Battelle
Columbus Laboratories

# CHAIN OF CUSTODY RECORD

Form No. _____

| Proj. No. | Project Title |
|---|---|
| G486111-T3 | Source Determination Study |

SAMPLERS:(Signature)
G. Hendyla / D. Conner / B. Headington

PO# 191762

| DATE | TIME | SAMPLE I.D. | SAMPLE TYPE (√) Helium (He) | SAMPLE TYPE (√) Tritium (3H) | Container No. | Number of Containers | Remarks |
|---|---|---|---|---|---|---|---|
| 02JUN05 | 1340 | GARField | X | X | | 2 | |
| 02JUN05 | 1052 | Sunset | X | X | | 2 | |
| 02JUN05 | 1530 | Bingham | X | X | | 2 | |
| 03JUN05 | 0930 | LFWC-2 | X | X | | 2 | |
| 03JUN05 | 1330 | LAWC-3 | X | X | | 2 | |
| 05JUN05 | 1130 | MW-1 | | X | | 1 | |

| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
|---|---|---|---|---|---|
| | 6-6-2005 16:00 | | | | |
| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
| | | | | | |
| Relinquished by: (Signature) | Date/Time | Received for Laboratory by: (Signature) Zufer Topo | Date/Time 6/8/05 | Remarks Sent to: University of Miami | |

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Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. _____

| Proj. No. | Project Title |
|---|---|
| G48611 1-T3 | Source Determination Study |

SAMPLERS: (Signature) D. Lowe

PO # 191762

| DATE | TIME | SAMPLE I.D. | SAMPLE TYPE (√) Tritium | Rec'd 8/18/05 | Container No. | Number of Containers | Remarks |
|---|---|---|---|---|---|---|---|
| 7/26/2005 | 14:45 | MW-21-2 | X | ✓ | | | |
| 7/26/2005 | 16:00 | MW-21-1 | X | ✓ | | | |
| 8/1/2005 | 08:57 | MW-20-5 | X | ✓ | | | |
| 8/1/2005 | 10:50 | MW-20-4 | X | ✓ | | | |
| 8/1/2005 | 12:30 | MW-20-3 | X | ✓ | | | |
| 8/1/2005 | 14:07 | MW-20-2 | X | ✓ | | | |
| 8/1/2005 | 16:08 | MW-20-1 | X | ✓ | | | |
| 8/15/2005 | 09:30 | MW-17-5 | X | ✓ | | | |
| 8/15/2005 | 10:45 | MW-17-4 | X | ✓ | | | |
| 8/15/2005 | 13:45 | MW-17-2 | X | ✓ | | | |
| 8/15/2005 | 15:30 | MW-17-1 | X | ✓ | | | |

| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
|---|---|---|---|---|---|
| | 8-16-05 16:00 | | | | |
| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
| | 8/18/05 10:00 | | | | |
| Relinquished by: (Signature) | Date/Time | Received for Laboratory by: (Signature) | Date/Time | Remarks | |
| | | | | To: University of Miami | |



Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. _____

| Proj. No. | Project Title |
|---|---|
| G48611 1-T3 | Source Determination Study |

SAMPLERS: (Signature) D. Lowe

PO # 191762

| DATE | TIME | SAMPLE I.D. | SAMPLE TYPE (√) Tritium | Rec'd 8/18/05 | Container No. | Number of Containers | Remarks |
|---|---|---|---|---|---|---|---|
| 7/19/2005 | 12:30 | MW-25-5 | X | ✓ | | | |
| 7/19/2005 | 16:15 | MW-25-2 | X | ✓ | | | |
| 7/20/2005 | 0900 | MW-19-5 | X | ✓ | | | |
| 7/20/2005 | 1100 | MW-19-4 | X | ✓ | | | |
| 7/20/2005 | 12:10 | MW-19-3 | X | ✓ | | | |
| 7/20/2005 | 15:00 | MW-19-1 | X | ✓ | | | |
| 7/21/2005 | 09:15 | MW-18-5 | X | ✓ | | | |
| 7/21/2005 | 10:30 | MW-18-4 | X | ✓ | | | |
| 7/21/2005 | 12:45 | MW-18-3 | X | ✓ | | | |
| 7/21/2005 | 16:30 | MW-18-2 | X | ✓ | | | |
| 7/21/2005 | 15:00 | MW-18-1 | X | ✓ | | | |
| 7/25/2005 | 09:00 | MW-24-4 | X | ✓ | | | |
| 7/25/2005 | 10:30 | MW-24-3 | X | ✓ | | | |
| 7/25/2005 | 15:30 | MW-24-5 | X | ✓ | | | |
| 7/26/2005 | 08:30 | MW-21-5 | X | ✓ | | | |
| 7/26/2005 | 10:30 | MW-21-4 | X | ✓ | | | |
| 7/26/2005 | 12:15 | MW-21-3 | X | ✓ | | | |

| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
|---|---|---|---|---|---|
| | 8-16-05 16:00 | | | | |
| Relinquished by: (Signature) | Date/Time | Received by: (Signature) | Relinquished by: (Signature) | Date/Time | Received by: (Signature) |
| | 8/18/05 10:00 | | | | |
| Relinquished by: (Signature) | Date/Time | Received for Laboratory by: (Signature) | Date/Time | Remarks | |
| | | | | To: University of Miami | |

BATTELLE GROUNDWATER SAMPLES
Tien Shiao
Collected: June 2005; Analyzed: June/November 2005

| SAMPLE | HELIUM 1E-8cc/g | NEON 1E-8cc/g | He corr. 1E-8cc/g | DEL He4 % | Del He3 % | R(3/4) in Ra | TRITIUM TU | UNCERT. +/-TU | 3H-3He AGE (y) | UNCERT. (y) |
|---|---|---|---|---|---|---|---|---|---|---|
| GARFIELD | 10.59 | 24.34 | 8.85 | **97.1** | **17.3** | **0.592** | 2.165 | 0.030 | 19.5 | 0.9 |
| BANGHAM | 8.89 | 26.60 | 6.56 | **45.3** | **27.4** | **0.866** | 2.589 | 0.039 | 23.1 | 0.7 |
| SUNSET | 7.04 | 20.31 | 6.56 | **44.8** | **48.5** | **1.012** | 5.671 | 0.050 | 20.4 | 0.4 |
| LAWC-3 | 4.68 | 18.95 | 4.67 | **2.3** | **0.0** | **0.961** | 4.576 | 0.050 | 0.0 | 1.0 |
| MW1 | - | - | - | - | - | - | 3.902 | 0.050 | - | - |
| LFWC-2 | - | - | - | - | - | - | 5.079 | 0.050 | - | - |

**NOTES:**

1- HELIUM column denotes observed total helium
2- NEON column denotes observed total neon
3- He corr. column denotes corrected total helium based on excess neon.

4- DEL He4 column is the corrected helium excess in percent, above solubility equilibrium.
5-DEL He3 column is He3 excess in percent, above solubility equilibrium, i.e. assumed to be tritiogenic He3.
6- R(3/4) column is the He3/He4 ratio in sample normalized to the same ratio in air.
7- TRITIUM column is the tritium concentration in Tritium Units.
8- H3-He3 AGE column is the apparent tritium-helium age of the sample in years.
9- UNCERT.column is the analytical uncertainty in tritium-He3 age, in years.
MW1 and LFWC-2 helium samplers did not yield viable helium samples, hence no helium measurements.

BATTELLE TRITIUM MEASUREMENTS: FINAL RESULTS
12/12/2005

| SAMPLE | TRIT.f(TU) | UNCER.(TU) |
|---|---|---|
| MW-17-1 | 2.929 | 0.037 |
| MW-17-2 | 6.596 | 0.059 |
| MW-17-3 | 7.75 | 0.054 |
| MW-17-4 | 0.537 | 0.011 |
| MW-17-5 | 0.865 | 0.026 |
| MW-17-5 | 2.006 | 0.03 |
| MW-18-1 | 2.472 | 0.037 |
| MW-18-2 | 2.91 | 0.036 |
| MW-18-3 | 2.394 | 0.036 |
| MW-18-4 | 0.337 | 0.02 |
| MW-18-5 | 0.136 | 0.014 |
| MW-19-1 | 1.153 | 0.023 |
| MW-19-2 | 11.763 | 0.071 |
| MW-19-3 | 2.365 | 0.035 |
| MW-19-4 | 3.927 | 0.059 |
| MW-19-5 | 9.255 | 0.074 |
| MW-20-1 | 4.355 | 0.044 |
| MW-20-2 | 3.352 | 0.05 |
| MW-20-3 | 2.475 | 0.031 |
| MW-20-4 | 1.19 | 0.024 |
| MW-20-5 | 0.079 | 0.008 |
| MW-21-1 | 7.591 | 0.607 |
| MW-21-2 | 8.04 | 0.064 |
| MW-21-3 | 8.229 | 0.074 |
| MW-21-4 | 3.878 | 0.047 |
| MW-21-5 | 4.996 | 0.05 |
| MW-24-1 | 3.131 | 0.039 |
| MW-24-2 | 3.194 | 0.04 |
| MW-24-3 | 0.788 | 0.016 |
| MW-24-4 | 0.299 | 0.018 |
| MW-24-5 | 0.171 | 0.017 |
| MW-25-1 | 5.549 | 0.05 |
| MW-25-2 | 2.299 | 0.034 |
| MW-25-3 | 2.693 | 0.034 |
| MW-25-4 | 2.436 | 0.03 |
| MW-25-5 | 0.141 | 0.014 |

BATTELLE MEMORIAL INSTITUTE
Tien Shiao
Samples collected:June-Sep.2005; Analyses: Nov.-Dec., 2005

| SAMPLE | HELIUM 1E-8cc/g | NEON 1E-8cc/g | He corr. 1E-8cc/g | DEL He4 % | Del He3 % | R(3/4) in Ra | TRITIUM TU | UNCERT. +/-TU | 3H-3He AGE (y) | UNCERT. (y) |
|---|---|---|---|---|---|---|---|---|---|---|
| MW-17-3 | 6.41 | 22.12 | 5.32 | 18.5 | 29.0 | 1.073 | 7.750 | 0.054 | 11.7 | 0.4 |
| MW-19-2 | 40.28 | 61.85 | 27.61 | 524.4 | 983.4 | 1.717 | 11.763 | 0.071 | 54.8 | 0.1 |
| MW-24-1 | 5.39 | 18.35 | 5.32 | 19.3 | 4.5 | 0.863 | 3.131 | 0.039 | 5.4 | 1.1 |
| MW-24-2 | 38.74 | 69.64 | 23.89 | 435.7 | 820.6 | 1.700 | 3.194 | 0.040 | 74.5 | 0.2 |
| MW-25-1 | 19.88 | 47.11 | 11.48 | 158.7 | 190.1 | 1.111 | 5.549 | 0.050 | 40.1 | 0.2 |
| MW-25-2 | 16.67 | 40.83 | 10.09 | 127.1 | 2.9 | 0.453 | 2.299 | 0.034 | 4.8 | 1.5 |
| MW-25-3 | 17.67 | 48.70 | 8.85 | 98.4 | 121.7 | 1.105 | 2.693 | 0.034 | 44.6 | 0.3 |
| MW-25-4 | 17.38 | 33.52 | 12.97 | 189.8 | 35.4 | 0.468 | 2.436 | 0.030 | 27.2 | 0.6 |

NOTES:

1- HELIUM column denotes observed total helium
2- NEON column denotes observed total neon
3- He corr. column denotes corrected total helium based on excess neon.
4- DEL He4 column is the corrected helium excess in percent, above solubility equilibrium.

5-DEL He3 column is He3 excess in percent, above solubility equilibrium, i.e. assumed to be tritiogenic He3.
6- R(3/4) column is the He3/He4 ratio in sample normalized to the same ratio in air.
7- TRITIUM column is the tritium concentration, at the time of measurement, in Tritium Units.
8- H3-He3 AGE column is the apparent tritium-helium age of the sample in years.
9- UNCERT.column is the analytical uncertainty in tritium-He3 age, in years.
10- With the exception of MW-17-3 and MW-24-1, all samples had very large air components in them. Correction for this component using neon increases the uncertainty in age determination well beyond the analytical uncertainty given under UNCERT. Column. Replicates were also run to minimize the uncertainty without much success: they contained just as much air. Therefore the real ages may be much shorter, in the 10-20y range.
11- MW-25-2 result is preliminary; the replicate for this sample could not be included with the rest, but it is now being re-analyzed. That result will be reported as an update within two weeks.

## Shiao, Tien

**From:** Shiao, Tien
**Sent:** Friday, September 09, 2005 11:17 AM
**To:** 'Zafer Top'
**Subject:** RE: Tritium Sample Volume

Zafer,

The current situation is that you will receive two or three sample bottles for each location for the tritium analysis. The bottles are non-preserved and I am assuming contact with the air should not be a problem since the tritium samples are grab samples. In addition I am assuming there are no hold time issues.

How about if the samples are kept cool for a previous analysis but currently kept at ambient temperature, would that be a problem?

The following samples collected for other analysis and their collection dates are provided below. We are trying to retrieve them from other labs to send to you for tritium analysis.

| Sample ID | Date Collected |
|---|---|
| MW-17-3 | August 15 |
| MW-19-2 | July 20 |
| MW-24-1 | July 25 |
| MW-24-2 | July 25 |
| MW-25-1 | July 19 |
| MW-25-3 | July 19 |
| MW-24-4 | July 19 |

Please let me know if there are any additional issues you can think of. We want to cover all bases and be sure the samples we sent to you is fine for the tritium analysis. If not, than we will have to go back to the field to re-sample and we will need to know about this as soon as possible. Sorry about this and thank you for your help. I will keep you posted.

Thanks,
Tien

At 10:13 AM 9/9/2005 -0400, you wrote:

>Zafer,
>
>
>
>I left you a message on your voicemail this morning. The helium
>samplers will be sent to you early next week. I will let you know the
>exact date. Please let me know if you encounter any problems with the
>helium samplers we sent you. The helium samplers were taken in
>duplicate in case any of the clamps were over tightened.
>
>
>
>In addition, our field technician missed taking 7 tritium samples.
>Therefore, either we will go back to take the additional tritium
>samples or we can send you the bottles already collected for other
>analysis. Therefore we were wandering what the exact volume needed for
>tritium analysis is. Currently, we have been sending you 1 L
>polyethylene containers of water for tritium analysis. Please let me
>know about this as soon as you can. Any suggestions will be appreciated.
>
>

**From:** Shiao, Tien
**Sent:** Monday, September 12, 2005 6:16 PM
**To:** 'Zafer Top'
**Cc:** Ohart, Carolyn J; Conner, David J
**Subject:** Helium Samplers
Zafer,

8 He samplers are being sent to you today (09/12/05) to arrive to you tomorrow. You should receive the He samplers in duplicate. The sample IDs are:

MW-17-3
MW-19-2
MW-24-1
MW-24-2
MW-25-1
MW-25-2
MW-25-3
MW-25-4

Please confirm receipt of samples and to fax me the COCs when you have verified the actual samples corresponds with the sample IDs on the COCs. On a side note, you are probably not going to get the tritium samples tomorrow. I will keep you updated.

Thanks for your help!

Best Regards,

Tien Shiao

Battelle Memorial Institute
Environmental Restoration Dept.
505 King Ave., Columbus, OH 43204
Room: 10-1-80
Business: (614) 424-3754
Mobile: (614) 370-3939
Fax: (614) 458-3754
shiaoh@battelle.org
www.battelle.org

**Shiao, Tien**

**From:** Shiao, Tien
**Sent:** Tuesday, September 13, 2005 2:22 PM
**To:** 'Zafer Top'
**Subject:** FW: samples

Dr. Top,

You will receive the following samples from APC Labs.

| Sample ID | Date Collected | Volume Required |
|---|---|---|
| MW-17-3 | August 15 | At least 400 mL |
| MW-19-2 | July 20 | At least 400 mL |
| MW-24-1 | July 25 | At least 400 mL |
| MW-24-2 | July 25 | At least 400 mL |
| MW-25-1 | July 19 | At least 400 mL |
| MW-25-3 | July 19 | At least 400 mL |
| MW-25-4 | July 19 | At least 400 mL |

Combined with MIT, you will have more than 500 mL of non preserved samples for the tritium analysis. Please let me know if there are any problems/issues.

Sincerely,
Tien

---

**From:** Frank Dudas [mailto:fdudas@MIT.EDU]
**Sent:** Tuesday, September 13, 2005 2:11 PM
**To:** Shiao, Tien
**Cc:** ztop@rsmas.miami.edu; sbowring@mit.edu
**Subject:** samples

Dear Tien,

I sent the following samples to Dr. Top by FedEx this afternoon (picked up at 2 pm), standard overnight delivery. They should arrive tomorrow (9/14) afternoon. Each of the samples is at least 200 mL.

| Sample ID | Date Collected | Volume Required |
|---|---|---|
| MW-17-3 | August 15 | At least 200 mL |
| MW-19-2 | July 20 | At least 200 mL |
| MW-24-1 | July 25 | At least 200 mL |
| MW-24-2 | July 25 | At least 200 mL |
| MW-25-1 | July 19 | At least 200 mL |
| MW-25-3 | July 19 | At least 200 mL |
| MW-25-4 | July 19 | At least 200 mL |

Regards,
Frank

--
Dr. Francis Ö. Dudás
Laboratory Manager, 54-1116

## Shiao, Tien

**From:** Zafer Top [ztop@rsmas.miami.edu]
**Sent:** Friday, September 23, 2005 9:39 AM
**To:** Shiao, Tien
**Subject:** Re: Tritium Samples

Tien:
I received the rest of the tritium samples and processed them. Helium and tritium measurements are independent and are reported separately. I will be away from the office until October 20.
Zafer

At 05:34 PM 9/22/2005 -0400, you wrote:

>Zafer,
>
>
>
>I left a voice message with you this afternoon. I wanted to check
>whether you received the tritium samples from MIT and APC Labs. I also
>wanted to check how the helium and the tritium are reported. For
>example, at locations where both tritum and helium samples are taken,
>will you be reporting a ratio for the results, or will tritium and
>helium be reported separately?
>
>
>
>Thanks,
>
>Tien
>
>