A.R.C.H.
CONSULTING GROUP, LLC

5607 Keystone Place North
Seattle, Washington 98103

(206) 301-8989 – office

www.archconsultants.com

June 6, 2014

Bill Haugen
Aquatic Supervisor
City of Lynnwood
18900 44th Avenue West
Lynnwood, Washington 98046-5008

AIR QUALITY TESTING SUMMARY 2011 – 2014
LYNNWOOD RECREATION CENTER
18900 44th Avenue West, Lynnwood, Washington

Dear Mr. Haugen,

On May 16, 2014, A.R.C.H. Consulting Group, LLC measured the air concentrations of chlorine & chloramine (nitrogen trichloride) in the North and South Natatoriums, known as the Family Pool and Lap Pool, respectively.

Additionally, from May 16 - 20, 2014, indoor air quality (IAQ) testing continuously measured the comfort indicators (carbon dioxide, temperature and percent relative humidity) and carbon monoxide in the Family and Lap pool natatoriums.

PURPOSE: The results of the 2014 testing are directly compared to the testing performed in 2011 and 2012 to determine if the recently installed Family Pool ventilation system is improving the air quality. Identical methods and equipment was used in all testing performed in 2011, 2012, & 2014. All doors in the Family Pool side remained closed throughout the testing. The roof vents on the Lap Pool side were briefly open a few times to reduce the air temperature.

APPENDICES: Appendix 1 – 3 contain all the test results from the 2014 testing.

Appendix 1: Chlorine & Chloramine (Nitrogen Trichloride) Laboratory Results

Appendix 2: North Pool (Family Pool) Indoor Air Quality Results

Appendix 3: South Pool (Lap Pool) Indoor Air Quality Results

FINDINGS: FAMILY POOL

Table 1: Airborne <u>Chlorine</u> Concentration in the North (Family) Pool

All Results in parts per million (ppm)

Year Tested	Morning	Afternoon		Evening	Average Concentration
2014	0.076	0.042		0.051	0.06
2012	--	0.15	0.15	0.16	0.15
2011	0.059	0.24		--	0.21

Table 2: Airborne <u>Chloramine</u> Concentration in the North (Family) Pool

All Results in parts per million (ppm)

Year Tested	Morning	Afternoon		Evening	Average Concentration
2014	<0.009	<0.005			<0.007
2012	--	0.25	0.24	0.31	0.27
2011	0.098	0.38		0.30	0.28

FINDINGS: FAMILY POOL

Figure 1: Lynnwood Rec Center - Family Pool

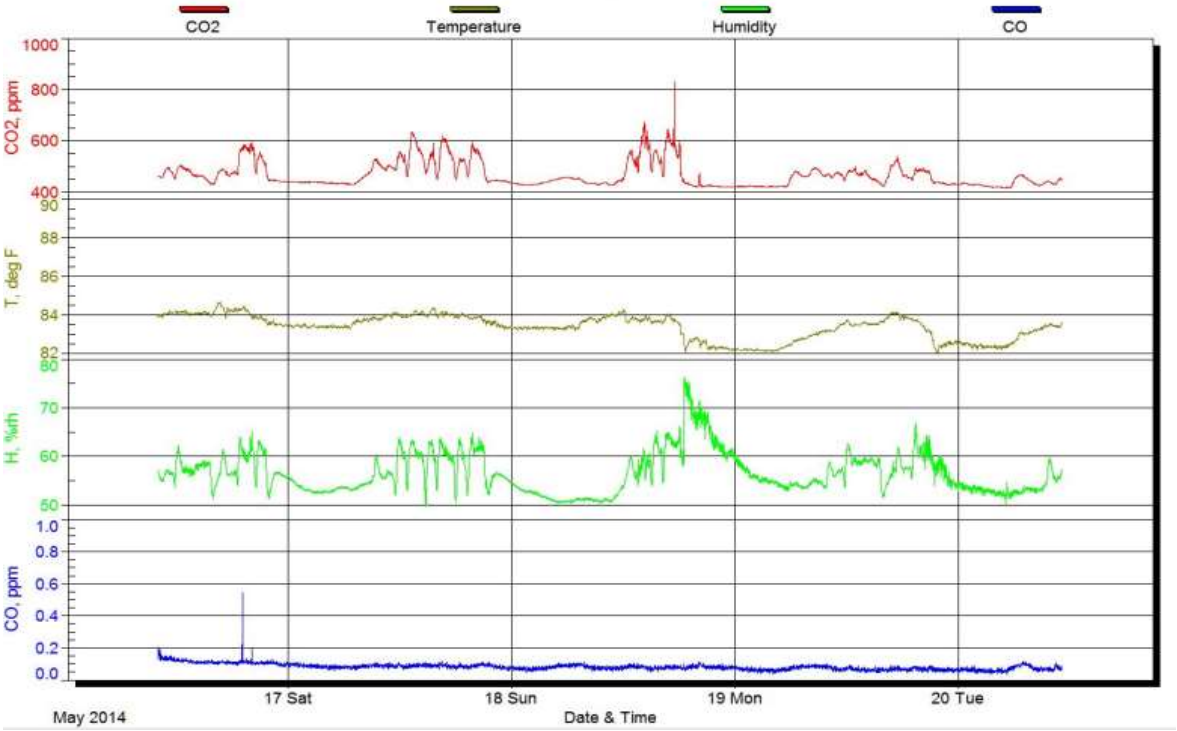
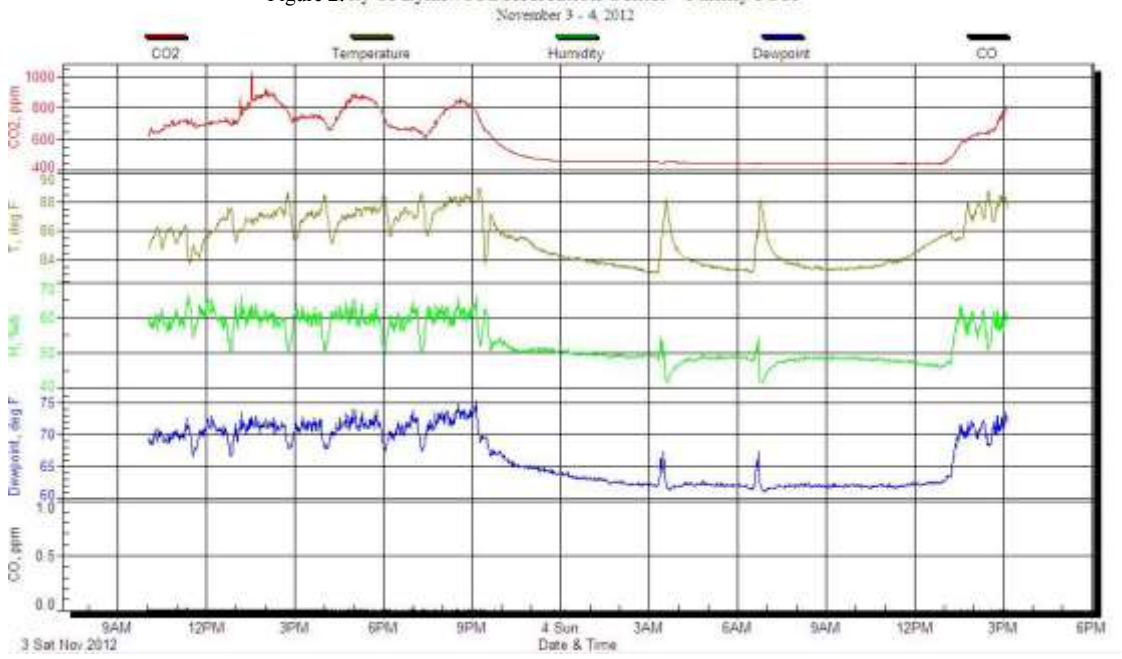
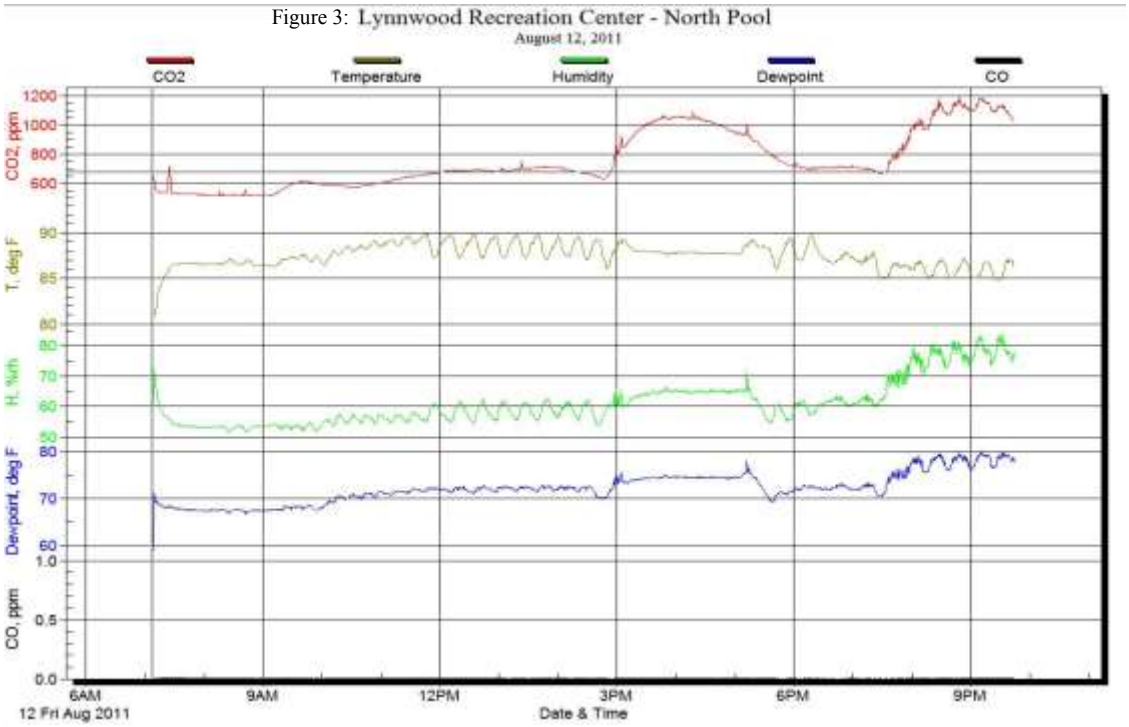


Figure 2: City of Lynnwood Recreation Center - Family Pool



FINDINGS: FAMILY POOL

Figure 3: Lynnwood Recreation Center - North Pool



Family Pool

FINDINGS: FAMILY POOL

Table 3: Chlorine: 15-Minute Air Sample Results

Family Pool

(Ceiling Exposures)

Location	2012 Results	2014 Results
Family Pool	0.27 ppm (11/3/12 at 2:45 pm)	<0.2 ppm (5/16/14 at 2:15 pm)
Family Pool	0.44 ppm (11/3/12 at 5:30 pm)	<0.2 ppm (5/16/14 at 5:45 pm)
Family Pool	0.50 ppm (11/3/12 at 6:00 pm)	<0.2 ppm (5/16/14 at 6:00 pm)
Family Pool	0.73 ppm (11/3/12 at 8:30)	<0.2 ppm (5/16/14 at 8:15 pm)
Family Pool	0.24 ppm (11/4/12 at 3:00 pm)	--
Lap Pool	<0.20 ppm (11/3/12 at 5:45 pm)	<0.2 ppm (5/16/14 at 6:00 pm)
Lap Pool	<0.20 ppm (11/3/12 at 8:30 pm)	<0.2 ppm (5/16/14 at 8:45 pm)

<0.2 ppm indicates no chlorine was detected

FINDINGS: LAP POOL

Table 4: Airborne Chlorine Concentration South (Lap) Pool

All Results in parts per million (ppm)

	Morning	Afternoon	Evening	Average Concentration
2014	0.042	0.023	0.029	0.03
2012	--	--	--	--
2011	0.05	0.06	0.10	0.07

Table 5: Airborne Chloramine Concentration South (Lap) Pool

All Results in parts per million (ppm)

Year Tested	Morning	Afternoon	Evening	Average Concentration
2014	<0.02	<0.01	--	<0.01
2012	--	--	--	--
2011	0.077	--	0.10	0.09

There was almost no odor in the Lap Pool Natatorium so the level of chloramine would be expected to be lower than the Family Pool side, but early air sampling pump shutoff caused the lowest level of detection to be only <0.02 ppm.

FINDINGS: LAP POOL

Figure 4: City of Lynnwood Rec Center - Lap Pool
May 16 - 20, 2014

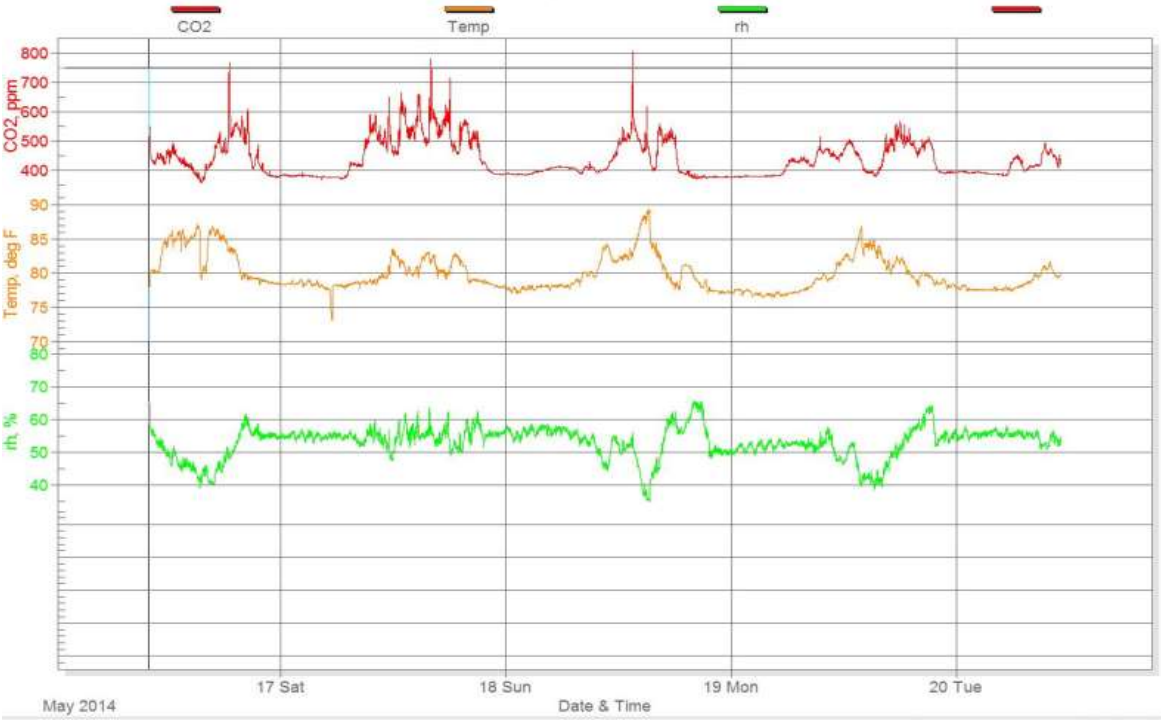
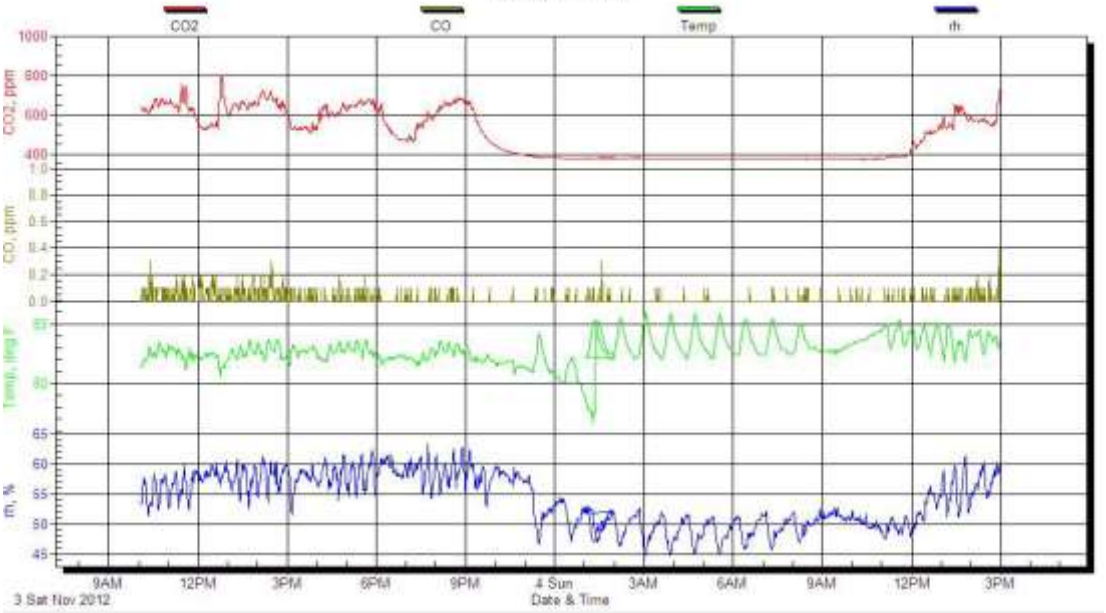
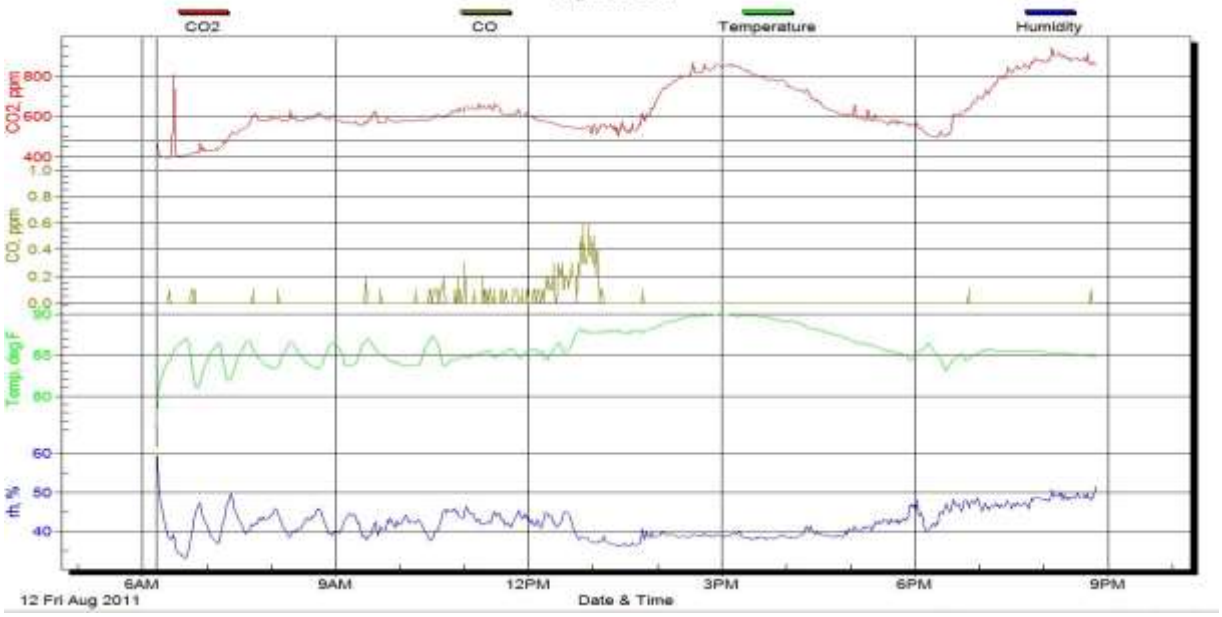


Figure 5: City of Lynnwood Recreation Center - lap Pool
November 3 - 4, 2012



FINDINGS: LAP POOL

Figure 6: Lynnwood Recreation Center - South Lap Pool



Lap Pool

CONCLUSIONS:

1. **Family Pool**

   a. **Chlorine**: Table 1 shows a reduction from 0.21 ppm in 2011 to 0.06 ppm in 2014. The airborne chlorine level has been reduced 2.5 to 3.5 times from previous measurements. A chlorine concentration of 0.06 ppm throughout the day is over 8 times lower than the Washington State Permissible Exposure Limit (PEL) for chlorine and 0.06 ppm is over 16 times lower than the permissible ceiling limit for chlorine.

      i. **Short-Term Chlorine Exposures:** Table 3 on page 5 shows the 15-minute short-term exposures to chlorine were all less than 0.2 ppm (the lowest level of detection for the method used). This 2014 measured chlorine level is significantly lower than the 2012 levels that ranged from 0.27 to 0.73 ppm.

   b. Chloramine: Chloramine is the main cause of irritation near an indoor pool; chloramine levels above 0.3 ppm can cause irritation. Table 2 shows that no chloramine was detected in any of the air samples. Chloramine if present was at levels less than an average of 0.007 ppm (<0.007 ppm). This is a large reduction, about 50 times lower, from 2012 and 2011 when the chloramine levels averaged 0.28 ppm.

   c. **Carbon Dioxide (CO2):** The carbon dioxide measurements, Figures 1 – 3, are an indirect measurement of the amount of outside (fresh) air. Maintaining CO2 levels below 1,000 ppm inside a building prevents a buildup of odors and air contaminants, prevents the air from feeling "stuffy" and prevents the occupants from feeling fatigued.

      The Co2 levels in 2014 remained below 700 ppm during occupied times, most of the time below 600 ppm, a normal level of CO2 inside a building. In 2011, CO2 levels exceeded 1,000 ppm and in 2012 levels ranged from 800 to 900 ppm.

   d. Temperature & Humidity: The air temperatures remained very steady during occupied times and the humidity hovered around 60% at the poolside. The slight peaks of humidity and CO2 on Sunday were most likely due to people sitting too close or being too curious about the instrument.

CONCLUSIONS: (continued)

2. **Lap Pool**

   a. **Chlorine:** The airborne chlorine levels in the Lap Pool remained at approximately 0.03 ppm slightly lower that the levels measured in 2011. An average concentration of 0.03 ppm of chlorine is most likely the normal level alongside a chlorinated indoor pool.

   b. **Chloramine:** No Chloramine was detected in 2014 air sampling down to levels of 0.02 ppm (<0.02 ppm). Hardly any odor was noticeable in the Lap Pool Natatorium so the level of chloramine was most likely much lower than the Family Pool but due to pump failure the lowest level of detection was only <0.02 ppm. The average level measured in 2011 was 0.09 ppm.

   c. **Carbon Dioxide (CO2):** The CO2 levels in 2014 hovered around 600 ppm, never exceeding 700 ppm, an indication of sufficient amounts of outside air. The sharp peaks seen throughout occupied times were due to people getting to close and breathing on the sensor. CO2 levels in 2011 & 2012 were slightly higher.

   d. **Temperature & Humidity:** The air temperatures in the Lap Pool were more variable due to the sun shining on the south side of the building. Occasionally, the ceiling vents were open for short periods to reduce the air temperature in the Lap Pool. The humidity remained fairly constant at 60%

Conclusion Summary:

Multiple air samples for chlorine, chloramine and carbon dioxide repeatedly shows that the new ventilation system in the Family Pool significantly reduces the air contaminants, especially chloramine, to levels that do not cause people irritation when sitting alongside the pool.

The ventilation system is also maintaining a comfortable environment supplying adequate amounts of outside air and circulating the air so people do not feel “stuffy” or lethargic.

Thank you very much for allowing A.R.C.H. Consulting Group the opportunity to perform this work. Please call if you need clarification or more details.

A.R.C.H. Consulting Group is owned and operated by Certified Industrial Hygienists who can assist in any health and safety concern you have. We specialize in evaluating your workers exposures to air contaminants, measuring personal noise exposures and performing sound level surveys, indoor air quality assessments and investigations, mold assessments and mold abatement protocols, and safety & hazard evaluations.

Please call me in the office at (206) 301-8989, on my cell phone at (206) 618-3088, or email at frank@archconsultants.com if you have any questions or concerns.

Sincerely,

Frank Riordan
Certified Industrial Hygienist

APPENDIX 1

2014 RESULTS

CHLORINE & CHLORAMINE (NITROGREN TRICHLORIDE)

AIR SAMPLE RESULTS

Mr. Frank Riordan
A.R.C.H. Consulting Group
5607 Keystone Place North
Suite B
Seattle, WA 98103

May 28, 2014

DOH ELAP #11626
AIHA-LAP #100324

Account# 14670

Login# L318983

Dear Mr. Riordan:

Enclosed are the analytical results for the samples received by our laboratory on May 20, 2014. All test results meet the quality control requirements of AIHA-LAP and NELAC unless otherwise stated in this report. All samples on the chain of custody were received in good condition unless otherwise noted.

Results in this report are based on the sampling data provided by the client and refer only to the samples as they were received at the laboratory. Unless otherwise requested, all samples will be discarded 14 days from the date of this report, with the exception of IOMs, which will be cleaned and disposed of after seven calendar days.

Current Scopes of Accreditation can be viewed at www.galsonlabs.com in the accreditations section under the "about Galson" tab.

Please contact Heidi Fruhlinger at (888) 432-5227, if you would like any additional information regarding this report.

Thank you for using Galson Laboratories.

Sincerely,

Galson Laboratories

Mary G Unangst

Mary G. Unangst
Laboratory Director

Enclosure(s)

GALSON LABORATORIES

6601 Kirkville Road
East Syracuse, NY 13057
(315) 432-5227
FAX: (315) 437-0571
www.galsonlabs.com

LABORATORY ANALYSIS REPORT

Client : A.R.C.H. Consulting Group
Site : Lynnwood Rec Center
Project No. : 2014-1732

Date Sampled : 16-MAY-14
Date Received : 20-MAY-14
Date Analyzed : 23-MAY-14
Report ID : 833144

Account No.: 14670
Login No. : L318983

Chlorine

Sample ID	Lab ID	Air Vol liter	Total ug	Conc mg/m3	ppm
#1-N-9-1	L318983-1	124	27	0.22	0.076
#3-S-9-1	L318983-3	270	19	0.070	0.024
#5-N-2-6	L318983-5	200	24	0.12	0.042
#7-S-2-6	L318983-7	152	10	0.066	0.023
#9-N-5-9	L318983-9	185	27	0.15	0.051
#10-S-5-9	L318983-10	180	15	0.085	0.029

COMMENTS: Please see attached lab footnote report for any applicable footnotes.

Level of quantitation: 5 ug
Analytical Method : mod. NIOSH 6011; IC
OSHA PEL : 1 ppm CEIL
Collection Media : 225-9006

Submitted by: tmk
Approved by : nkp
Date : 27-MAY-14 NYS DOH # : 11626
QC by: Tom Burgess

< -Less Than
> -Greater Than
NA -Not Applicable
mg -Milligrams
ug -Micrograms
ND -Not Detected
m3 -Cubic Meters
l -Liters
ppm -Parts per Million
kg -Kilograms
NS -Not Specified

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LABORATORY ANALYSIS REPORT

Client : A.R.C.H. Consulting Group
Site : Lynnwood Rec Center
Project No. : 2014-1732

Date Sampled : 16-MAY-14
Date Received : 20-MAY-14
Date Analyzed : 23-MAY-14
Report ID : 833336

Account No.: 14670
Login No. : L318983

Nitrogen Trichloride

	Sample ID	Lab ID	Air Vol liter	Front ug	Back ug	Total ug	Conc mg/m3	ppm
#	#2-N-9-1	L318983-2	132	<6	<6	<6	<0.05	<0.009
	#4-S-9-1	L318983-4	62	<6	<6	<6	<0.1	<0.02
	#6-N-2-9	L318983-6	265	<6	<6	<6	<0.02	<0.005
#	#8-S-2-9	L318983-8	124.8	<6	<6	<6	<0.05	<0.01

COMMENTS: Please see attached lab footnote report for any applicable footnotes.

Level of quantitation: 6 ug
Analytical Method : In-house: II-NCL3; IC
OSHA PEL : NA
Collection Media : MNCL3

Submitted by: tmk
Approved by : tlh
Date : 28-MAY-14 NYS DOH # : 11626
QC by: Tom Burgess

< -Less Than
> -Greater Than
NA -Not Applicable
mg -Milligrams
ug -Micrograms
ND -Not Detected
m3 -Cubic Meters
l -Liters
ppm -Parts per Million
kg -Kilograms
NS -Not Specified

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East Syracuse, NY 13057
(315) 432-5227
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www.galsonlabs.com

LABORATORY FOOTNOTE REPORT

Client Name : A.R.C.H. Consulting Group
Site : Lynnwood Rec Center
Project No. : 2014-1732

Date Sampled : 16-MAY-14
Date Received: 20-MAY-14
Date Analyzed: 23-MAY-14

Account No.: 14670
Login No. : L318983

Unless otherwise noted below, all quality control results associated with the samples were within established control limits or did not impact reported results.

Unrounded results are carried through the calculations that yield the final result and the final result is rounded to the number of significant figures appropriate to the accuracy of the analytical method. Please note that results appearing in the columns preceeding the final result column may have been rounded in order to fit the report format and therefore, if carried through the calculations, may not yield an identical final result to the one reported.

The stated LOQs for each analyte represent the demonstrated LOQ concentrations prior to correction for desorption efficiency (if applicable).

Unless otherwise noted below, reported results have not been blank corrected for any field blank or method blank.

L318983 (Report ID: 833344):
SOPs: ii-n6011(10)
When air volumes are supplied, Chlorine is quantitated as Cl2 in the ppm calculation.

Accuracy and mean recovery data presented below is based on a 95% confidence interval (k=2). The estimated uncertainty applies to the media, technology, and SOP referenced in this report and does not account for the uncertainty associated with the sampling process.

Parameter	Accuracy	Mean Recovery
Chlorine	+/-6%	101%

L318983 (Report ID: 833336):
SOPs: ii-ncl3(5)

\# L318983 (Report ID: 833336):
Cassette received without an inlet nib. Impact on sample result is unknown.

Accuracy and mean recovery data presented below is based on a 95% confidence interval (k=2). The estimated uncertainty applies to the media, technology, and SOP referenced in this report and does not account for the uncertainty associated with the sampling process.

Parameter	Accuracy	Mean Recovery
Nitrogen Trichloride	+/-16.2%	99.9%

< -Less Than	mg -Milligrams	m3 -Cubic Meters	kg -Kilograms
> -Greater Than	ug -Micrograms	l -Liters	NS -Not Specified
NA -Not Applicable	ND -Not Detected	ppm -Parts per Million	

GALSON LABORATORIES

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East Syracuse, NY 13057
Tel: (315) 432-5227
888-432-LABS (5227)
Fax: (315) 437-0571
www.galsonlabs.com

302985

☐ New Client?

Client Account No.*: 14670

Report To*: Frank Riordan
ARCH Consulting Group, LLC
5607 Keystone Pl N
Seattle, WA 98103
Phone No.*: 206-301-8989
Cell No.: 206-618-3088
Email Results to: Frank
Email address: Frank@archconsultants.com

Invoice To*:
Phone No.:
Email:
P.O. No.:
Credit Card: ☐ Card on File ☐ Call for Credit Card Info.

120

☐ Samples submitted using the FreePumpLoan™ Program ☐ Samples submitted using the FreeSamplingBadges™ Program

Need Results By:	(surcharge)
☒ 5 Business Days	0%
☐ 4 Business Days	35%
☐ 3 Business Days	50%
☐ 2 Business Days	75%
☐ Next Day by 6pm	100%
☐ Next Day by Noon	150%
☐ Same Day	200%

Site Name: Lynnwood Rec Center Project: 2014-1732 Sampled by: Frank Riordan

Comments:

List description of industry or Process/interferences present in sampling area:

State samples were collected in (e.g., NY): WA

Please indicate which OEL this data will be used for:
☑ OSHA PEL ☐ ACGIH TLV ☐ Cal OSHA
☐ MSHA ☐ Other (specify):

Sample Identification* (Maximum of 20 characters)	Date Sampled	Collection Medium	Sample Volume Sample Time Sample Area*	Sample Units^: L, ml,min,in2,cm2,ft2	Analysis Requested*	Method Reference^	Hexavalent Chromium Process (e.g., welding plating, painting, etc.)*
#1-N-9-1	05/16/14	Washed Silver membrane	124	L	Chlorine	NIOSH 6011	
#2-N-9-1	05/16/14	Treated Quartz Filter	132	L	Nitrogen Trichloride (Chloramine)	II NCL-III	
#3-S-9-1	05/16/14	Washed Silver membrane	270	L	Chlorine	NIOSH 6011	
#4-S-9-1	05/16/14	Treated Quartz Filter	62	L	Nitrogen Trichloride (Chloramine)	II NCL-III	
#5-N-2-6	05/16/14	Washed Silver membrane	200	L	Chlorine	NIOSH 6011	
#6-N-2-9	05/16/14	Treated Quartz Filter	265	L	Nitrogen Trichloride (Chloramine)	II NCL-III	
#7-S-2-6	05/16/14	Washed Silver membrane	152	L	Chlorine	NIOSH 6011	
#8-S-2-9	05/16/14	Treated Quartz Filter	124.8	L	Nitrogen Trichloride (Chloramine)	II NCL-III	
#9-N-5-9	05/16/14	Washed Silver membrane	185	L	Chlorine	NIOSH 6011	
#10-S-5-9	05/16/14	Washed Silver membrane	180	L	Chlorine	NIOSH 6011	

Samples Received in Light Sensitive Material: (Yes) or No

^Galson Laboratories will subsititute our routine/preferred method if it does not match the method listed on the COC unless this box is checked: ☐ Use method(s) listed on COC

For metals analysis: if requesting an analyte with the option of a lower LOQ, please indicate if the lower LOQ is required (only available for certain analytes - see SAG):

For crystalline silica: form(s) of silica needed must be indicated (Quartz, Cristobalite, and/or Tridymite)*:

Chain of Custody	Print Name	Signature	Date/Time
Relinquished by:	Frank Riordan		5/19/14
Received by LAB:	Michelle Krause	Michelle Krause	5/20/14 1054

Samples received after 3pm will be considered as next day's business
* Required fields, failure to complete these fields may result in a delay in your samples being processed.

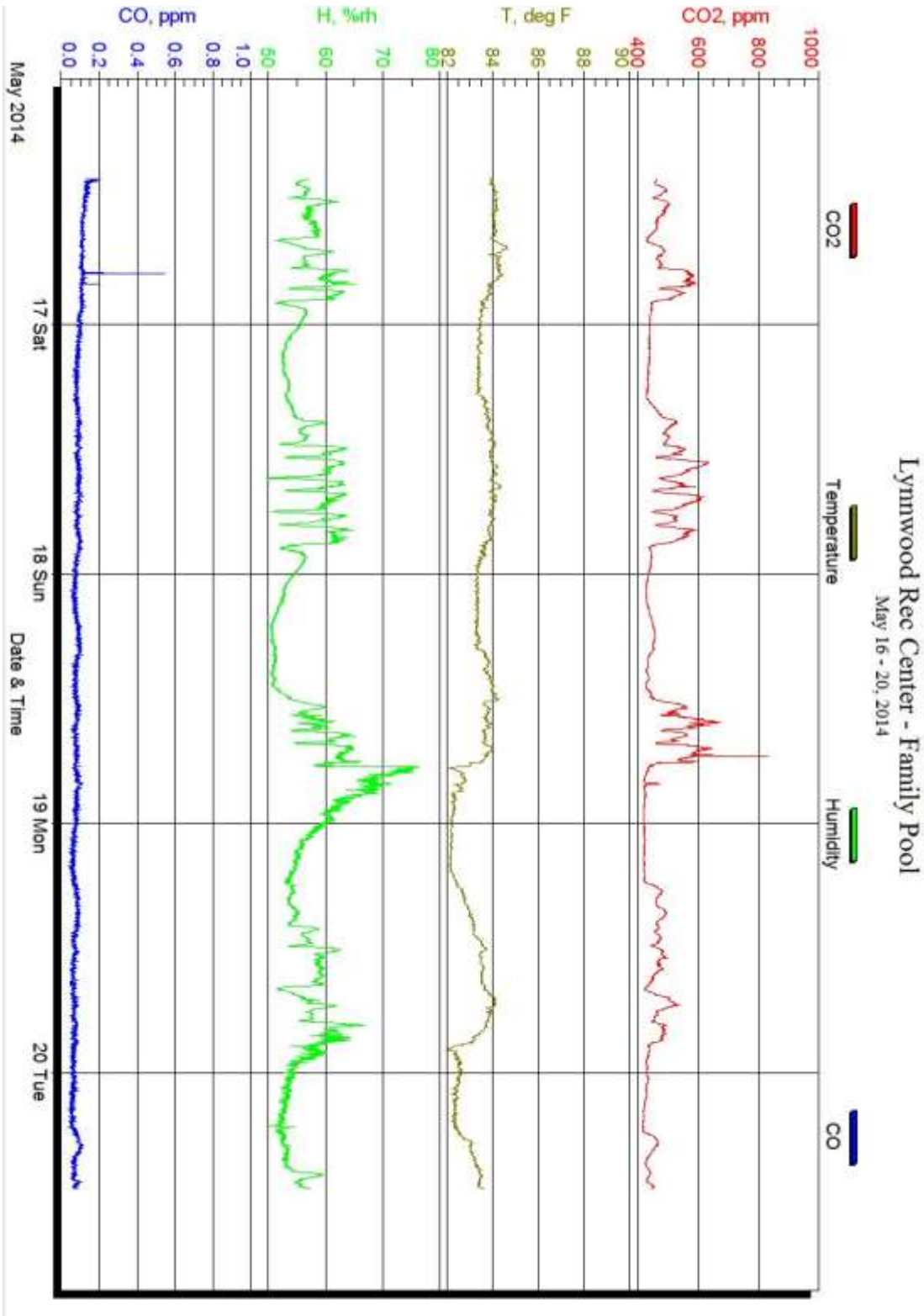
A.R.C.H.
CONSULTING GROUP, LLC

APPENDIX 2

2014 RESULTS

NORTH POOL (FAMILY POOL) INDOOR AIR QUALITY RESULTS

ARCH
CONSULTING GROUP, LLC



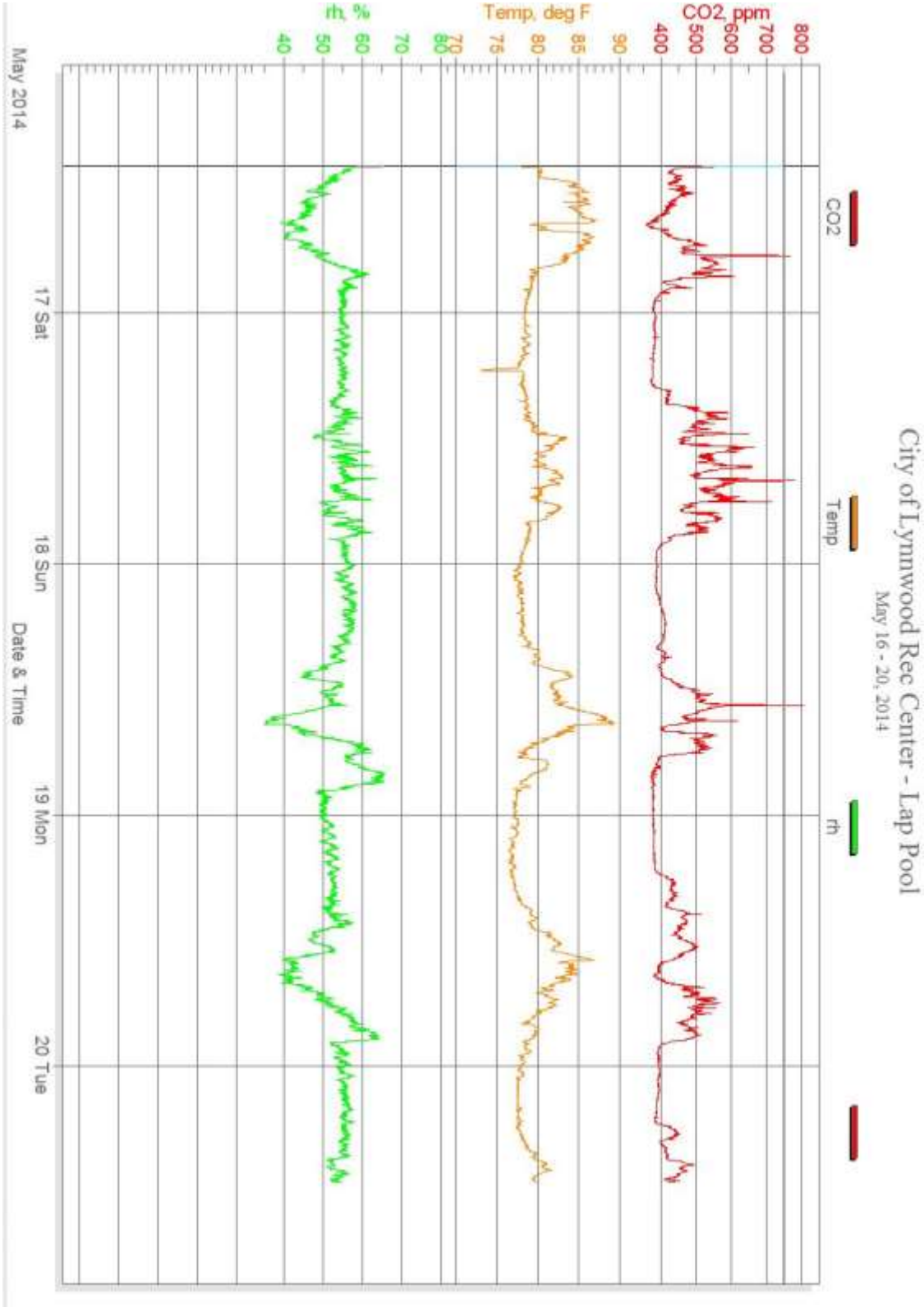
Graph Statistics

Statistics				
	CO2	T	H	CO
Avg	466 ppm	83.4 deg F	56.5 %rh	0.1 ppm
Max	831 ppm	84.7 deg F	76.3 %rh	0.5 ppm
Max Date	05/18/2014	05/16/2014	05/18/2014	05/16/2014
Max Time	17:31:31	16:38:44	18:36:30	19:03:44
Min	415 ppm	82.0 deg F	49.6 %rh	0.0 ppm
Min Date	05/20/2014	05/19/2014	05/17/2014	05/20/2014
Min Time	05:09:21	21:49:23	14:46:38	05:14:21
TWA (8 hr)	471			0.1
TWA Start Date	05/16/2014			05/16/2014
TWA Start Time	09:45:46			09:45:46
TWA End Time	11:12:19			11:12:19

APPENDIX 3

2014 RESULTS

SOUTH POOL (LAP POOL) INDOOR AIR QUALITY RESULTS


City of Lynnwood Rec Center - Lap Pool
May 16 - 20, 2014
rh, %
Temp, deg F
CO2, ppm
40
50
60
70
80
70
75
80
85
90
400
500
600
700
800
May 2014
17 Sat
18 Sun
19 Mon
20 Tue
Date & Time
CO2
Temp
rh

Graph Statistics

Statistics			
	CO2	Temp	rh
Avg	438 ppm	79.9 deg F	53.0 %
Max	808 ppm	89.4 deg F	65.7 %
Max Date	05/18/2014	05/18/2014	05/18/2014
Max Time	13:30:45	15:15:45	20:04:45
Min	359 ppm	70.2 deg F	35.1 %
Min Date	05/16/2014	05/16/2014	05/18/2014
Min Time	15:30:45	09:54:45	15:15:45
TWA (8 hr)	435		
TWA Start Date	05/16/2014		
TWA Start Time	09:52:45		
TWA End Time	11:07:45		