (F): 72			Temperature (F): 62		
Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	10.1	11.15	Surface	24.5	6.82	Surface	21.6	7.59
2.0	10.1	11.05	2.0	23.4	6.84	2.0	21.3	7.47
4.0	10.1	10.95	4.0	23.1	6.83	4.0	21.2	7.42
6.0	10.0	10.97	6.0	23.0	6.80	6.0	21.1	7.39
8.0	10.0	10.94	8.0	22.9	6.79	8.0	21.1	7.35
10.0	10.0	10.97	10.0	22.9	6.79	10.0	21.0	7.33
12.0	10.0	10.95	12.0	22.9	6.77	12.0	21.0	7.30
14.0	10.0	10.90	14.0	22.9	6.76	14.0	21.0	7.24
16.0	10.0	10.95	16.0	22.9	6.73	16.0	21.0	7.23
18.0	10.0	10.90	18.0	22.9	6.72	18.0	20.9	7.21
20.0	10.0	10.9	20.0	22.9	6.69	20.0	Bottom	Bottom
22.0	Bottom	Bottom	22.0	Bottom	Bottom			

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2018.**

Date: 5/8/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: cloudy, south wind @ 5-10  
 Temperature (F): 73

Date: 7/24/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 18  
 Weather Conditions: mostly sunny, wind NW @ 5-10  
 Temperature (F):

Date: 8/29/2018  
 Secchi Disk (ft.): 5.5  
 Depth of Bottom Sample (ft) 20  
 Weather Conditions: partly cloudy, light winds  
 Temperature (F):

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	12.5	11.55	Surface	26.2	7.90	Surface	21.5	6.20
2.0	12.1	11.62	2.0	25.7	7.67	2.0	21.5	6.18
4.0	12.0	11.61	4.0	25.6	7.48	4.0	21.4	6.17
6.0	12.0	11.59	6.0	25.4	7.26	6.0	21.4	6.16
8.0	11.9	11.58	8.0	25.3	7.14	8.0	21.4	6.17
10.0	11.8	11.59	10.0	25.3	7.19	10.0	21.4	6.16
12.0	11.7	11.58	12.0	25.3	7.16	12.0	21.4	6.14
14.0	11.7	11.56	14.0	25.3	7.16	14.0	21.4	6.15
16.0	11.7	11.55	16.0	25.0	7.16	16.0	21.4	6.14
18.0	11.7	11.53	18.0	23.8	6.78	18.0	21.4	6.13
20.0	11.6	11.5	20.0	Bottom	Bottom	20.0	21.4	6.1
22.0	Bottom	Bottom				22.0	Bottom	Bottom

## **APPENDIX D**

### **Agency Correspondence**