St. Regis Mohawk Tribe Data

Report: Fluoride

CAA Fluoride Grant: XA98279801-3

TABLE OF CONTENTS

CHAPTER 1 **INTRODUCTION** *1*

Site Description *1*

Contaminant of Concern *3*

Data Sources *3*

CHAPTER 2 **METHODS** *4*

Field Sampling and Analytical Methods *4*

Data Analysis Methods *6*

CHAPTER 3 **RESULTS AND DISCUSSION** *7*

Tribe Garden Results *7*

ALCOA Grass Monitoring Results *17*

Preliminary Screening Assessments of Risk *21*

CHAPTER 4 **CONCLUSIONS** *2 4*

REFERENCES *2 5*

CHAPTER 1 | INTRODUCTION

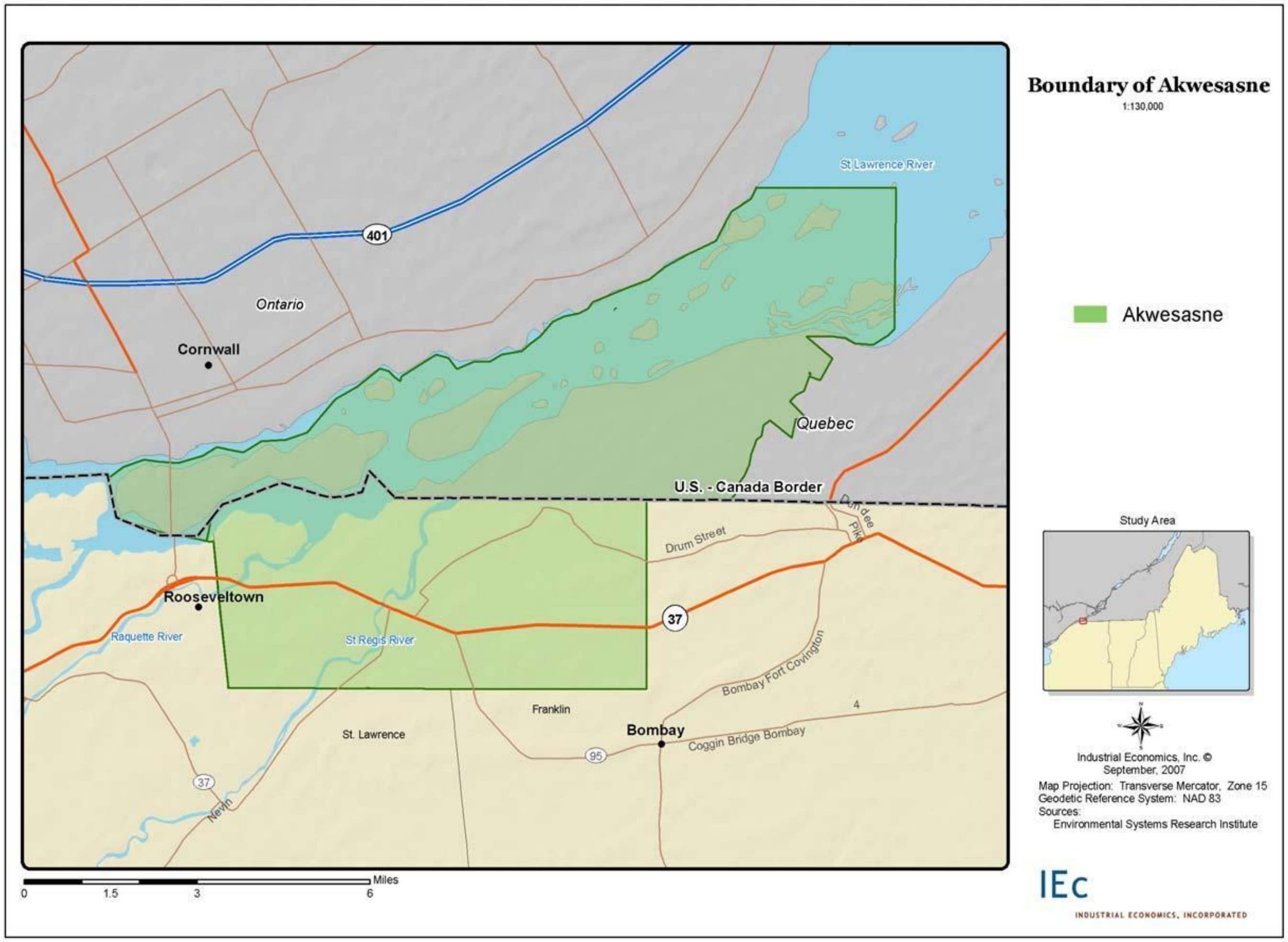
Past industrial activities in and around the St. Regis Mohawk Territory of Akwesasne have resulted in contamination of the land, water, and air with hazardous substances, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), aluminum, styrene, cyanides, dioxins, dibenzofurans, phenols, and fluoride compounds. In order to address potential concerns by community members about exposures to various contaminants in the region, the Tribe has asked Industrial Economics, Incorporated to produce a series of data reports that summarize pertinent information about contamination of natural resources of specific concern to the Tribe.

This report synthesizes available information about concentrations of fluoride measured in vegetables grown in Tribal members' gardens, as well as in soil from the gardens, and water applied to the gardens. It also examines concentrations of fluoride measured in cattle feed grasses as part of ongoing monitoring of fluoride pollution and particulate fluoride from filter samples as well as local deer jaw samples.

SI TE DESC RIPTI ON

Akwesasne is located on the banks of the St. Lawrence River, at its confluence with the Raquette and St. Regis rivers, and traverses the U.S.-Canadian border. Roughly 75 miles northeast of Lake Ontario and 60 miles southwest of Montreal, Akwesasne sits within the St. Lawrence Valley and contains approximately 29,000 acres of undisputed land in both the United States and Canada (Exhibit 1-1). Exhibit 1-1 also includes territory that is part of a recent land claim made by the Tribe located on Barnhart and Long Sault Islands, Hogansburg triangle, Fort Covington, and Massena, among other areas (Hagler Bailly Services 1998).

EXHIBIT 1-1


Boundary of Akwesasne
1:130,000
Akwesasne
Study Area
Industrial Economics, Inc. ©
September, 2007
Map Projection: Transverse Mercator, Zone 15
Geodetic Reference System: NAD 83
Sources:
Environmental Systems Research Institute
IEc
INDUSTRIAL ECONOMICS, INCORPORATED
St Lawrence River
401
Ontario
Cornwall
Quebec
U.S. - Canada Border
Drum Street
Rooseveltown
37
Raquette River
St Regis River
Bombay Fort Covington
Franklin
Bombay
St. Lawrence
Coggin Bridge Bombay
95
4
Nevin
Miles
0
1.5
3
6

CONTAMINANT OF CONCERN

Fluoride is the negatively charged ionic form of the element fluorine. In the environment, fluoride is highly reactive, so it usually is bound to positively charged ions such as sodium or calcium, or positively charged binding sites on organic molecules. In water, these compounds can dissolve, allowing fluoride to exist in a free or unbound state. Fluoride occurs naturally in soils and water, and is commonly found in vegetation in varying concentrations.

Fluoride is well known for its use in the prevention of tooth decay, and it is regularly added to tap water by municipalities for this reason. At elevated concentrations, however, fluoride has been shown to cause adverse health effects, including dental fluorosis, or graying of the teeth, as well as adverse effects on skeletal bone. According to the World Health Organization, total daily intake of fluoride in water of 0.5 milligrams per liter (mg/L) has been shown to have beneficial effects for oral health, but dental fluorosis occurs at exposures above 1.5 mg/L in drinking water. The WHO also states that six mg/L is the threshold above which skeletal effects begin to occur, and that definitive skeletal effects have been demonstrated at fluoride concentrations in drinking water of 14 mg/L (WHO 2004). These WHO thresholds, however, do not explicitly account for exposure to fluoride through pathways other than drinking water.
The U.S. Environmental Protection Agency maintains, "a safe level of fluoride exposure can be determined. No cases of crippling skeletal fluorosis have been observed in the United States associated with the consumption of 2 L of water/day containing 4 mg/L fluoride (50 FR 20614). Assuming a 70 kg adult ingests 0.01 mg fluoride/day in the diet and consumes 8 mg fluoride/day in drinking water (2 L/day containing 4 mg/L fluoride), this would correspond to a total intake of 0.12 mg/kg/day. Thus, 0.12 mg fluoride/kg/day is a safe exposure level for this more severe endpoint in adults" (EPA 2007a).
Fluoride is also used industrially in aluminum and steel manufacturing, and in the production of some fertilizers. As a consequence, fluoride can be released to the environment. Usually, releases of fluoride from aluminum manufacturing are to the air through stack emissions, which ultimately result in the deposition of fluoride onto the land surrounding the aluminum facility.

The primary sources of fluoride in Akwesasne have been identified as the aluminum production facilities owned and operated by ALCOA near Massena: the ALCOA West and ALCOA East facilities (formally Reynolds Aluminum). Fluoride emissions from these facilities were responsible for causing the deaths of cattle in the 1960s and are at least partially responsible for causing the ultimate collapse of the cattle industry in the immediate vicinity of the plants. Specifically, researchers working on Cornwall Island linked skeletal fluorosis in grazing cattle to fluoride emissions from the ALCOA facilities, and documented resultant slaughtering due to this contamination, followed by a general reduction in cattle farming on the island (Raloff 1980, Environment Canada 1996).

RESEARCH REPORT

The first part of the grant focused on identifying studies that have been done on fluoride standards for vegetation, evaluating the information that does/does not support lower fluoride standards, developing support statements for the vegetation fluoride standards that are written in the Tribal Implementation Plan, and developing a library of the studies that support the lower fluoride standards for vegetation.

Attached is a list of references and citations (appendix A). Within this attachment are verbal citations from the articles and whether they support the TIP standard. This document also shows that Akwesasne has 1.54-45.17 ppm fluoride dry weight compared to 0.63-11.3 ppm fluoride for vegetables from an uncontaminated site. In several of the articles it states that the forage standard for NYS is not protecting the vegetation.

The articles in the attachment are on file with the SRMTED in a library of articles about Fluoride. This report also indicates which of the standards the research supports.

DATA SOURCES

This report focuses on two data sources. The data was generated by the Tribe as part of an assessment of fluoride contamination in the community and consists of concentrations of fluoride in vegetables, soil, and water, white tail deer jaw bones and ambient air particulate fluoride concentrations. The second set of data comprises results from yearly monitoring of fluoride in grasses measured cooperatively by ALCOA and the Tribe.

CHAPTER 2 | METHODS

This chapter outlines the methods used for data collection and analysis. In order to assess potential exposure of community members to fluoride contamination within Akwesasne, the Tribe Environment Division collected data on concentrations of fluoride in vegetables, soil, and water from community member gardens. In addition, data on fluoride concentrations in grasses grown in the vicinity of Akwesasne have been collected as part of a collaborative yearly monitoring effort performed in cooperation with researchers affiliated with ALCOA. The Environment Division also collected local white tail deer jaw bones to have analyzed for fluoride content as well as glass fiber filters for the concentration of particulate fluoride in the ambient air.

TRIBE GARDEN DATA

FIELD SAMPLING AND ANALYTICAL METHODS

A detailed sampling and analysis plan was developed by the Tribe Environment Division (ED) prior to conducting the garden sampling study. Samples of garden vegetables, soil, and water were collected by the Tribe Environment Division in 2005. All samples were given unique identifiers and transported using appropriate sample handling and tracking procedures. Samples were either analyzed directly by Environment Division personnel or transferred to professional analytical laboratories for analysis. Planting and harvesting was performed with the assistance of community members. Sample locations are indicated along with analytical results in Chapter 3. Sampling and analysis details described in the Tribe sampling and analysis plan are provided below for each medium sampled (SRMT 2004).

Garden Plant Sam ples

To capture the natural variation in the uptake of fluoride by different garden plants, a variety of vegetables and strawberries were planted in May or June of 2005. All vegetables were planted as "certified organic" seeds. Strawberries were planted as pre-grown plants.[1] Vegetables planted and sampled, with average growing times to maturity indicated in parentheses, included:

- Provider Bush Green Beans (50 Days),
- Danvers Carrots (75 Days),
- Ashworth Yellow Sweet Corn (72 Days),
- Winter Luxury Pie Pumpkins (100 Days),
- Costata Romanesca Zucchini (60 Days),

1 "Certified organic" seeds refer to seeds from plants grown without the use of synthetic fertilizers and pesticides. Strawberry plants were not "certified organic."

- Waltham Butternut (105 Days), and
- Kennebec Potatoes (80-90 Days).

Strawberry plants were of the Tristar Everbearing variety. Flowers from strawberry plants were pruned for the first six weeks of growth. All other plants were not pruned. This was done by instruction (http://www.fedcoseeds.com/forms/ft31cat.pdf):

> "Day-Neutral Strawberries (like Tristar) flower regardless of day length as long as temperatures are between 35 and 85°, and produce fruit from June to October. They are also uncommonly productive—about one pound of fruit per plant the first year, and slightly less the second year. Productivity peaks in August the first year. The second year, berry size decreases in the hottest weather and increases in cooler weather.
> They are heavy feeders and benefit from 3–4" of manure worked 4–6" into the soil prior to planting, and monthly side-dressing of manure throughout the season. Plant 6–12" apart. Mulch with black plastic or thick straw immediately after planting. Remove flowers for the first six weeks, and remove all runners the first season. Mulch in late fall. Side-dress with manure monthly during the second season beginning in May. Till under after the second year and begin again."

Seven to ten individual pieces of the edible portion of vegetables ("vegetables" in the remainder of this document refers to both vegetables and strawberries) were harvested from each plant at maturity from August through October. Samples were collected by individual garden owners in one-gallon Ziploc bags, and transferred to the Environment Division Laboratory on ice for storage. Samples were stored frozen until shipment to Battelle Analytical Laboratories for analysis using EPA SW846 Method 7471. This method involves a step in which the vegetable samples are digested, and then measured using a fluoride-specific probe.

Water Samples

Water used to water the gardens was sampled at the beginning of the study at planting in May or June and end of the growing season, in October. Water sources varied at each of the gardens; some participants in the study watered with well water, while others watered with river water or water from rain barrels. A single water sample was collected in a one-ounce whirlpak bag at each garden, transported to the Environment Division Laboratory on ice in a cooler, and analyzed using an Orion fluoride probe using EPA Method 340.2.

Soil Samples

Two replicates of composite soil samples were collected from each garden by Environment Division personnel in one-ounce Whirlpak bags.[2,3] Soil samples were transferred to the Environment Division Laboratory on ice for storage. Samples were stored frozen until shipment to Battelle Analytical Laboratories for analysis using EPA SW846 Method 7471. As mentioned above, this method involves a step in which the soil samples are digested, and then measured using a fluoride-specific probe.

2 For more details about soil sampling, readers are referred to the Tribe Quality Assurance Project Plan for fluoride and the recently released report entitled "Data Report: PCBs in Garden Soils of Akwesasne" (SRMT 2004, IEc 2007).

3 Although two soils samples were taken by the Tribe, only 10 percent (two samples) of the replicate samples were analyzed by Battelle to assess repeatability.

A NNUAL GRASS MONITORING DATA

Two typical hay or feed varieties of grasses, Timothy grass (*Phleum pratens*) and Orchard grass (*Dactylis glomerata, L.*), have been sampled annually from 2000 through 2006 as part of ongoing monitoring of fluoride in grasses. This monitoring has been performed by representatives of ALCOA and the Tribe. Sample locations are indicated along with analytical results in Chapter 3. In general, grasses grown in plots at each of these 12 locations were harvested monthly from May through October, for each year of monitoring, excluding site 13S, which was sampled yearly beginning in 2003, and site

8S, which was only sampled in the year 2000. Concentrations of fluoride measured in grass samples were measured by Battelle Analytical Laboratories, using American Society for Testing and Materials (ASTM) Method D3270-91.

Jaw Bones

The deer were located either from notification of road kills from NYS and tribal Police and from local hunters. The lower jaw samples were then cut from the head and body, using gloves for protection, and put in PE Bag for analysis. The sample bag was assigned a unique sample number for each jaw; this number will be recorded in field data sheets and Chain of Custody Sheets when submitting samples. The bag was then placed in a cooler with ice packs for transport to the ED office and placed in the freezer. Samples were kept frozen until ready to be shipped. Samples were appropriately labeled and sent via Federal Express to the Battelle Analytical Laboratories for analysis using EPA Method 340.2 for Fluoride measurement. A field log book was kept that contains information on sample site, field data including (type of kill), sampler name and signature, and unusual conditions in the sample area.

Filters

The filters that were used for the analysis of particulate concentration of fluoride in the ambient air were taken with a TEOM (Tapered Element Oscillating Microbalance) that the Tribe currently uses to monitor particulate matter within Akwesasne. The ACCU (Automatic Cartridge Collection Unit) is connected to the TEOM and is setup to collect every 6^{th} day. The ACCU system takes 24-hour samples utilizing 47 mm glass fiber filters. The SRMT Air Quality Program will condition for at least 24 hours and weigh the 47mm glass fiber filters in house. The filters will be weighed (after moisture equilibration <50 % RH) before and after sampling to determine the net weight (mass) gain. The analytical balance used (Scientech, Mod# SA 210, S/N# 5232) has been calibrated to a NIST traceable 100g calibration mass. The microbalance capable of measuring to 0.0001g is in the same environment in which the filters are conditioned (15º to 30º Celsius). The pre-sampling (tare) weighing was within 30 days of the sampling period. The Post sampling conditioning and weighing was completed within 240 hours (10 days) after the end of the sample period, unless the filter sample is maintained at 4° Celsius or less during the entire time between retrieval from the sampler and the start of conditioning, in which case the period did not exceed 30 days. Filter IDs were assigned to each filter. Collection of filters will be documented and logged. Filters were stored < 0 °C in the SRMT Environment Division Laboratory. The over 200 filters that were analyzed were collected between Ohiarihko:wa/July 2001 and Tsiothohrha/December 2005. The Fluoride is extracted from the filter using 10-mls of deionized water and 10-mls of a total ionic strength adjustment buffer (TISAB)

The sample and reagent are placed in a conical tube and shaken for 4-hrs and left to sit for 24 hrs. After 24 hrs they are analyzed with an Ion-Selective Electrode (ISE) based on method 9214 Potentiometric Determination Of Fluoride In Aqueous Samples With Ion-Selective Electrode.

DATA ANALYSIS METHODS

Data were checked for consistency and summary statistics were calculated. Only single point estimates were measured for fluoride concentrations in water and soil, so standard deviations are not calculated. In some cases multiple samples of a given vegetable were supplied from a single garden. In such circumstances, multiple samples were considered replicates, and were averaged to calculate a single point estimate for the concentration of fluoride in the given vegetable variety taken from a single garden. Consequently, only single point estimates are presented for a given vegetable variety for each garden.

To calculate distances between sample sites and the ALCOA facilities, straight-line distances were calculated and the distances from any given sample site to both facilities were averaged. Trend analysis and line fitting were performed using Microsoft Excel. Results are presented in the following chapter. Meteorology was examined as part of the data analysis. A wind rose and plotted data from the area are attached in Attachment B.

CHAPTER 3 | RESULTS AND DISCUSSION

Fluoride concentrations in vegetables are presented in Exhibits 3-1, 3-2, and 3-3.[4] Concentrations are reported on a dry weight basis, normalizing the concentrations to account for the variable amounts of water found normally in different vegetables. Individual vegetable samples ranged from 0.71 micrograms per gram (µg/g) to 255.4 µg/g. Different varieties of plants are known to accumulate more or less contamination (Kabata-Pendias 2000). This is evident in reviewing the results of the fluoride analysis of the different vegetable varieties sampled from Tribe gardens. For example, zucchini had the highest fluoride concentration, averaging 26.1 µg/g across all garden sites. Butternut squash and pumpkin had slightly lower fluoride concentrations, averaging 13.9 µg/g and 13.7 µg/g, respectively. Strawberries had the lowest fluoride concentration of all vegetables sampled, with an average of 4.3 µg/g across all gardens. In addition to variation in fluoride concentrations between vegetable types, there were also variations in fluoride concentrations of a given vegetable between gardens. These differences may be attributable to variations in localized fluoride concentrations, or to differences in the physiology, location, or growth behavior of individual plants.

TRIBE GARDEN RESULTS

Average concentrations of fluoride in all vegetables grown in a given garden allow for estimation of the likely dose of fluoride to which a community member may be exposed. Average concentrations of fluoride across all vegetables sampled in each garden ranged from 3.7 µg/g to 39.6 µg/g. Differences in average fluoride concentrations between gardens are expected both because different varieties of vegetables were sampled from each garden, and because of likely differences in localized fluoride contamination of the environment.

[4] All vegetable concentrations of fluoride are presented as dry weights. Presenting values in this manner allows for the comparison of contaminant concentrations across different vegetable varieties, independent upon the contribution of the weight of water in each vegetable. However, for considerations of portion size and risk associated with the consumption of a give vegetable, wet weights are considered and are discussed below.

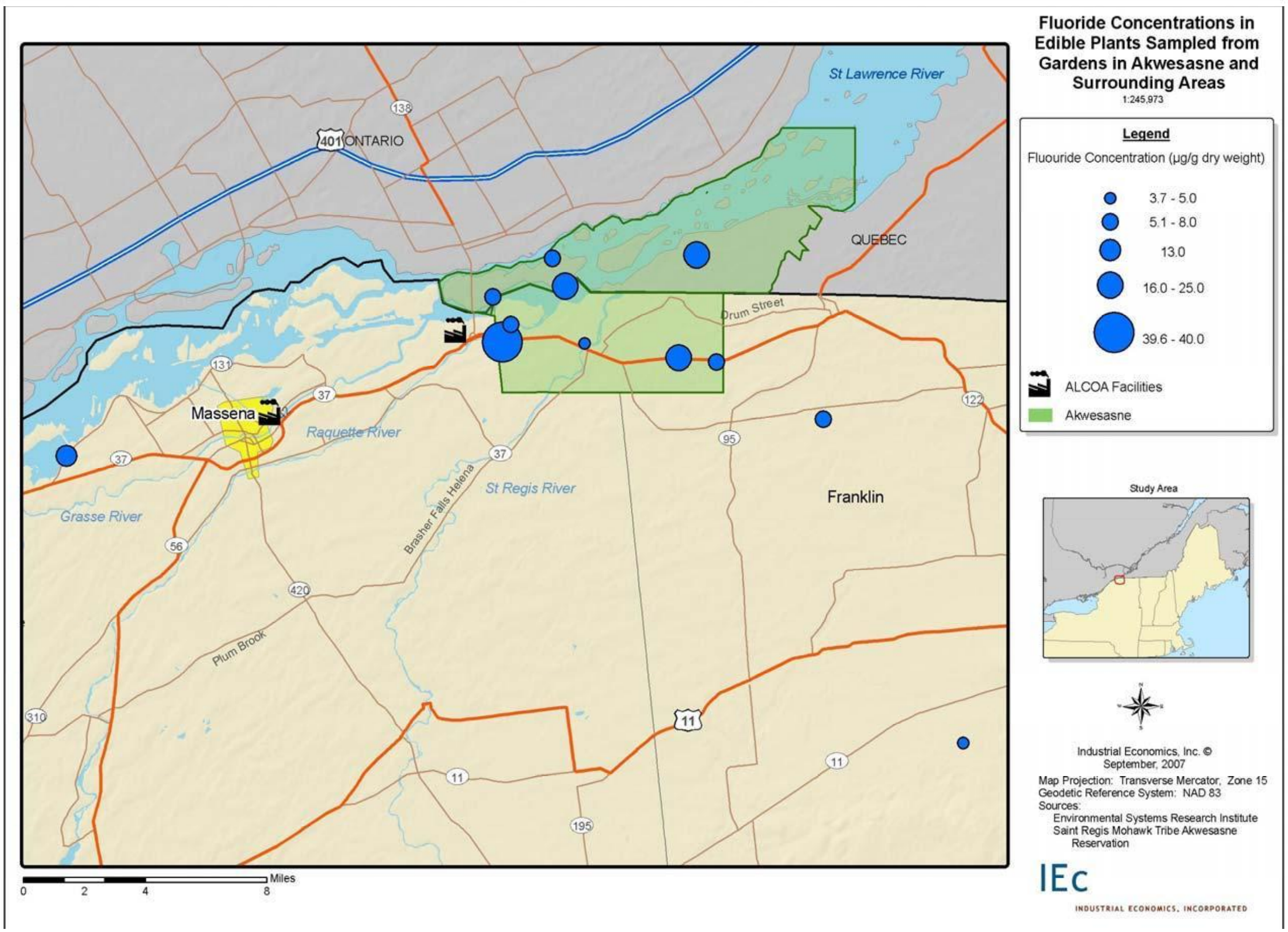
EXHIBIT 3 - 1 AVERAGE FLUORIDE CONCENTRATION IN VEGETABLES GROWN IN COMMUNITY GARDENS

GARDEN ID	VEGETABLES SAMPLED[1]	AVERAGE FLUORIDE CONCENTRATION[2] (µG/G DRY WEIGHT)
FLAB	Butternut Squash (2 replicates) Carrots Green Beans Pumpkin (2 replicates) Zucchini (3 replicates)	39.6
FLBL	Butternut Squash Corn Green Beans Potatoes Pumpkin Strawberry Zucchini	24.3
FLBT	Butternut Squash Corn Green Beans (2 replicates)	6.4
FLDB	Butternut Squash Carrots Corn Green Beans Potatoes Zucchini	16.2
FLGB	Butternut Squash Carrots Corn Green Beans Potatoes Pumpkin Strawberry Zucchini (2 replicates)	4.8
FLJB	Carrots Corn Green Beans Potatoes Pumpkin Strawberry Zucchini (3 replicates)	13.0
FLJJ	Butternut Squash Carrots Corn Green Beans Potatoes Pumpkin Zucchini (4 replicates)	7.1

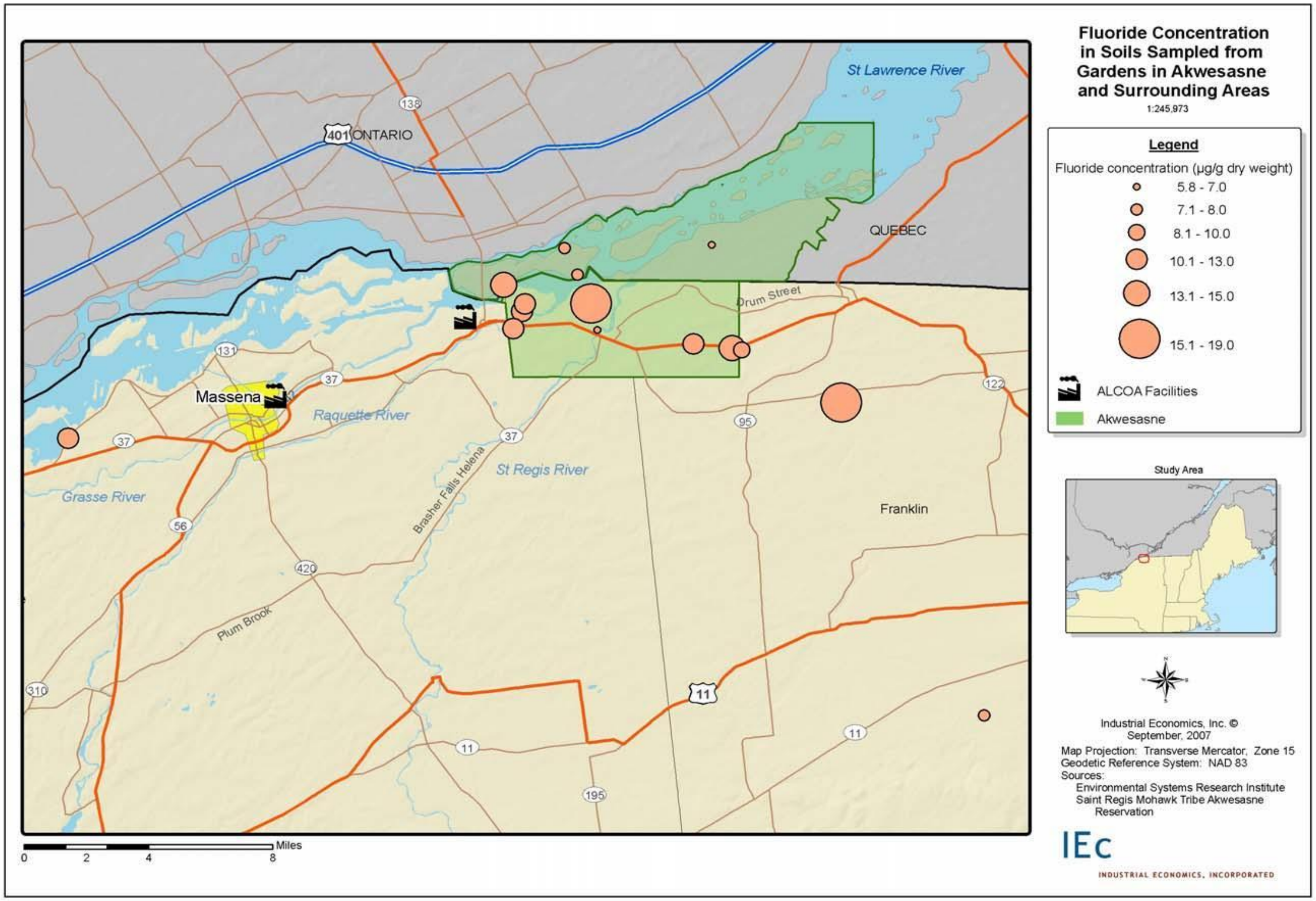
GARDEN ID	VEGETABLES SAMPLED[1]	AVERAGE FLUORIDE CONCENTRATION[2] (µG/G DRY WEIGHT)
FLJT	Butternut Squash Carrots (2 replicates) Corn (2 replicates) Green Beans Potatoes Zucchini (3 replicates)	7.7
FLKJ	Butternut Squash Carrots Corn Green Beans Potatoes Strawberry Zucchini	5.1
FLLB	Butternut Squash (2 replicates) Carrots Corn Green Beans Pumpkin Zucchini	16.0
FLMW	Butternut Squash Carrots Corn Green Beans Pumpkin Zucchini (4 replicates)	3.7
FLSL	Butternut Squash Corn Green Beans Potatoes Pumpkin Strawberry Zucchini	7.4

Notes: [1] One sample of each vegetable was sampled, unless otherwise noted.

[2] Average garden concentrations were calculated after replicates of individual vegetable types were averaged.


Fluoride Concentrations in Edible Plants Sampled from Gardens in Akwesasne and Surrounding Areas
1:245,973
Legend
Flouride Concentration (µg/g dry weight)
3.7 - 5.0
5.1 - 8.0
13.0
16.0 - 25.0
39.6 - 40.0
ALCOA Facilities
Akwesasne
Study Area
Industrial Economics, Inc. ©
September, 2007
Map Projection: Transverse Mercator, Zone 15
Geodetic Reference System: NAD 83
Sources:
Environmental Systems Research Institute
Saint Regis Mohawk Tribe Akwesasne Reservation
IEc
INDUSTRIAL ECONOMICS, INCORPORATED
St Lawrence River
ONTARIO
QUEBEC
Massena
Raquette River
Grasse River
St Regis River
Brasher Falls Helena
Plum Brook
Drum Street
Franklin
Miles
0 2 4 8

E XH I B I T 3 - 5



Fluoride Concentration in Soils Sampled from Gardens in Akwesasne and Surrounding Areas
1:245,973
Legend
Fluoride concentration (µg/g dry weight)
5.8 - 7.0
7.1 - 8.0
8.1 - 10.0
10.1 - 13.0
13.1 - 15.0
15.1 - 19.0
ALCOA Facilities
Akwesasne
Study Area
St Lawrence River
ONTARIO
QUEBEC
Drum Street
Massena
Raquette River
St Regis River
Grasse River
Brasher Falls Helena
Plum Brook
Franklin
Miles
0
2
4
8
Industrial Economics, Inc. ©
September, 2007
Map Projection: Transverse Mercator, Zone 15
Geodetic Reference System: NAD 83
Sources:
Environmental Systems Research Institute
Saint Regis Mohawk Tribe Akwesasne Reservation
IEc
INDUSTRIAL ECONOMICS, INCORPORATED

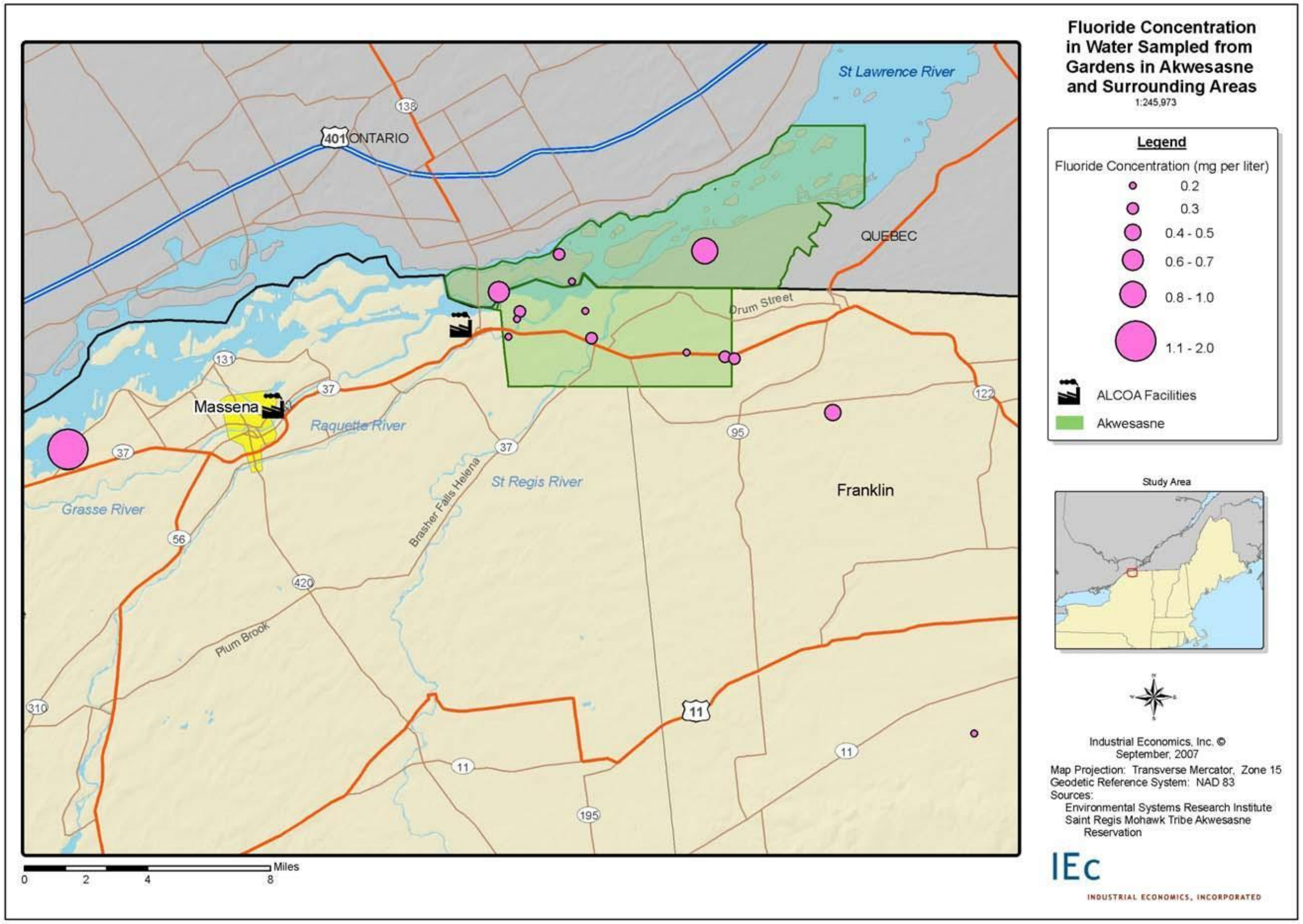
Concentrations of fluoride measured in water used to water community gardens are presented in Exhibits 3-6 and 3-7. Water concentrations of fluoride ranged from 0.2 mg/L to 2.0 mg/L, were in the range expected given normal water fluoridation concentrations, and were all below the 4.0 mg/L threshold suggested to be safe for direct consumption by EPA (EPA 2007a).[5] Although plant concentrations of fluoride have been shown to correlate with concentrations of fluoride in rainwater, it does not appear that such a correlation exist with water used to water plants (Kabata-Pendias 2000). It is more likely that rainwater and plant concentrations both correlate with gaseous air concentrations of fluoride.

EXHIBIT 3 – 6 FLUORIDE CONCENTRATIONS IN WATER USED TO WATER TRIBE GARDENS

GARDEN ID	FLUORIDE CONCENTRATION (MG/L)[1]
FLAB	0.2
FLBL	0.2
FLBT	0.3
FLDB	1
FLFS1*	0.3
FLFS2*	0.3
FLGB	0.3
FLJB	2
FLJJ	0.5
FLJT	0.2
FLKJ	0.3
FLLB	0.2
FLMN	0.2
FLSC*	0.2
FLSL	0.7
Notes: * Vegetables were not sampled for these gardens.	
[1] One sample was measured at each garden.	

[5] All water samples were measured above the detection limit of the Orion probe, which is 0.02 ppm.

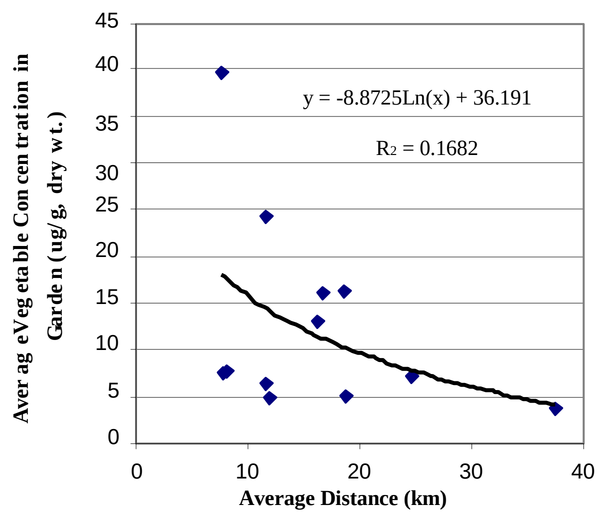
EXHIBIT 3-7



Fluoride Concentration in Water Sampled from Gardens in Akwesasne and Surrounding Areas
1:245,973
Legend
Fluoride Concentration (mg per liter)
0.2
0.3
0.4 - 0.5
0.6 - 0.7
0.8 - 1.0
1.1 - 2.0
ALCOA Facilities
Akwesasne
Study Area
St Lawrence River
ONTARIO
QUEBEC
Drum Street
Massena
Raquette River
St Regis River
Grasse River
Brasher Falls Helena
Plum Brook
Franklin
Miles
0
2
4
8
Industrial Economics, Inc. ©
September, 2007
Map Projection: Transverse Mercator, Zone 15
Geodetic Reference System: NAD 83
Sources:
Environmental Systems Research Institute
Saint Regis Mohawk Tribe Akwesasne Reservation
IEc
INDUSTRIAL ECONOMICS, INCORPORATED

In order to assess the potential relationship between fluoride emissions from the ALCOA facilities and fluoride concentrations in gardens, we plotted average vegetable concentrations for each garden by a measure of the average distance to both of the ALCOA facilities. This plot is shown in Exhibit 3-8.

EXHIBIT 3-8 **RELATIONSHIP BETWEEN AVERAGE VEGETABLE FLUORIDE CONCENTRATION AND PROXIMITY TO ALCOA FACILITIES**



These data indicate that contamination from fluoride in garden vegetables decreases with increasing distance from the ALCOA plants. A trend line fit to the data demonstrates a logarithmic relationship between contamination and distance with an r^2 value of 0.17.

A LCOA GRASS MONITORING RESULTS

Grass monitoring results indicate that fluoride contamination varies across sites. Fluoride concentrations in grass at each site averaged over the duration of the monitoring study (2000 through 2006) are presented in Exhibit 3-9, and in map form below in Exhibit 3-11. In addition, annual averages of fluoride concentrations across all sites are presented in Exhibit 3-10.

EXHIBIT 3 - 9 AVERAGE FLUORIDE CONCENTRATIONS IN HAY GRASS

SITE	NUMBER OF SAMPLES TAKEN AT EACH SITE	AVERAGE FLUORIDE CONCENTRATION IN GRASS OVER SIX MONTH GROWING SEASON (µG/G, DRY WEIGHT)	STANDARD DEVIATION OF FLUORIDE CONCENTRATIONS (µG/G, DRY WEIGHT)
(1) Wilson Hill Refuge	37	3.0	7.9
(2A) Love Farm	39	4.2	10.7
(3A) North of ALCOA	37	38.5	24.3
(5A) Massena Airport	36	3.6	3.2
(4A) Donahue Road	36	3.8	5.1
(6R) Barnhart	36	2.6	2.0
(7R) Reynolds Site	37	3.5	3.7
(8S) Swamp	4	2.0	1.4
(9S) Iroquois Village	32	5.2	4.9
(10S) Pete Martin	32	9.8	6.8
(11S) MIL	37	5.7	11.9
(13S) Leo Swamp Road	17	2.9	4.2

EXHIBIT 3-10 PLOT OF FLUORIDE CONCENTRATIONS IN GRASSES NEAR AKWESASNE OVER TIME

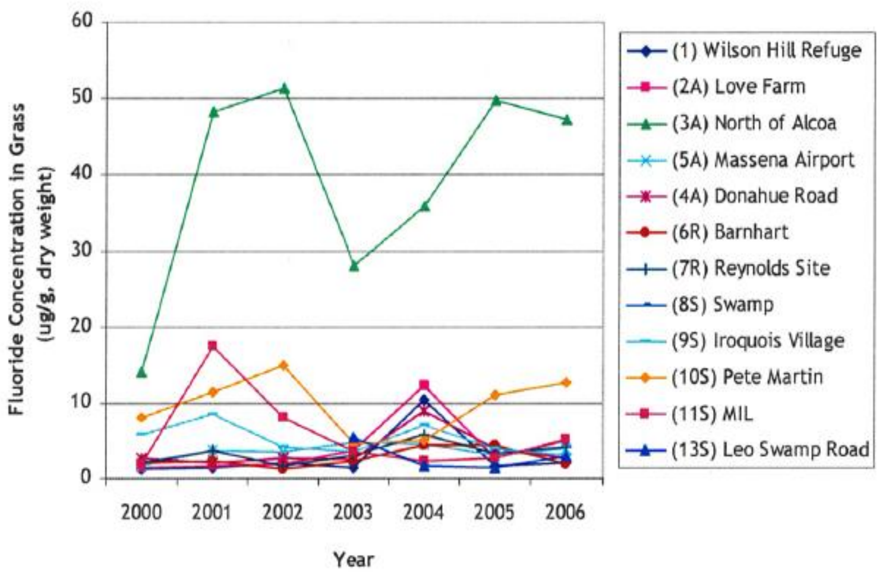
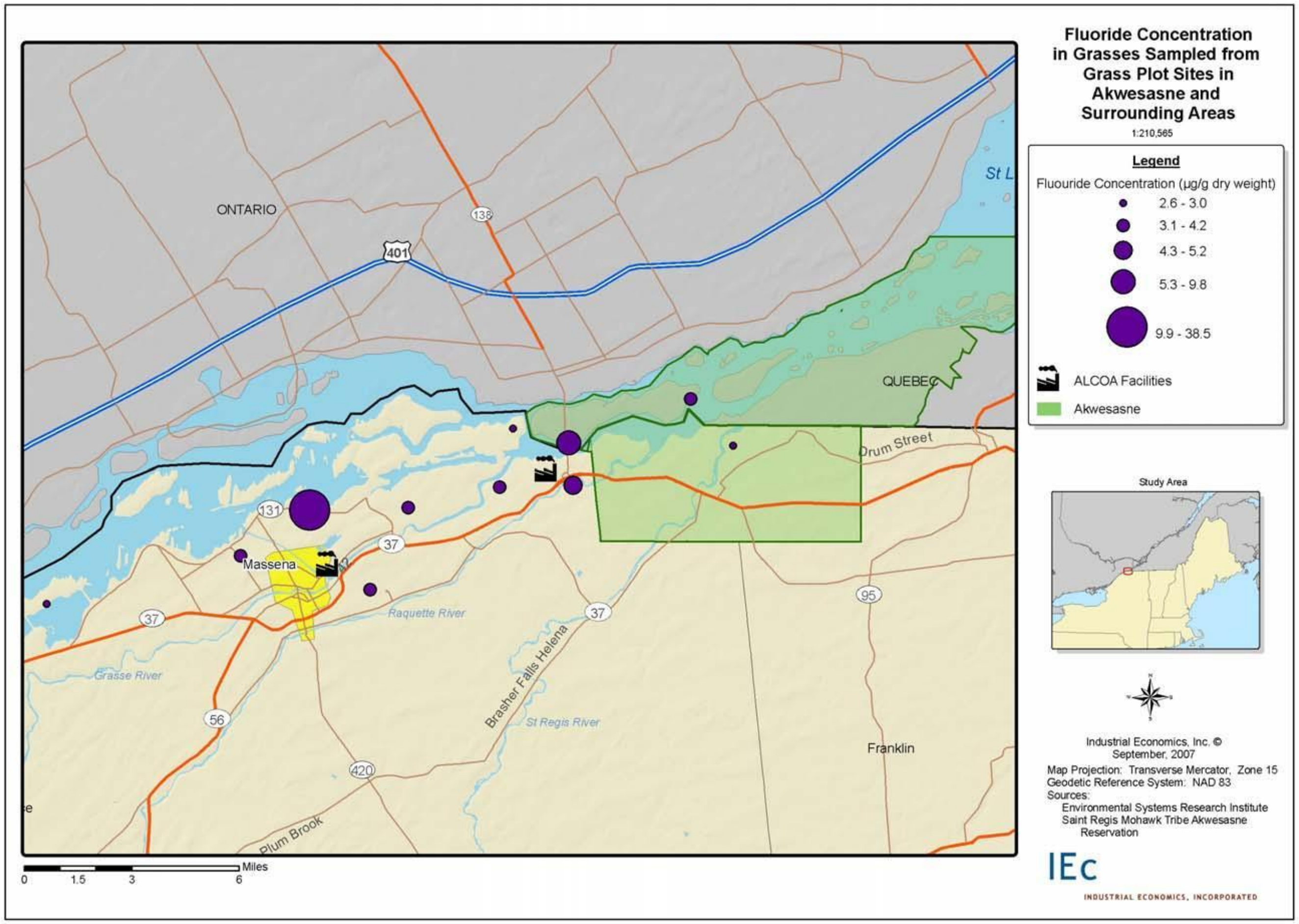


EXHIBIT 3 - 10



Fluoride Concentration in Grasses Sampled from Grass Plot Sites in Akwesasne and Surrounding Areas
1:210,565
Legend
Flouuride Concentration (µg/g dry weight)
2.6 - 3.0
3.1 - 4.2
4.3 - 5.2
5.3 - 9.8
9.9 - 38.5
ALCOA Facilities
Akwesasne
Study Area
ONTARIO
QUEBEC
St L
Massena
Drum Street
Raquette River
Grasse River
Brasher Falls Helena
St Regis River
Plum Brook
Franklin
401
138
131
37
56
420
95
Miles
0
1.5
3
6
Industrial Economics, Inc. ©
September, 2007
Map Projection: Transverse Mercator, Zone 15
Geodetic Reference System: NAD 83
Sources:
Environmental Systems Research Institute
Saint Regis Mohawk Tribe Akwesasne Reservation
IEc
INDUSTRIAL ECONOMICS, INCORPORATED

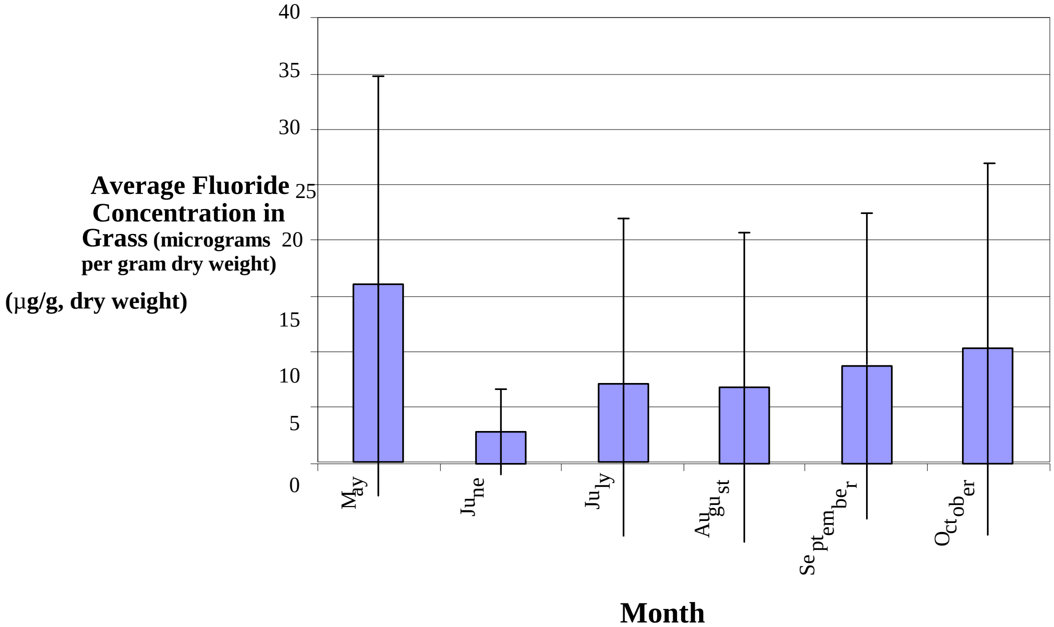
As can be seen in Exhibit 3-10, site 3A, North of ALCOA West facility, appears to be a hotspot of contamination. Site 10S, Pete Martin, also appears to be elevated compared to the remaining sites. The existence of a hotspot of contamination directly north of one of the ALCOA plants is not surprising, as the prevailing wind direction in Massena is from the South (EPA 2002).

Similar to the vegetable data, average concentrations of fluoride in grass also decreased with increasing distance from the ALCOA facilities, however the relationship was not as strong as that observed in the vegetable data (data not shown).

Finally, a spike in fluoride concentrations is visible across most of the remaining sites in 2004. In 2004, samples were collected starting in May, whereas most other years, the first monthly samples were collected in June. May samples for 2004 were elevated compared to samples from the rest of the growing season for most sites. Such results suggest a seasonal effect of fluoride contamination and appear to be responsible to at least some extent for the elevation of 2004 average fluoride concentrations.

To assess seasonal effects, we examined fluoride concentrations across all sites and all years averaged by the month when the sample was taken. Monthly average fluoride concentrations are presented in Exhibit 3-11. The highest monthly average concentrations of fluoride in grass were observed in May, followed by a drop in average fluoride concentrations in June. Although the sample size in May is smaller than for any other month, average fluoride concentrations in May and June are statistically different from one another at the 0.05 level of significance. Average monthly fluoride concentrations then increase from June through October, however differences between the months of June through October are not statistically significant, and average concentrations from the remaining months other than June are not statistically significant from the average concentration in May.

EXHIBIT 3-11 MONTHLY VARIATIONS IN FLUORIDE CONCENTRATION AVERAGED FROM 2000 TO 2006



Note: Error bars represent one standard deviation. Lower bars extend to zero because standard deviations for each month are greater than the average values.

PRELIMINARY SCREENING ASSESSMENTS OF RISK

To provide context for concentration information presented above for fluoride in various media, below we present a preliminary assessment of the risk associated with the observed fluoride contamination in the gardens throughout Akwesasne and the surrounding area. First, we present a screening analysis of risk to community members who may be consuming home-grown vegetables from gardens. Second, we assess risk to cattle consuming hay grass grown in the vicinity of the ALCOA facilities. We stress that the analyses presented below are only preliminary screening analyses do not represent full assessments of the potential risks associated with fluoride exposure by community members in Akwesasne, or by domestic or wild animals.

PRELIMINARY SCREENING ASSESSMENT OF RISK TO COMMUNITY MEMBERS

To address risks associated with the consumption of home grown vegetables, we calculated a risk of developing adverse health effects associated with a hypothetical exposure scenario that involved consumption of home grown vegetables, taking into consideration ingestion of water. This scenario did not incorporate the accidental ingestion of soil, because vegetable samples were taken from community gardens by community members under circumstances that would be similar for direct consumption. Therefore, we assumed that any soil residue on vegetables would have been accounted for in measurements of fluoride in vegetable samples.

Rather than using the dry weights of vegetables, we used their wet weights because this is the form in which vegetables are consumed. Finally, we assumed that water used to water gardens was the same source water that would be ingested directly by community members.

For this screening-level analysis of potential risk, we used the highest average wet Weight concentrations of fluoride for all vegetables from a given garden (4.05 µg/g for Garden FLBL) and assumed consumption of 4.88 g of vegetables per kilogram of body Weight per day. This latter quantity is the average quantity of vegetables consumed by a sub-population of Native Americans polled for purposes of developing consumption factors published by EPA (EPA 2007b). Consumption of vegetables at this rate, in conjunction with ingestion of fluoridated water at a concentration of 2.0 ppm leads to a daily dose for a 70 kg adult of 0.077 mg fluoride/kg/day, which is below the safe level of 0.12 mg fluoride/kg/day indicated by EPA.[6,7,8]

PRELIMINARY ASSESSMENT OF RISK TO CATTLE EATING HAY

The State of New York has promulgated regulations for the protection of domestic livestock in the form of forage consumption standards. These standards state that total fluoride concentrations in forage feed for grazing ruminants should not exceed, on a dry weight basis, the following levels (6 NYCRR § 257-8.3):

- **40 ppm** as an average concentration over the growing season (not to exceed six months),
- **60 ppm** for any 60 day period, and
- **80 ppm** for any 30 day period.[9]

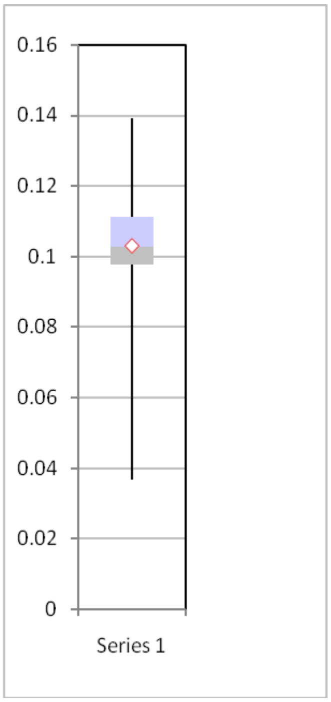
Grass concentrations of fluoride exceeded these thresholds only at site 3A, North of the ALCOA West facility. At this site, average growing season concentrations were elevated above the 40 ppm threshold for monitoring years 2001, 2002, 2005, and 2006. The 60 day average threshold of 60 ppm was surpassed on one occasion in 2001, twice in 2002, twice in 2005, and once in 2006. Finally the 80 ppm threshold for any 30 day period was surpassed once in 2005 and once in 2006. Concentrations measured at all of the other sites did not exceed any of the thresholds indicated.

[6] For purposes of this assessment, we assume a fluoride concentration of 2.0 mg/L, which was the highest observed water concentration measured at each of the gardens. We note, however, that not all garden owners were watering their gardens with the same water used for consumption.

[7] [4.88 g vegetables/kg-day * 4.05 µg fluoride/g vegetables / 1000 µg/g] + [2.0 mg/L water * 2 L water/day / 70 kg] = [0.02 mg/kg-day] + [.057 mg/kg-day] = 0.077 mg/kg-day

[8] We highlight that this is a screening level analysis of risk, and does not consider other routes of exposure to fluoride, such as inhalation, accidental ingestion of toothpaste, or the consumption of other types of food that may contain fluoride.

[9] We note that site-specific data collection by researchers in the late 1970s suggested that cattle within Akwesasne experienced deleterious effects of fluoride exposure even at concentrations below these thresholds considered to be safe (Raloff 1980).



	Series 1
Min	0.0366
25th	0.0978
Median	0.1028
75th	0.1113
Max	0.139
Mean	0.102966
SD	0.014016
Minimum	0.0366
First Quartile	0.0612
Second Quartile	0.005
Third Quartile	0.0085
Fourth Quartile	0.0277
Maximum	0
Fourth Quartile -	0
Third Quartile -	0
Second Quartile -	0
First Quartile -	0
Average	0.102966

EXHIBIT 3-12 Frequency of fluoride concentrations in Ambient Air on Glass Fiber Filters (µg/m^3)

The value of the glass fiber filters range from 0.0366-0.1390 µg/m^3. The standard for fluoride including hydrogen fluoride is 30.0 µg/m^3 for inhalation exposure. (http://oehha.ca.gov/air/chronic_rels/pdf/7664393.pdf). The ACCU system is setup to retrieve particles 2.5 microns or less

1.66	0.70	1.20	3.30
1.12	1.56	0.39	2.57
2.43	2.27	4.15	3.03
1.33	1.36	2.62	1.66
3.41	2.02	1.28	0.92
1.08	2.78	2.87	1.18
0.75	2.76	4.25	1.10
1.05	0.72	0.29	0.81
0.78	0.83	2.77	2.08
1.71	1.19	1.18	1.30

EXHIBIT 3-13 Concentrations of fluoride in White Tail Deer Jaw Bones (PPM)

Exhibit 3-13 shows the actual concentration of Fluoride in the collected White Tail Deer Jaw bones. These amounts, in PPM, according to a paper compiled by Michael Connett in Tsiothorko:wa/January 2004 are not significant to bone fluorosis. The concentration of fluoride in bone that has possible effects is 2,000-4,000 PPM but at levels at and above 4,000 PPM bone fluorosis has been confirmed in humans.

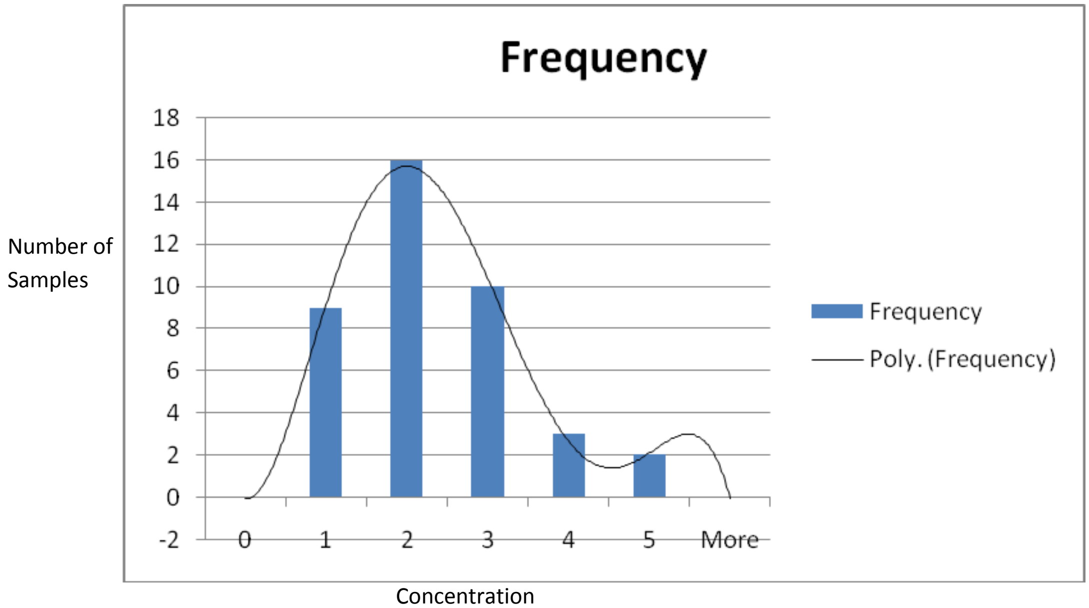


EXHIBIT 3-14 Frequency of fluoride concentrations in White Tail Deer Jaw Bone

Exhibit 3-14 shows the frequency of the different concentrations of the fluoride content found in the deer jaws collected in various areas in and around Akwesasne and the Alcoa East Plant. Of the 40 data points the range runs from 0.29-4.25 ppm with most values fall between 1.00-2.00.

CHAPTER 4 | CONCLUSIONS

Low levels of fluoride contamination in the soils and flora of Akwesasne is still apparent after historical contamination by two ALCOA facilities in the area was first recorded several decades ago. Data collected by the Tribe Environment Division on concentrations of fluoride in vegetables grown in the private gardens of community members indicate that the risk of adverse health effects from fluoride exposure via the consumption of home grown vegetables is likely below the level the U.S. EPA considers to be safe.

Additional yearly monitoring data collected since 2000 as part of a cooperative sampling agreement between ALCOA and the Tribe indicates that a hotspot of fluoride contamination persists north of the ALCOA West plant. Grass samples taken from a yearly monitoring plot in that area exhibited concentrations of fluoride that were elevated above thresholds for the protection of grazing ruminants for the years 2001, 2002, 2005, and 2006. Data from the remaining monitoring sites in and around Akwesasne indicate that hay grass in the area does contain fluoride, but not at levels of concern for use of hay as cattle feed.

Spatial analysis of vegetable data indicates a spatial trend in fluoride contamination. Fluoride contamination decreases with increasing distance from the ALCOA plants. Such a trend supports the assertion that the ALCOA plants may represent the dominant sources of fluoride pollution in the area. The Deer part of the study indicates that the local deer have not been affected by the fluoride pollution that still exists in the Akwesasne area.

REFERENCES

Environment Canada. 1996. The State of Canada's Environment—1996, Long Sault to Beauharnois: the St. Lawrence River restructured. Available online at: http://www.ec.gc.ca/soer-ree/English/soer/1996Report/Doc/1-6-6-5-5-3-1.cfm. Website accessed August 9, 2007.

EPA (U.S. Environmental Protection Agency). 2007a. Integrated Risk Information System (IRIS): Fluorine (soluble Fluoride). Available online at: http://www.epa.gov/iris/subst/0053.htm. Website accessed August 21, 2007.

EPA. 2007b. Exposure Factors Handbook. National Center for Environmental Assessment, Office of Research and Development. Available online at: http://www.epa.gov/ncea/efh/. Website accessed August 23, 2007.

EPA. 2002. Meteorological Data from Massena, New York (1961 – 19990). Available online at: http://www.epa.gov/ceampubl/tools/metdata/ny/. July 2.

Hagler Bailly Services, Inc. 1998. St. Lawrence Environment NRDA – Data Compilation Report. Prepared for the St. Lawrence Environment Trustee Council. August 28, 1988.

Industrial Economics, Incorporated. 2007. Data Report: PCBs in Garden Soils of Akwesasne. Report produced for the Environment Division of the St. Regis Mohawk Tribe. April 5.

Kabata-Pendias, A. and H. Pendias. 2000. Trace Elements in Soils and Plants. CRC Press, Boca Raton, Florida.

Raloff, J. 1980. The St. Regis Syndrome. Science News. The Fluoride Action Network. July 19. Available online at: http://www.fluoridealert.org/pollution/1204.html. Website accessed August 9, 2007.

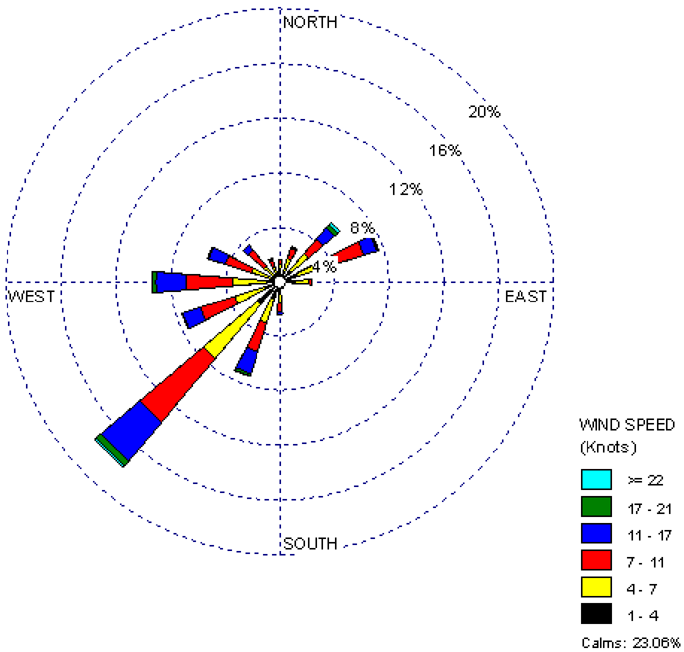
SRMT (St. Regis Mohawk Tribe). 2004. Quality Assurance Project Plan, Fluoride Project and Environmental Contaminants. St. Regis Mohawk Tribe Environment Division. Akwesasne.

WHO (World Health Organization). 2004. Fluoride in Drinking Water. Background Document for Development of WHO *Guidelines for Drinking-water Quality*. WHO Report WHO/SDE/WSH/03.04/96.

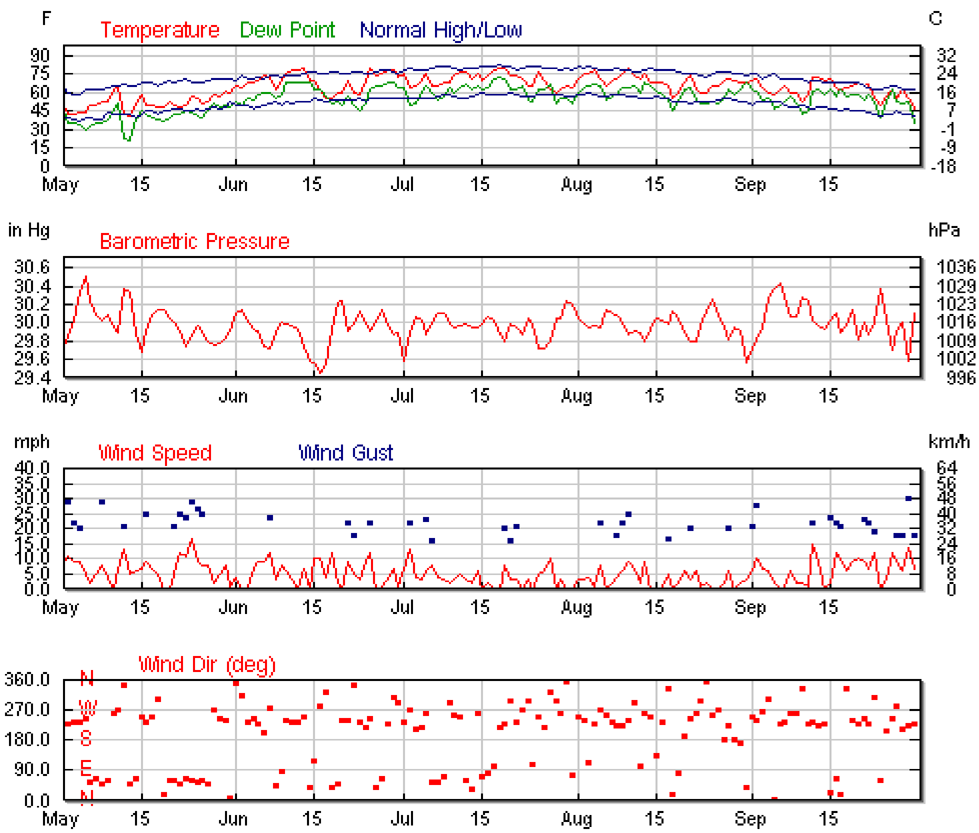
Attachment A: References and Citations

Attachment B: Wind Rose (2007) and Meteorological information for Massena (2005)

Figure



4.1 Wind rose plot showing the 2007 estimated annual wind direction at Massena, NY (44.9°N, 74.9 °W)



Histogram from Onerahtohko:wa/May2005 to Seskehko:wa/September 2005:

Source:

http://www.wunderground.com/history/airport/KMSS/2005/5/1/CustomHistory.html?dayend=30&monthend=9&yearend=2005&req_city=NA&req_state=NA&req_statename=NA