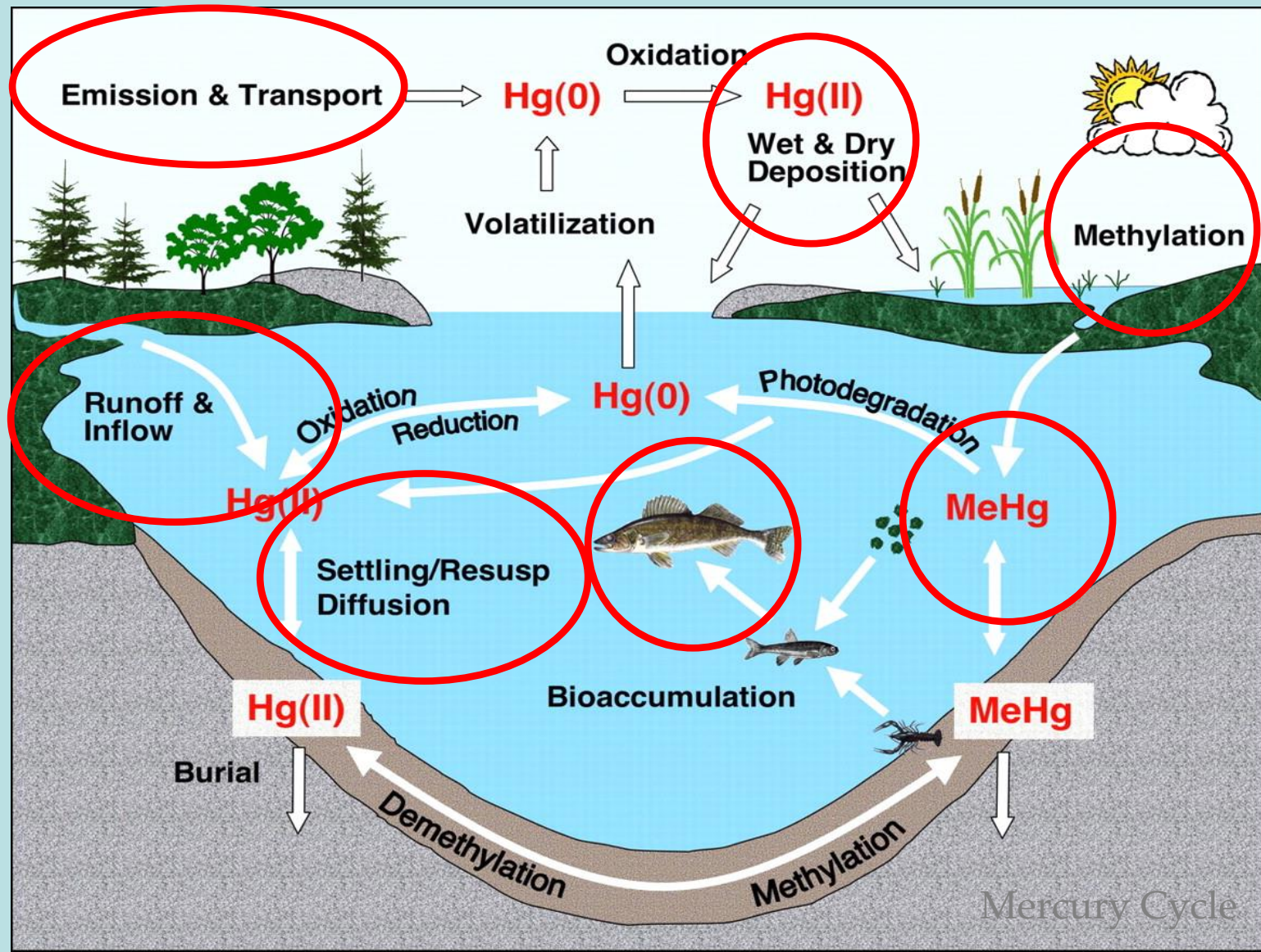
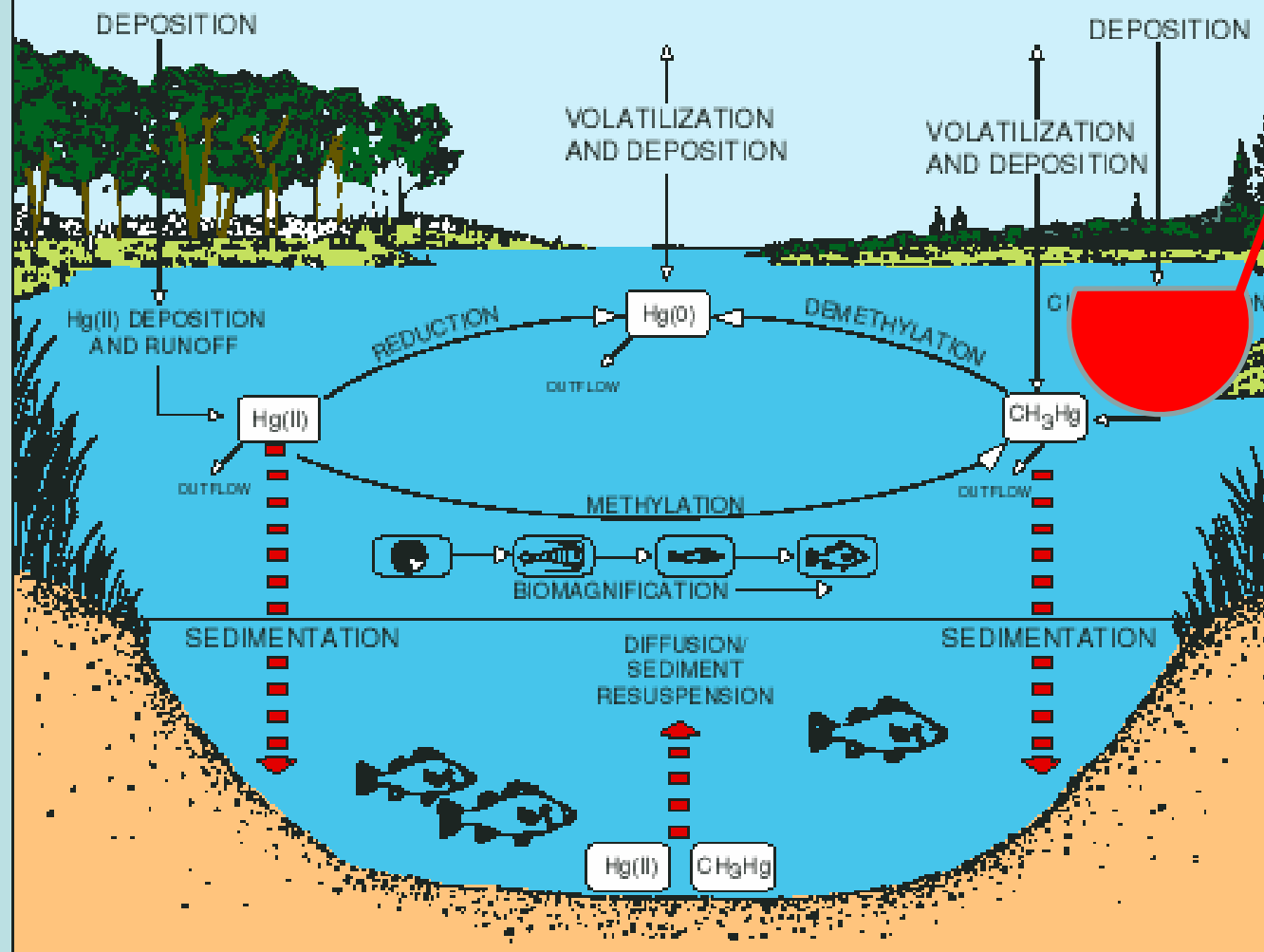


Measurement of Mercury Wet Deposition

What Can Be Measured?



AQUATIC MERCURY CYCLE



Wet
deposition
Mercury
sample

Concentration

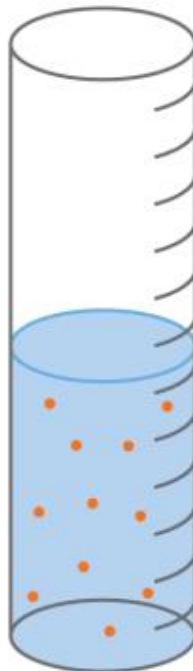
Mass of pollutants per unit volume of water collected (milligrams/liter, nanograms/liter)

Deposition

Mass of pollutant that falls on a fixed unit of area for a unit of time (a flux, kilograms/m² year)

$$\text{CONCENTRATION} \times \text{PRECIPITATION} = \text{WET DEPOSITION}$$

Concentration
2 mg/L



X

Precipitation
35.4 inches per year
(Over a one square meter area,
that is 9 liters per year)



= Deposition

18 mg/m² per year or 1.8 kg/m²
(18 million mg/hectare per year or 18 kg/ha)

1 meter

1 meter



Mercury Deposition Network (MDN)



Collects one-week precipitation-only samples with MDN wet-dry collector



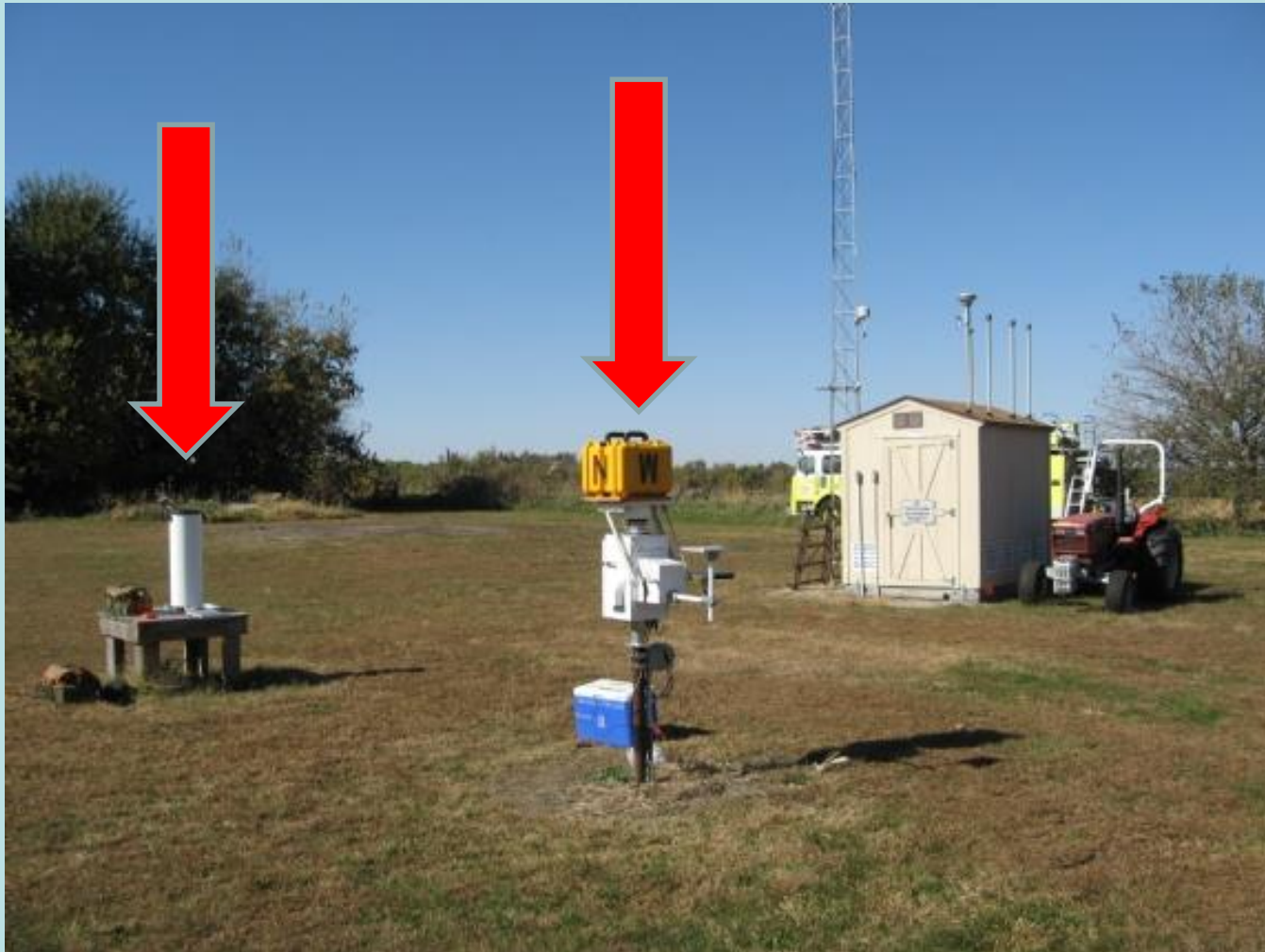
Measures precipitation with gage



- Two independent measurements**
- **Concentration w/ sampler**
 - **Depth of precipitation w/ gage**



Typical Wet Deposition Site (MDN)

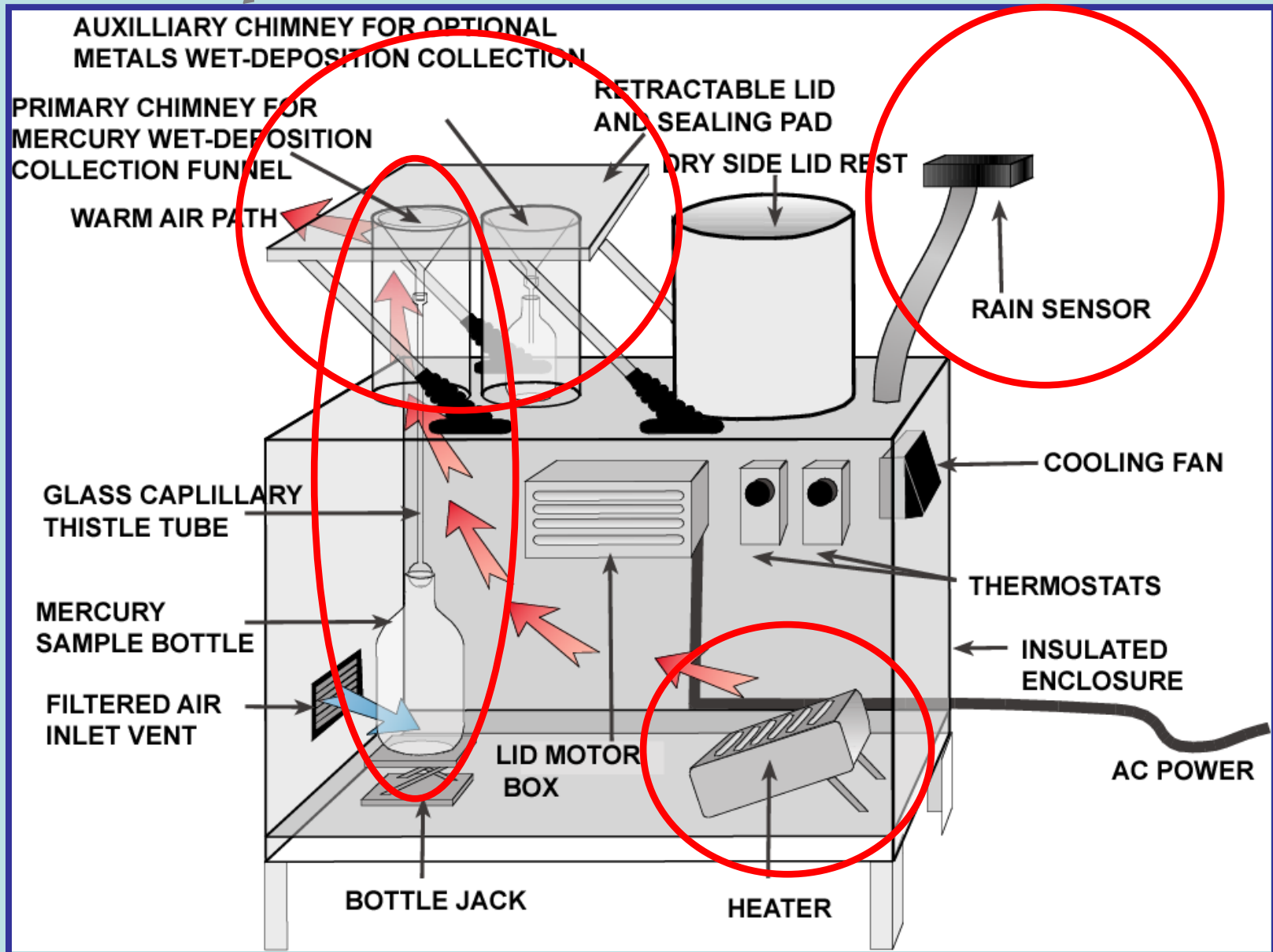




Equipment At Bondville



Wet Deposition Collection



NADP MDN Operations Manual, 2013-02
Version 2.1

Mercury Deposition Network Site Operations Manual



National Atmospheric Deposition Program

Printed SOP to
every Site

Samples are Collected in Four Steps

- Fill out paperwork
- Collect Sample First
- Clean sampler
- Install clean glassware

Field Form

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
A Cooperative Research Program
State Air Pollution Control Agencies (NADP-3)
Federal and State Agencies
and Private Research Organizations

MDN OBSERVER FORM

Send Completed Form With Each Shipping Cooler
Problem? Call the HAL toll free at 1-877-621-6960

1. STATION
Name **Program Office Site 01**
ID **P 0 0 1**

2. OBSERVER
Print name **N.S. Liaison**
ID **N S L**

3. BOTTLE
Sample ID **M D N 0 3 1**
Date **1 2 0 2 0 8**
Time **1 2 0 9 0 8**

4. ANALYSIS TYPE
Total Mercury ☒
Methyl Mercury ☐

5. OBSERVATIONS Check yes or no if samples following: Describe all observations.
YES NO
1. Bird droppings ☒ ☐
2. Cloudy or discolored ☒ ☐
3. Soot/tail/dirt/smudges ☒ ☐

7. PRECIPITATION RECORD
Type: MON TUE WED THU FRI SAT SUN MON TUE WED
Circle one: R S M U R S M U R S M U R S M U R S M U R S M U
Inches:
or one:
Z T MM Z T MM Z T MM Z T MM Z T MM Z T MM Z T MM
Z - Zero T - Trace MM - Missing
Total Precipitation: **0.0**

9. ENCLOSURE TEMPERATURE
MAXIMUM **3** °F
MINIMUM **4** °F

10. REMARKS For example: equipment malfunction, contamination, farming, burning, logging, leakage, etc.
Temperature below 20°F, sensor is not heating.
Tree 25m NE of collector removed.
Pile of treated lumber railroad ties 60m S of collector removed.
Liquid in overflow dish, but sample bottle not full. No cracks in sample bottle or sample train.

11. SUPPLIES
Circle 1 needed, until rechecked.
Gloves ☐
Field Forms ☐
Rain Gauge Charts ☐
Sample Bottle ☐
Rain Gauge Ink ☐
Dry Side Bag ☐
Lid Seal Pad ☐
ACM Air Filter ☐
Mill-O Water ☐

HAL Use Only
Preserve ☐
HCL ☐
BrCl ☐
Compos ☐
Split ☐
Split Bot ☐

WHITE - Program Office Copy YELLOW - HAL Copy PINK - Site Operator Copy

Printed in color-coded Triplicate

- One kept by site
- One for lab (stays with bottle)
- One that stays with data (Program Office)



Completing MOF.

Samples are Collected in Four Steps

- Fill out paperwork
- Collect Sample First
- Clean sampler
- Install clean glassware

Onsite Activities

Table 3 Responsibilities of the Site Operator

Activity	Frequency
Inspect site and equipment	Weekly*
Verify sensor operation	Weekly*
Collect and process sample	Weekly*
Collect and process raingage data	Weekly*
Complete MOF	Weekly*
Ship sample and MOF to the HAL	Weekly*
Change dry side bucket bag	Weekly*
Maintain/stir anti-freeze solution in raingage	Weekly*, when winterized
Troubleshoot equipment	As needed
Equipment repairs and maintenance	As needed
Replace/upgrade equipment	As needed
Replace collector lid seal	Annually
Winterize/Summerize equipment	Annually (location dependent)
Participate in External Site Performance and Systems Survey	Once every 3-4 years

* Every Tuesday morning.

Samples
arrive on site



- Fill out paperwork



Completing MOF.

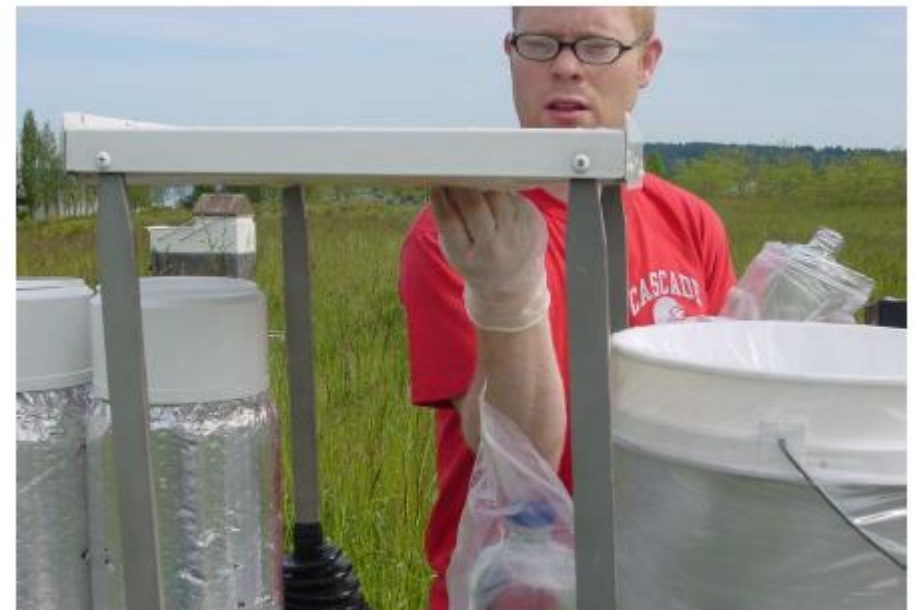
- Remove the weekly sample



- Clean the Sampler



Wiping down chimneys.



- Replace with New Glassware and finish paperwork.



Placing new sample bottle in overflow dish.



Completing MOF.

Ship the Sample to the Laboratory

Ground shipping

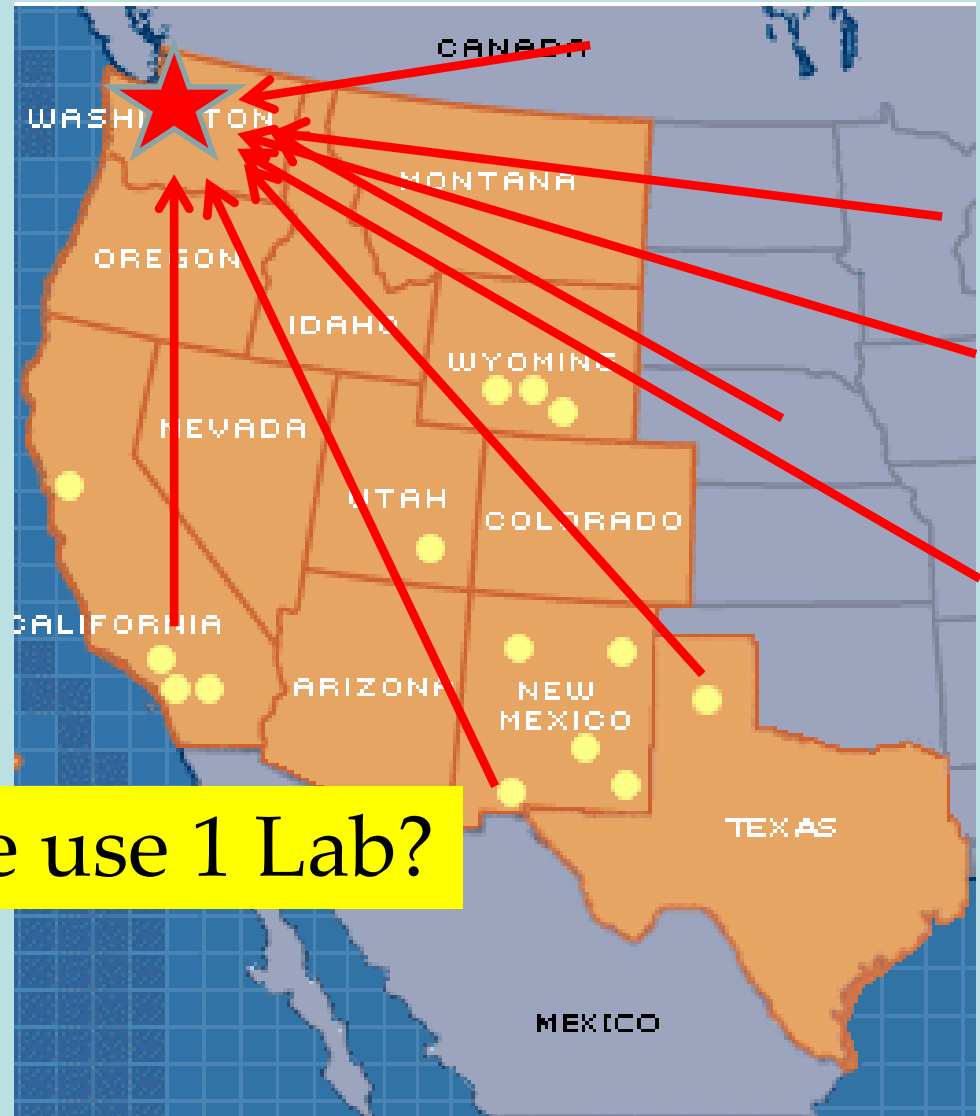
3-4 days



One Laboratory for All Samples

Eurofins Frontier Geosciences
Seattle Washington, USA

Why do we use 1 Lab?







CAUTION: BIOHAZARD
SINK IS FOR MDN USE ONLY
(Due to low level requirements)

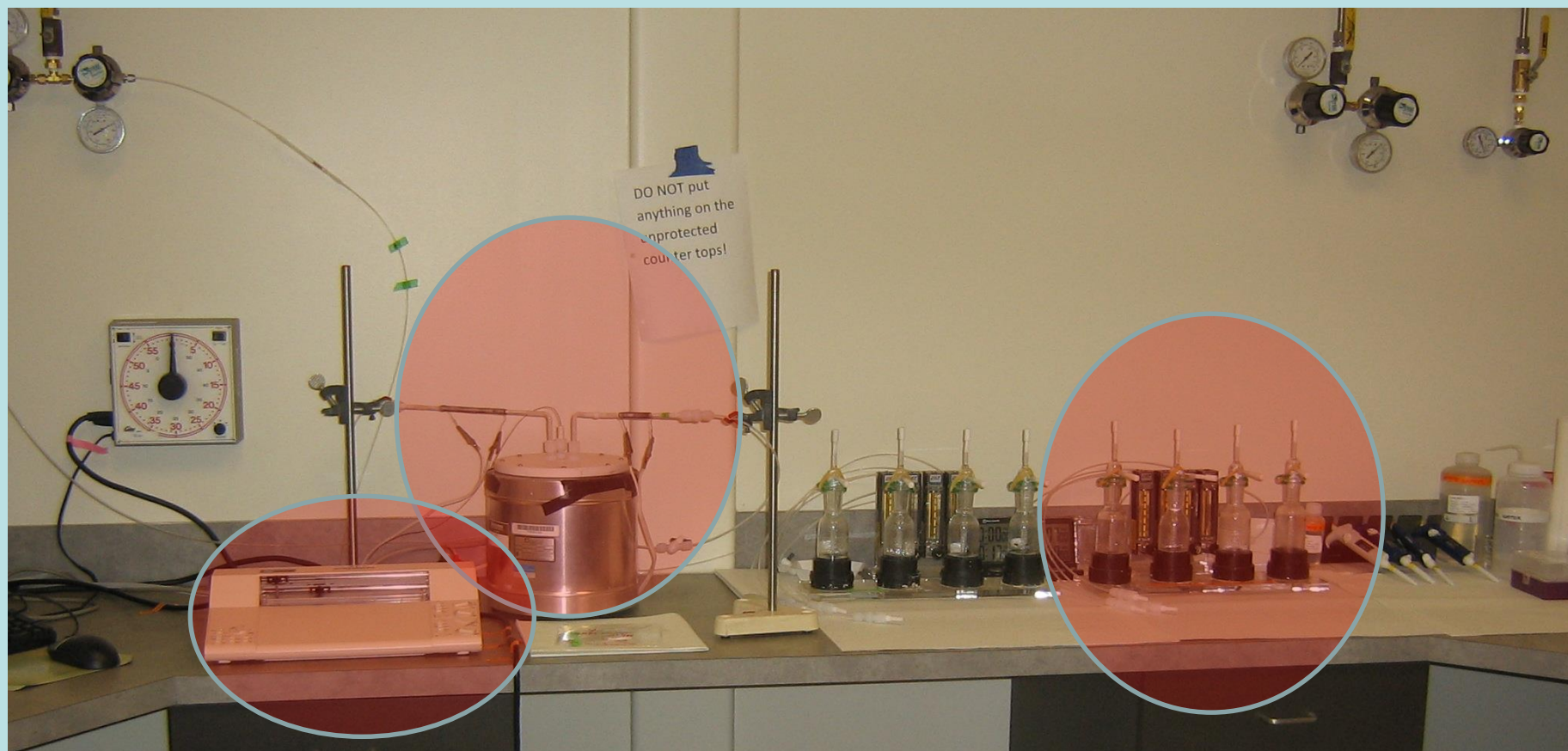
SINK IS FOR MDN
USE ONLY
(Due to low level
requirements)



LARGE

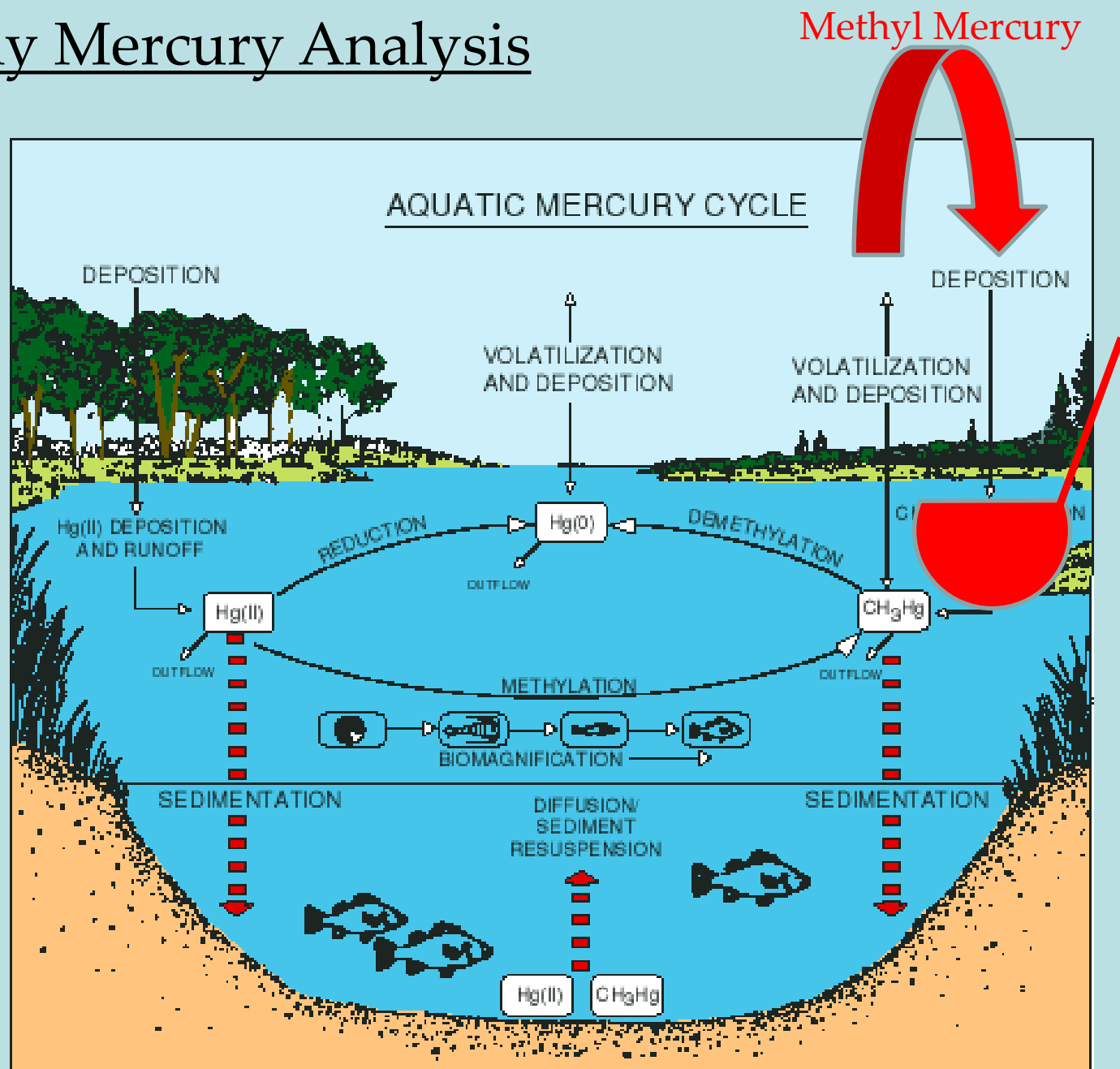
MEDIUM

Analysis: EPA Method 1631



Methyl Data Option

Methy Mercury Analysis



Data Processing

NOTE CODE:

Code	Description	Quality Rating (QR) code	Valid for Summary Statistics (Y/N)
e	Extended sample time (> 8days)	B	Y
d	debris present	B	Y
m	missing information	B	Y
z	site operations problems	B	Y
h	sample handling problems	B	Y
i	low volume sample (1.5 mL ≤ sample volume < 10 mL) (Hg conc. data are reported but they are less certain than samples with a sample volume of at least 10 mL)	B	Y
b	bulk sample (sample exposed the whole time)	C	N
v	Rain gage indicates precipitation occurred but the sample volume was less than 1.5 mL, or the sample volume was less than 10% of indicated rain gage precipitation amount.	C	N
u	undefined sample (sample exposed for at least 6 hours without precipitation)	C	N
f	serious problems in field operations that compromise sample integrity	C	N
l	laboratory error	C	N
c	contamination of sample	C	N
p	no precipitation data from either the rain gage or the sample volume	C	N
n	no sample submitted	C	N

Notes

(sample condition)

assigned to each sample

NOTE CODE:

Code	Description	Quality Rating (QR) code	Valid for Summary Statistics (Y/N)
e	Extended sample time (> 8days)	B	Y
d	debris present	B	Y
m	missing information	B	Y
z	site operations problems	B	Y
h	sample handling problems	B	Y
i	low volume sample (1.5 mL ≤ sample volume < 10 mL) (Hg conc. data are reported but they are less certain than samples with a sample volume of at least 10 mL)	B	Y
b	bulk sample (sample exposed the whole time)	C	N
v	Rain gage indicates precipitation occurred but the sample volume was less than 1.5 mL, or the sample volume was less than 10% of indicated rain gage precipitation amount.	C	N
u	undefined sample (sample exposed for at least 6 hours without precipitation)	C	N
f	serious problems in field operations that compromise sample integrity	C	N
l	laboratory error	C	N
c	contamination of sample	C	N
p	no precipitation data from either the rain gage or the sample volume	C	N
n	no sample submitted	C	N

Valid Invalid Decisions

“A” Quality
“B” Quality

“C” Quality- invalid

NOTE CODE:

Code	Description	Quality Rating (QR) code	Valid for Summary Statistics (Y/N)
e	Extended sample time (> 8days)	B	Y
d	debris present	B	Y
m	missing information	B	Y
z	site operations problems	B	Y
h	sample handling problems	B	Y
i	low volume sample (1.5 mL ≤ sample volume < 10 mL) (Hg conc. data are reported but they are less certain than samples with a sample volume of at least 10 mL)	B	Y
b	bulk sample (sample exposed the whole time)	C	N
v	Rain gage indicates precipitation occurred but the sample volume was less than 1.5 mL, or the sample volume was less than 10% of indicated rain gage precipitation amount.	C	N
u	undefined sample (sample exposed for at least 6 hours without precipitation)	C	N
f	serious problems in field operations that compromise sample integrity	C	N
l	laboratory error	C	N
c	contamination of sample	C	N
p	no precipitation data from either the rain gage or the sample volume	C	N
n	no sample submitted	C	N

Annual Statistics

“A” Quality
“B” Quality

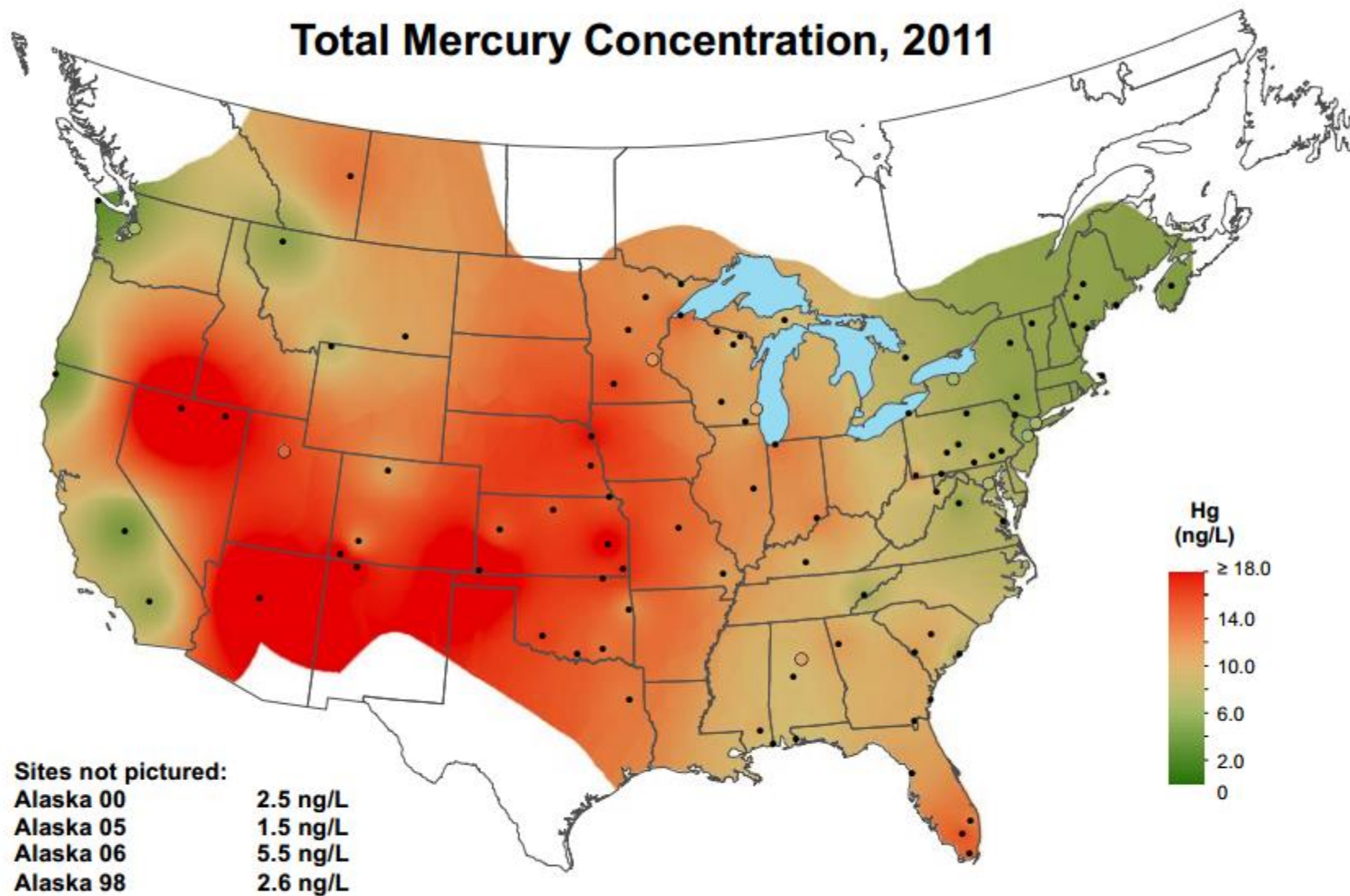
“C” Quality- invalid

National Atmospheric Deposition Program/MDN

Weekly Mercury Concentrations and Depositions

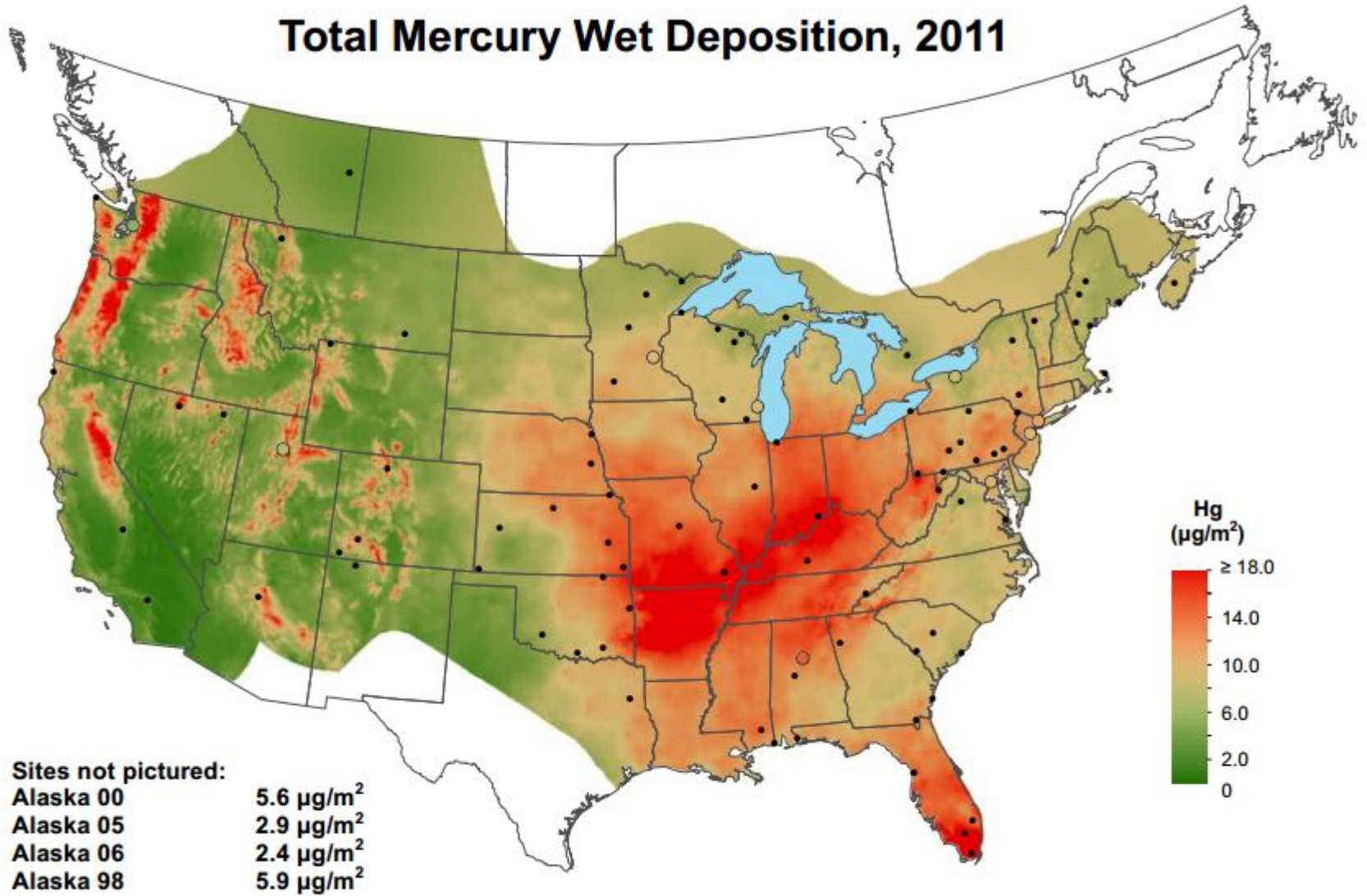
SiteID	Date On	Date Off	RGPPT	SVOL	SUBPPT	HgConc	HgDep	Sample Type	QR	Notes	YrMonth	DateMod
			mm	ml	mm	ng/L	ng/m²					
OK99	04/29/2003 10:00	05/06/2003 17:27	3.05	30.20	3.05	--	--	W	C	zu	200305	10/10/2004
OK99	05/06/2003 17:44	05/13/2003 21:05	47.24	446.30	47.24	24.21	1143.68	W	A		200305	10/26/2004
OK99	05/13/2003 21:30	05/20/2003 21:30	82.55	917.30	82.55	14.16	1169.56	W	B	dm	200305	10/10/2004
OK99	05/21/2003 01:00	05/27/2003 17:45	11.43	73.60	11.43	6.59	75.35	W	B	m	200305	10/10/2004
OK99	05/27/2003 18:00	06/03/2003 15:15	74.42	836.70	74.42	10.51	782.39	W	B	dzh	200305	10/10/2004
OK99	06/03/2003 15:20	06/10/2003 15:25	2.41	42.90	2.41	10.86	26.20	W	A		200306	10/10/2004
OK99	06/10/2003 16:00	06/17/2003 18:00	38.10	476.40	38.10	9.27	353.53	W	B	dm	200306	10/10/2004
OK99	06/17/2003 18:12	06/24/2003 16:11	4.32	48.40	4.32	9.95	43.00	W	B	d	200306	10/10/2004
OK99	06/24/2003 16:30	07/01/2003 17:35	30.61	367.10	30.61	25.32	775.06	W	A		200306	10/10/2004
OK99	07/01/2003 17:45	07/08/2003 15:32	0.00	0.00	0.00	--	0.00	D	B	z	200307	10/10/2004
OK99	07/08/2003 16:43	07/15/2003 22:30	37.08	479.00	37.08	22.18	822.56	W	B	d	200307	10/10/2004
OK99	07/15/2003 23:00	07/22/2003 16:00	12.70	187.80	12.70	25.79	327.64	W	B	z	200307	10/10/2004
OK99	07/22/2003 16:10	07/29/2003 17:20	-7.00	0.00	0.13	--	--	T	B	zh	200307	10/10/2004
OK99	07/29/2003 17:20	08/05/2003 15:15	53.85	424.40	35.42	11.45	405.83	W	B	dmzh	200308	10/10/2004
OK99	08/05/2003 15:15	08/12/2003 19:15	12.83	160.10	12.83	6.33	81.25	W	B	z	200308	10/10/2004
OK99	08/12/2003 19:35	08/19/2003 18:27	6.48	74.90	6.48	16.91	109.52	W	B	z	200308	10/10/2004
OK99	08/19/2003 18:40	08/26/2003 16:15	2.16	33.20	2.16	18.84	40.69	W	B	z	200308	10/10/2004
OK99	08/26/2003 16:35	09/02/2003 16:35	126.11	1664.30	126.11	5.57	703.19	W	B	z	200308	10/10/2004
OK99	09/02/2003 17:00	09/09/2003 21:10	-7.00	0.00	0.13	--	--	T	A		200309	10/10/2004
OK99	09/09/2003 21:15	09/16/2003 20:00	19.56	248.00	19.56	6.86	134.34	W	B	dm	200309	10/10/2004

Total Mercury Concentration, 2011



National Atmospheric Deposition Program/Mercury Deposition Network
<http://nadp.isws.illinois.edu>

Total Mercury Wet Deposition, 2011



National Atmospheric Deposition Program/Mercury Deposition Network
<http://nadp.isws.illinois.edu>

Network Cost

	Mercury Deposition Network (MDN)	
	Total Mercury (TM) Weekly/Daily Sampling	
Program Office/Data	\$2,700	\$2,700
Add. PO fee for daily	none	\$675
Chemistry	\$6,994	\$20,982
NED Fee (equipment)	\$182	\$182
TOTAL	\$9,876	\$24,539
<i>Estimated shipping</i>	<i>\$1,040</i>	<i>\$3,120</i>
<i>~ Total with shipping</i>	<i>\$10,916</i>	<i>\$27,659</i>

