Laboratory Procedure Manual

Analyte: **Volatile Organic Compounds (VOCs)**

Matrix: **Whole Blood**

Method: **Headspace Solid-Phase Microextraction with Benchtop GC MS**

As performed by:

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Important Information for Users

The Centers for Disease Control and Prevention (CDC) periodically refines these laboratory methods. It is the responsibility of the user to contact the person listed on the title page of each write-up before using the analytical method to find out whether any changes have been made and what revisions, if any, have been incorporated.

Public Release Data Set Information

This document details the Lab Protocol for testing the items listed in the following table

Data File Name	Variable Name	SAS Label
VOCWB_G & VOCWBS_G	LBX2DF	Blood 2,5-dimethylfuran (ng/mL)
	LBXV06	Blood Hexane (ng/mL)
	LBXV1A	Blood 1,1-dichloroethane
	LBXV1D	Blood 1,2-dichlorobenzene (ng/mL)
	LBXV1E	Blood Vinylidene chloride (ng/mL)
	LBXV2A	Blood 1,2-dichloroethane (ng/mL)
	LBXV2C	Blood cis-1,2-dichloroethene (ng/mL)
	LBXV2E	Blood 1,1,2-tricholorethane (ng/mL)
	LBXV2T	Blood trans-1,2-dichloroethene (ng/mL)
	LBXV3B	Blood 1,3-dichlorobenzene (ng/mL)
	LBXV4C	Blood Tetrachloroethene (ng/mL)
	LBXV4E	Blood 1,1,2,2-tetrachloroethane (ng/mL)
	LBXVBZ	Blood Benzene (ng/mL)
	LBXVCB	Blood Chlorobenzene (ng/mL)
	LBX4CE	Blood 1,1,1,2-tetrachloroethane (ng/mL)
	LBXVCT	Blood Carbon tetrachloride (ng/mL)
	LBXVDB	Blood 1,4-dichlorobenzene (ng/mL)
	LBXVDE	Blood 1,2-dibromoethane (ng/mL)
	LBXVDM	Blood Dibromomethane (ng/mL)
	LBXVDP	Blood 1,2-dichloropropane (ng/mL)
	LBXVDX	Blood 1,4-Dioxane (ng/mL)
	LBXVEB	Blood Ethylbenzene (ng/mL)
	LBXVFN	Blood Furan (ng/mL)
	LBXVHE	Blood Hexachloroethane (ng/mL)
	LBXVIPB	Blood Isopropylbenzene (ng/mL)
	LBXVMC	Blood Methylene chloride(ng/mL)
	LBXVNB	Blood Nitrobenzene (ng/mL)
	LBXVOX	Blood o-xylene (ng/mL)
	LBXVTC	Blood Trichloroethene (ng/mL)
	LBXVTE	Blood 1,1,1-trichloroethane (ng/mL)
	LBXVTP	Blood 1,2,3-trichloropropane (ng/mL)
	LBXVXY	Blood m-/p-xylene (ng/mL)

1. Clinical Relevance and Summary of Test Principle

a. Clinical Relevance

Biomonitoring of volatile organic compounds (VOCs) in blood provides useful information on exposure and internal dose of environmental chemicals. To support studies exploring the relationship between exposure to these chemicals and adverse health effects, an automated analytical method was developed using capillary gas chromatography (GC) and mass spectrometry (MS) with selected-ion monitoring (SIM) detection and isotope-dilution. This method quantifies levels of individual VOCs in blood to low-parts-per-trillion range. Because nonoccupationally exposed individuals have blood VOC concentrations in this range, this method is applicable for determining these quantities and investigating cases of sustained or recent low-level exposure.

b. Test Principle

Volatile organic compounds are measured in specially collected whole blood samples by headspace solid-phase microextraction (SPME)/gas chromatography/isotope dilution mass spectrometry using a similar method as described by Blount, *et al*.[1] Analysis of the blood sample is performed by equilibrium headspace analysis using SPME. For analysis, 3-mL of blood is transferred by gas-tight syringe from a blood collection tube to a headspace vial. The SPME fiber is inserted into the headspace of a hermetically sealed sample vial containing the blood sample. The VOCs partitions into the coating on the outside of the SPME fiber shaft. This fiber is then inserted into the heated GC inlet where the VOCs rapidly desorb because of the high temperature. Extracted VOCs are focused at the head of the GC column using a cryogenic trap. Analytes are separated on a capillary column designed for VOC analyses and quantified using SIM MS (unit mass resolution). Response calibration is performed using isotopically labeled standards to normalize calibration standards and blood sample responses. This method is applicable to the determination of a broad range of VOCs in 3-mL blood with detection limits in the low-parts-per-trillion range. Because nonoccupationally exposed individuals have blood VOC concentrations in this range, this method is applicable for determining these quantities and investigating cases of exposure to VOCs.

Alteration of particular aspects of this method can result in major biases. Care is required to produce non-contaminated blanks, blood collection tubes, and quality control materials. Efforts must be taken to minimize the sources of VOC contamination. Some typical contamination sources include the use of solvents, bleach and cleaning products, dry-cleaned clothing, air fresheners, perfumes, fuel/exhaust fumes, off-gassing from paints/adhesives/plastics, and inadequate lab air handling.[2-4]

2. Computerization; Data-System Management

a. Software and knowledge requirements

Data are processed and reviewed with instrument software provided by the instrument manufacturer or equivalent software from a different company. The reviewed data are entered into a relational database.

b. Sample information

Information pertaining to particular specimens is entered into a database either manually or electronically transferred. Blood samples from each analysis batch are processed into a single file using data analysis software that provides blood level results along with corresponding calibration curve, QC, blank data. The result file is transferred

electronically into the database. No personal identifiers are used, and all samples are referenced to a blind coded sample identifier.

c. Data maintenance

Integrity of specimen and analytical data generated by this method involves visual inspection of all peak integrations, proofreading all transcribed data, storage of data in multiple computer systems, and redundant data archiving. Original data files contain traceable header information (e.g., date, analytical run number, sample type and sample identification) and are stored on recordable media on site. Data is accessed directly by Ethernet connection to the instrument computer. The raw data are also archived on the shared network drive along with relevant meta-data including peak integrations, calibration curves, blanks, and isotope corrections. Processed results files are transferred electronically into the local area network (LAN) and stored in a shared directory. Processed data is loaded into the database system using an automated data import module.

d. Information security

Information security is managed at multiple levels. The information management systems that contain the final reportable results are restricted through user ID, password and/or smart card security access. The computers and instrument systems that contain the raw and processed data files require specific knowledge of software manipulation techniques and physical location. Site security is provided at multiple levels through restricted access to the individual laboratories, buildings, and site. Confidentiality of results is protected by referencing results to blind coded sample IDs (no names or personal identifiers).

3. Procedures for Collecting, Storing, and Handling Specimens; Specimen Rejection

a. Special instructions

No special instructions such as fasting or special diets are required.

b. Sample collection

Isopropyl alcohol, which may be used to disinfect the venipuncture site, can contaminate the collected sample and cause nonspecific interferences of the analytical measurement. Contamination is prevented by drying the site that has been swabbed with isopropyl alcohol with a gauze bandage and allowing it to dry for 5 to 10 sec.

The specimen type is whole blood collected in specially cleaned, 10-mL or 7-mL draw glass tubes containing potassium oxalate and sodium fluoride anticoagulant. Additional information on preparation of these blood collection tubes can be found in Section 6.d.

c. Sample handling

The CDC-prepared blood collection tubes contain anticoagulant that inhibits metabolism and prevents coagulation. Metabolic inhibition increases sample shelf life by minimizing metabolic impact on blood VOC levels during storage. Once samples have been collected, they are mixed thoroughly to completely dissolve and distribute the anticoagulant. Because blood is perishable and VOCs are highly volatile, care is taken to insure that samples are kept at refrigerator temperatures (i.e., 2–6 °C) during storage and shipment. All samples are placed on wet ice or into a refrigerator within 30 min of sample collection. In addition, samples are shipped with enough wet ice or equivalent cooling material to insure that the samples remain cool (but not frozen) throughout the shipment

process. Shipment is scheduled to ensure that they will arrive at CDC on normal business days to guarantee their proper processing upon arrival. Samples are not frozen or stored at freezer temperatures at any time during sample collection and shipment. Samples are shipped within 1 to 2 days of collection so that they are typically analyzed within 2 to 3 weeks of collection.

Specimen stability has been demonstrated for analytes measured by this method for 16 weeks at refrigerated temperatures (2–6 °C). Note that blood samples change with time of refrigerated storage. After 10 weeks of storage the blood often begins to thicken and is therefore difficult to handle. Even though analytical results may not change over this time, samples may be less amenable to analysis. Certain volatile organic compounds are produced naturally, and metabolism may alter their concentration with storage.

Storage at freezing temperatures results in cell rupture. In addition, freezing of blood can lead to breakage of blood collection tubes and loss of sample in some cases. Because VOCs are lost whenever the containers in which they are contained are opened, blood samples are not transferred to another container.

d. Sample quantity

The blood collection tube is filled to capacity to minimize headspace losses. Headspace losses depend upon the blood-air partition constant of a compound. The minimum acceptable amount for analysis is 3 mL.

e. Unacceptable specimens

The criteria for unacceptable specimen are a low volume (<3 mL), failure to maintain sample temperature between 2 °C and 6 °C causing the blood sample to clot, suspected contamination, use of an untreated blood collection tube, and significant clotting of the specimen.

Failure to obtain adequate sample volume is obvious when the samples are received. Visual inspection of the blood collection tube reveals when estimated blood volume is less than the required 3 mL. Maintenance of temperature during shipment is verified by examining the shipment temperature upon receipt. Clotting is indicated by failure of the sample to flow when the blood collection tube is inverted. Clotting can occur from failure to properly mix the sample and anticoagulant as described above. A description of reasons for each rejected sample is recorded in the relational database as the samples are logged into the laboratory.

4. Preparation of Reagents, Calibration Materials, Control Materials, and All Other Materials; Equipment and Instrumentation

a. Reagents and sources

1) Solvents

Solvents and how they are used are listed below;

HPLC grade acetone is sometimes used for primary dilution of neat native standards and labeled analogs for improved solubility of nonpolar compounds. Before use, HPLC grade acetone is verified through analytical measurement not to significantly bias the analytical measurement.

Purge and trap grade methanol is used for all intermediate native standards and isotopically labeled internal standards. Before use, purge and trap grade methanol must first be shown not to significantly bias the analytical measurement.

HPLC grade water is primarily used to produce VOC free water. Variability in contaminant levels requires testing of product lots. This water is further processed by nitrogen sparging and distillation to further reduce VOCs before use. Methods for this procedure are based on previously published techniques for removing residual VOCs from reagent water.[5] Water is validated to contain no detectable levels of those VOCs being analyzed.

2) Calibration and Control Materials

Compounds used for preparation of calibration standards and quality control materials are listed in Table 1 and are purchased from companies meeting guidelines of International Organization of Standards Guide 34. Recommended isotopically labeled internal standards listed in Table 2 can be used. Other isotopic analogs may be used because of availability and costs limitations as long as there are no interfering chromatographic or mass spectral interferences. All chemicals are used without further purification unless required. Native standard materials are at least 97% pure. Isotopically labeled internal standards are of sufficient chemical and isotopic purity to produce levels needed for accurate quantitation and impurities do not interfere with analyses of the other VOC analytes.

Table 1. Reagents for calibration and control materials

Compound	Formula	Safety
1,1,1,2-Tetrachloroethane	$CHCl_3CHCl$	a,b,e
1,1,1-Trichloroethane	CH_3CCl_3	a,b
1,1,2,2-Tetrachloroethane	$CHCl_2CHCl_2$	a,c
1,1,2-Trichloroethane	$CH_2ClCHCl_2$	a,b
1,1-Dichloroethane	CH_3CHCl_2	a,b
1,1-Dichloroethylene	$CH_2=CCl_2$	c,d
1,2,3-Trichloropropane	$ClCH_2CH(Cl)CH_2Cl$	a,b,e
1,2-Dibromoethane	$BrCH_2CH_2Br$	a,b,e
1,2-Dichlorobenzene	$C_6H_4Cl_2$	b,e
1,2-Dichloroethane	CH_2ClCH_2Cl	a,d
1,2-Dichloropropane	$CH_3CHClCH_2Cl$	d,e
1,3-Dichlorobenzene	$C_6H_4Cl_2$	b,e
1,4-Dichlorobenzene	$C_6H_4Cl_2$	a,b
1,4-Dioxane	$C_4H_8O_2$	a,b,e,d
2,5-Dimethylfuran	$C_6H_{12}O$	b,d
Benzene	C_6H_6	a,d
Carbon Tetrachloride	CCl_4	a,b
Chlorobenzene	C_6H_5Cl	d,e
cis-1,2-Dichloroethylene	$CHCl=CHCl$	d,f
Dibromomethane	CH_2Br_2	a,b,e
Ethylbenzene	$C_6H_5CH_2CH_3$	d,e
Furan	C_4H_4O	a,b,d,e
Hexachloroethane	CCl_3CCl_3	a,e
Isopropylbenzene	$C_6H_5CH(CH_3)_2$	b,d,e
m-/*p*-Xylene	$C_6H_4(CH_3)_2$	d,e
Methylene Chloride	CH_2Cl_2	b,e
n-Hexane	$CH_3(CH_2)_4CH_3$	b,d,e,g
Nitrobenzene	$C_6H_5NO_2$	b,d
o-Xylene	$C_6H_4(CH_3)_2$	d,e
Styrene	$C_6H_5CH=CH_2$	a,d
Tetrachloroethylene	$CCl_2=CCl_2$	a,g
Toluene	$C_6H_5CH_3$	b,d
trans-1,2-Dichloroethylene	$CHCl=CHCl$	d,f
Trichloroethylene	$CHCl=CCl_2$	a,g

a - Cancer suspect agent b – Toxic c – Lachrymator
d – Flammable e – Irritant f - Moisture sensitive
g – Mutagen

Table 2. Isotopically labeled internal standards

Compound	Formula	Safety
1,1,1,2-Tetrachloroethane-$^{2}H_2$	$C^{2}HCl_3C^{2}HCl$	a,b,e
1,1,1-Trichloroethane-$^{2}H_3$	$C^{2}H_3CCl_3$	a,b
1,1,2,2-Tetrachloroethane-$^{2}H_2$	$C^{2}HCl_2C^{2}HCl_2$	a,c
1,1,2-Trichloroethane-$^{2}H_3$	$C^{2}H_2ClC^{2}HCl_2$	a,b
1,1-Dichloroethane-$^{2}H_3$	$C^{2}H_3CHCl_2$	a,b
1,1-Dichloroethylene-$^{2}H_2$	$C^{2}H_2=CCl_2$	c,d
1,2,3-Trichloropropane-$^{2}H_5$	$ClC^{2}H_2C^{2}H(Cl)C^{2}H_2Cl$	a,b,e
1,2-Dibromoethane-$^{13}C_1$	$Br^{13}CH_2CH_2Br$	a,b,e
1,2-Dichlorobenzene-$^{13}C_6$	$^{13}C_6H_4Cl_2$	b,e
1,2-Dichloroethane-$^{2}H_4$	$C^{2}H_2ClC^{2}H_2Cl$	a,d
1,2-Dichloropropane-$^{2}H_6$	$C^{2}H_3C^{2}HClC^{2}H_2Cl$	d,e
1,3-Dichlorobenzene-$^{13}C_6$	$^{13}C_6H_4Cl_2$	b,e
1,4-Dichlorobenzene-$^{13}C_6$	$^{13}C_6H_4Cl_2$	a,b
1,4-Dioxane-$^{2}H_8$	$C_4{}^{2}H_8O_2$	a,b,e,d
2,5-Dimethylfuran-$^{13}C_2$	$(^{13}CH_3)_2C_4H_6O$	b,d
Benzene-$^{13}C_6$	$^{13}C_6H_6$	a,d
Carbon Tetrachloride-$^{13}C_1$	$^{13}CCl_4$	a,b
Chlorobenzene-$^{13}C_6$	$^{13}C_6H_5Cl$	d,e
cis-1,2-Dichloroethylene-$^{2}H_2$	$C^{2}HCl=C^{2}HCl$	d,f
Dibromomethane-$^{2}H_2$	$C^{2}H_2Br_2$	a,b,e
Ethylbenzene-$^{13}C_6$	$^{13}C_6H_5CH_2CH_3$	d,e
Furan-$^{2}H_4$	$C_4{}^{2}H_4O$	a,b,d,e
Hexachloroethane-$^{13}C_1$	$^{13}CCl_3CCl_3$	a,e
Isopropylbenzene-$^{2}H_5$	$C_6{}^{2}H_5CH(CH_3)_2$	b,d,e
m-/p-Xylene-$^{13}C_6$	$^{13}C_6H_4(CH_3)_2$	d,e
Methylene Chloride-$^{13}C_1$	$^{13}CH_2Cl_2$	b,e
n-Hexane-$^{2}H_{14}$	$C^{2}H_3(C^{2}H_2)_4C^{2}H_3$	b,d,e,g
Nitrobenzene-$^{13}C_6$	$^{13}C_6H_5NO_2$	b,d
o-Xylene-$^{2}H_6$	$C_6H_4(C^{2}H_3)_2$	d,e
Styrene-$^{13}C_6$	$^{13}C_6H_5CH=CH_2$	a,d
Tetrachloroethylene-$^{13}C_1$	$^{13}CCl_2=CCl_2$	a,g
Toluene-$^{13}C_7$	$^{13}C_6H_5{}^{13}CH_3$	b,d
trans-1,2-Dichloroethylene-$^{2}H_2$	$C^{2}HCl=C^{2}HCl$	d,f
Trichloroethylene-$^{13}C_1$	$^{13}CHCl=CCl_2$	a,g

a - Cancer suspect agent b – Toxic c – Lachrymator
d – Flammable e – Irritant f - Moisture sensitive
g – Mutagen

b. Preparation of glassware

Glassware that is found to have detectable levels of VOC residue is solvent rinsed and vacuum baked to ensure removal of contamination for all VOCs being analyzed. All glassware is kept in a vacuum oven at sufficient temperature and pressure to prevent VOC recontamination. Before use, the glassware is cooled to room temperature under vacuum. When glassware is removed from the oven it is sealed with polytetrafluoroethylene (PTFE) lined caps, when appropriate.

c. Preparation of headspace vial septa

Headspace vial septa are verified to provide sufficient seal to maintain detection above the limit of detection. Septa are cleaned by vacuum baking and verified through analysis of the bulk material to be free of those VOCs being analyzed.[3] After cleaning, septa are

stored in a vacuum oven of sufficient vacuum and temperature to prevent VOC recontamination.

d. Preparation of blood collection tubes

Blood collection tubes (e.g., Vacutainers) obtained from commercial sources contain high levels of VOC residue in the butyl rubber stoppers. This residue can mask the levels of VOC analytes originally in the blood at the time of sample collection, and thus prevent accurate exposure assessment. The most commonly encountered blood collection tube VOC contaminants are listed in Table 3. Blood collection tube lot variation is avoided by purchasing in batches of 10,000, which lasts several years. The selected lot is prescreened for VOC residue levels. To prevent sample contamination, the VOCs are removed from blood collection tubes using a special cleaning method.[6] A combination of solvent swelling and vacuum baking is used to remove residue levels from the rubber stopper that interfere with accurate quantitation.[4] Following treatment of the blood collection tubes, the tubes are labeled with a new expiration date that reflects a 1-year shelf life. The shelf life of a blood collection tubes is limited mainly by the amount of time the blood collection tube can remain under vacuum, however VOC residue levels from the stopper can increase with time if deeply penetrated VOCs are not completely removed. Tubes used are supplied by laboratory sciences (DLS) staff for all blood VOC studies.

Table 3. Analytes most commonly found to contaminate blood collection tubes

Analyte
1,1,1-Trichloroethane
1,4-Dichlorobenzene
Benzene
Dibromomethane
Ethylbenzene
4-Methyl-2-pentanone
m/*p*-Xylene
o-Xylene
Styrene
Tetrachloroethylene
Toluene
Trichloroethylene

Blood collection tube rubber stoppers are cleaned by removing the stoppers from the glass section of the tube. Stoppers are solvent swelled in boiling purge and trap grade methanol and vacuum baked for at least 3 weeks. The glass tube and anticoagulant salt are vacuum baked to remove any adsorbed residue. Once cleaned, the blood collection tubes are reassembled and reevacuated through a needle.

Cleaned blood collection tubes are tested for acceptable vacuum with a water-draw volume check. A sample of at least 5 tubes per batch of 300 is evaluated to ensure that contamination is below detectable levels for those analytes being analyzed. For this evaluation VOC free water is stored in the blood collection tubes oriented horizontally for 7–14 days at room temperature and then analyzed.

e. Preparation of blank water

Distilling, dispensing and storing of water are performed to minimize contamination from the surrounding environment and validated by comparison with an established reference or by standard addition. HPLC grade water is used as the starting material. The HPLC grade water is cleaned by heated sparging with nitrogen, boiling and refluxing, hermetic dispensing into precleaned ampules (cleaned in accordance with 4.b), and flame sealing with a water torch. After production, the flame seal is verified to be leak tight.

f. Preparation of native analytical standards

1) Handling of neat compounds

Inexpensive analytes purchased as neat liquids in flame sealed ampules are discarded after use. Expensive compounds (e.g., custom synthesis products) are saved for future use in flame sealed ampules. All compounds stored for future use that are expected to exceed the manufacturer's expiration date must be stored in an explosion-proof -70 °C freezer. However, purity must be revalidated by quantitation upon reuse. Short-term storage of neat standards that are not to exceed the manufacturers expiration date are stored at 2–6 °C in a chemical storage refrigerator separate from blood samples, blanks and quality control materials.

2) Filling and sealing of glass ampules

Neat standard materials to be stored for reuse are transferred to glass ampules, typically 1 mL, and filled under three-quarters capacity. Ampules are chilled throughout the aliquoting process. Pipettes are conditioned with the material before transferred to the storage ampules. Liquid is placed in the bottom of the ampule and is not adhering to the neck of the ampule before flame sealing. Sealed ampules are leak checked.

3) Final concentrations of the standards

Standards are formulated starting with the primary stock solutions prepared from neat materials diluted with either purge and trap grade methanol or HPLC acetone. Lower concentration primary stock solutions involve only a single serial dilution of the highest concentration stock. Seven intermediate levels are formulated from the primary stock solutions in purge and trap grade methanol using only a single dilution step. The 7 working standards are prepared in VOC free water using a single dilution of the corresponding intermediate levels and are separated by a factor of $\sqrt{10}$ ranging from low ppt to low ppb levels. The water is verified to have VOCs below detectable levels for the analytes of interest. Positive displacement pipettes are used for transfer of all liquids in the µl range with at least 2% accuracy. Class A volumetric flasks are used to make all standards. The primary stock solution concentrations are based on the gravimetric measure of mass transferred to the volumetric flask.

4) Aqueous working standards

Aqueous working standards are formulated in 25-mL quantities with added internal standard. 3.0 mL of each the aqueous working standards is transferred into cleaned 10-mL headspace vials using a gas-tight glass barrel/PTFE plunger pipetter. The vials are immediately sealed with recently cleaned caps and grouped by concentration in separate wide mouth specimen jars to prevent cross contamination. Furthermore, the standard set is stored in a dedicated refrigerator at 2–6ºC and analyzed as part of an analytical batch within 1 week.

g. Preparation of isotopically labeled internal standard solutions

1) Primary isotopically labeled internal standard stock solutions

Primary isotopically labeled internal standard stock solutions are made by dilution of the neat compound into purge and trap grade methanol. These solutions are stored in 1-mL ampules and flame sealed as described in Section 6.f.2. Concentrations of the primary labeled internal standard stock solutions are analyte dependent and range from 0.5 to 20 mg/mL. The primary isotopically labeled internal standard stock solutions are stored in a freezer below -60 °C.

2) Secondary isotopically labeled internal standard stock solutions

The secondary isotopically labeled internal standard stock solution is made by combining primary stock solutions and diluting to concentrations between standard levels 2 and 5. Solutions are mixed thoroughly and approximately 0.25 mL of these solutions are flame sealed in chilled 1-mL ampules as described above in Section 6.f.2. Ampulized stock solutions are stored in a freezer below -60 °C.

3) Working isotopically labeled internal standard solution

The working isotopically labeled internal standard solution is prepared daily from the ampulized secondary stock solution. The secondary stock solution is added to the standard formulations, water blanks, QC samples and unknown samples proportionally. Final labeled internal standard concentrations in samples vary depending on the analyte and are less than standard level 5 but greater than standard level 2. For storage the working solution is transferred directly from the formulation flask to cleaned 2-mL screw cap vials inset with PTFE lined septa. Vials are filled to leave no headspace and stored at 4 °C no longer than 2 days.

h. Preparation of quality control materials

QC materials are prepared at two concentration levels in fetal bovine serum. Residue is removed from fetal bovine serum by either sorption or volatilization under hermetic conditions; however, certain compounds are difficult to remove while maintaining the properties of the serum. Target and measured concentrations vary because of significant background levels that might not be removed during the cleaning process or adsorption/diffusion loss during sample preparation. The characterized mean is determined by analysis of at least 20 separate samples using different sample runs and instruments. The low concentration QC material is typically between standard level 1 and 3, whereas the high concentration QC material is between standard level 3 and 5. The QC materials are thoroughly mixed under hermetic conditions, transferred and flame sealed in 10-mL ampules for storage below -60 °C. Short-term storage up to -20 °C may occur but does not exceed 6 weeks. The concentration consistency across the lot is evaluated by comparing samples prepared at the beginning, middle and end of the batch. If this comparison reveals variability of more than 25% for any analyte, the lot is reformulated.

i. Proficiency testing materials

Proficiency testing (PT) materials are prepared at four levels from neat compounds in a manner similar to the intermediate standard materials. PT intermediate solutions are prepared, aliquoted into ampules, and flame sealed using the same preparation technique as described in Section 6.f.2. The PT reference materials are purchased from a different International Organization of Standards Guide 34 certified chemical company than those used in the formulation of the standards. PT solutions are prepared at intermediate

concentrations and diluted in the same manner as the standards. Each of the 4 final PT concentrations lies between standard levels 2 and 3, levels 3 and 4, levels 5 and 6, and levels 6 and 7. A proficiency testing coordinator, independent from the sample analysis team, blind-codes the PT stock ampules and administers and verifies accuracy of quantified results of four PT samples at each of the four concentration levels and one sample at any of the four different levels.

j. Clean-up procedure for the 5-mL Luerlock gas-tight syringe

Each blood sample is delivered from the blood collection tube to the headspace vial using a cleaned 5-mL Luerlock gas-tight syringe. Headspace syringes are decontaminated with a 10% bleach solution and thoroughly cleaned of VOC residue with rinses of filtered deionized water and purge and trap grade methanol followed by vacuum baking. Syringe cleaning batches are verified to be clean by analysis of 2 water control samples prepared using two randomly selected syringes with each sample run.

k. Instrumentation and operation

SPME of the headspace sample is performed using a Combi-Pal autosampler. Samples are queued on an autosampler tray and maintained at 15 ± 0.5 °C until they are analyzed. During analysis the samples are transferred to an agitating incubator set to at least 350 rpm and 40 ± 1 °C as the headspace is sampled with a 75-µm Carboxen-PDMS coated SPME fiber (Supelco, Bellefonte PA) for consistently specified time period of at least 6 min and no more than 15 min. The SPME fiber is then immediately transferred into the GC injection port fitted with a glass liner with an i.d. of 1 to 2 mm and held at 250 ± 0.5 °C. The sample is introduced into an Agilent DB-VRX column (40 m x 0.18 mm x 1 µm film) via pulsed splitless injection set at 50 psi. After 1.0 min, but no more than 2 min, the injection port pressure is then dropped to maintain a constant flow of 1.1 ± 0.1 mL/min of helium. In-line after the injection port is a cryogenic trap. At the start of the GC run the cryotrap is set to approximately -100 °C for at least 1 min, but no more than 2 min, then ballistically heated to approximately 225ºC (13.0ºC/sec). The GC oven temperature is programmed to ramp from 0 °C (1.5 min hold) at 7 °C/min to 140 °C, then 40 °C/min to 220 °C (for at least a 4.5 min hold). Quantitation by a quadrupole MS is performed using SIM of each primary quantitation ion, confirmation ion, and internal standard ion using at least a 15-ms dwell time for each. Examples of possible ions are shown in Table 4. When required, qualitative analyses are performed using full mass scan from m/z 21 to 500.

Identification of unknowns is established by comparison of GC retention time with that of a known standard and mass spectral data.

Table 4. Example of ions used for the internal standard and the quantification and confirmation of compounds, listed in elution order

Compound	ISTD (m/z)	Native (m/z)	Confirm (m/z)
1,1,1,2-Tetrachloroethane	137	131	133
1,1,1-Trichloroethane	102	97	99
1,1,2,2-Tetrachloroethane	86	83	85
1,1,2-Trichloroethane	102	97	83
1,1-Dichloroethane	66	63	65
1,1-Dichloroethylene	100	96	98
1,2,3-Trichloropropane	116	110	75
1,2-Dibromoethane	111	107	109
1,2-Dichlorobenzene	152	146	148
1,2-Dichloroethane	67	62	64
1,2-Dichloropropane	67	76	63
1,3-Dichlorobenzene	152	146	148
1,4-Dichlorobenzene	152	146	148
1,4-Dioxane	96	88	58
2,5-Dimethylfuran	98	95	96
Benzene	84	78	77
Carbon Tetrachloride	120	117	119
Chlorobenzene	118	112	77
cis-1,2-Dichloroethylene	100	96	98
Dibromomethane	178	174	93
Ethylbenzene	97	91	106
Furan	72	68	39
Hexachloroethane	204	201	166
Isopropylbenzene	110	105	120
m-/p-Xylene	97	91	106
Methylene Chloride	85	84	49
n-Hexane	66	57	41
Nitrobenzene	129	123	77
o-Xylene	112	91	106
Styrene	110	104	103
Tetrachloroethylene	169	166	164
Toluene	98	91	92
trans-1,2-Dichloroethylene	100	96	98
Trichloroethylene	133	130	132

Sample queues run for extended time periods of up to 24 hours. All samples awaiting analysis are racked into chilled trays (15 ± 1 °C). If the measurement is delayed to the next day, samples are left on a cooled sample tray at 15 ± 1 °C. Samples are not placed in a refrigerator that has not been recently vented.

The SPME fiber assembly can entrap VOCs and is evaluated before use. Typically, a conditioned SPME fiber is baked out in the GC inlet at 250 °C for a minimum of 5 hours before the VOC contaminants fully partition out of the fiber assembly. A fiber blank,

prepared by injecting the fiber without sampling a vial, is evaluated using the same analytical GCMS method as an unknown to confirm that all VOC concentrations are below instrument background levels. During the analytical run, the SPME fiber remains in the GC injection port until ready to collect the next sample and is not exposed to the laboratory air for more than 1 min so as to reduce the influence of ambient contamination.

The analysis of VOCs in whole blood at parts-per-trillion levels is an extremely complex measurement. There are no alternative analysis approaches that achieve the combined sensitivity and specificity over the broad range of compounds described in this method. At times when the analytical system fails, the prepared samples are stored between 2 and 15 °C for no more than 48 hours before analysis.

5. Calibration and Calibration Verification

All calibration standards are prepared in water as a matrix because it proved to be difficult to consistently reduce the background VOC levels in serum or whole blood below detectable levels. Matrix spike experiments are performed to verify that calibration curves in whole blood and water had the same slope. This result validates the use of water-based calibrators for quantifying VOCs in whole blood.

a. Instrument response calibration

A full set of seven calibrators is analyzed with each batch of data and used for the quantitation of analytes in all samples from that batch. Calibration curves are constructed for each analyte from the response ratios of the seven calibrators, which are separated in concentration by a factor of $\sqrt{10}$. The slope and intercept of curves are determined by linear least squares of data weighted 1/X. Calibration curves for some compounds can be linearized by universal transform by adjusting for background and internal standard ion contribution to the standard ion and/or exclusion of nonlinear portion of the curve. A non-linear curve can be fit with a second order quadratic curve as long as no data points are quantified through extrapolation. Calibration curves are composed of at least five standard levels that span the range of all detectable unknown samples, and achieve a squared coefficient of determination of at least 0.98. The highest point on the calibration curve is above the expected range of results for non-occupationally exposed people and the lowest point is near or below the measurable detection limits.

b. Calibration verification

Calibration accuracy is tested with each run by analysis of water blank and quality control samples. A full set of calibrators is analyzed with each batch of blood samples. Absolute accuracy is verified by performance tests at approximately 6 months.

6. Procedure Operation Instructions; Calculations; Interpretation of Results

a. Analysis of samples

Prior to analysis, all blood and QC samples are thoroughly mixed and equilibrated at room temperature. For analysis, 3-mL samples of blood, bovine serum QC, and water blank samples are transferred to standard 10-mL headspace vials via separate 5-mL Luerlock gas-tight syringes fitted with disposable 18 gauge needles. Each sample is immediately spiked with the working internal standard solution, which is delivered by positive displacement pipet, and capped. Sample quantities are verified gravimetrically. All materials have been cleaned in accordance with methods described in Section 6.

b. Data analysis

Samples are quantified by their analyte ion peak area (or peak height) to internal standard ion peak area (or peak height) ratio, which compensates for loss after sample preparation, as well as variation in partitioning and SPME extraction efficiency. Blood, water blank and QC sample concentrations are multiplied by the appropriate dilution factor, which are determined by sample weight, and quantified from the standard response curves.

c. Data Processing

1) Peak Integration

Each peak is visually inspected and peak integration is corrected if the integrator erroneously integrates a peak. The integration approach for all samples is kept consistent for a specific target ion. However, if the absolute ion signal is not at least a factor of 3 above the peak-to-peak noise then peak integration is not adjusted or values are not reported. For levels measured above the LOD, confirmation ion signal is quantified.

2) Excluding calibrators

Calibrator data is only excluded if the data significantly affects (>10%) the detectable result and the cause affecting only that standard is identified. Scenarios that might only affect a single standard include a poor seal on a headspace vial, a cracked secondary standard ampule, no or low addition of internal standard, and contamination of the standard set during storage. However, standards level 6, 7, or both can be excluded if the calibration curve is nonlinear over this region and all QCs and unknowns fall below standard level 5.

3) Excluding sample data

Sample data is excluded if no or low ISTD is added to the blood sample. Absolute internal standard response is evaluated for consistency among the standards, water blanks, QCs and blood samples. An unusually high internal standard level can occur if the ISTD is added twice. A low or absent ISTD response can occur if no internal standard is added, an intermediate standard vial was cracked, or a vial cap seal was poor.

d. Formal Quality Control Material Evaluation

Quality control sample results are formally evaluated by an independent quality control officer following import of data into a relational database. The QC samples analyzed with a batch of data are evaluated against the characterized means and standard deviation limits determined by the QC officer. The QC samples are evaluated using modified Westgard rules as specified by DLS SAS program.[7,9] Any failure of QC rules for an analyte results in rejection of the corresponding data for that analyte on the specific day in question. Once the source of the QC problem is identified, the samples are subsequently reanalyzed.

e. Additional Quality Assurance Data Evaluation

Other quality parameters are examined in addition to evaluation of quality control specimen for acceptable precision and accuracy. These include evaluation of confirmation ion ratios, sufficient internal standard response, and water blank sample bias.

f. Blood sample repeat limits

Unknown blood samples that yield concentrations higher than the 95th percentile of the accumulated National Health and Nutrition Examination Survey (NHANES) population are repeated. This action is performed to ensure that the sample was not inadvertently contaminated throughout the sample preparation process.

Repeat measurements of samples stored at 2–6 °C indicate that whole blood VOC samples can be banked for a total of 16 weeks if the blood remains unclotted and homogenized. Because these are whole blood samples, longer storage results in samples which are harder to manipulate, which produces additional analytical problems. Thus, even though analytical results may not change over this time, samples may be less amenable to analysis.

7. Reportable Range of Results

a. Reportable Limits

The lowest reportable value is the higher of the detection limit and the lowest standard. The upper reportable value is the highest linear standard.

b. Limits of Detection

Limits of detection are based on calculation of three times the standard deviation at zero concentration ($3S_0$) as described by Taylor.[7] Assay detection limits change with improvements in sensitivity, precision, and sample integrity.

8. Quality Assessment

Quality assurance and quality control procedures follow standard practices.[8] Daily experimental checks are made on the stability of the analytical system. Standards and quality control materials are added to each day's run sequence. At least three quality assessment sample types are analyzed in each run that include the water blank and two QC samples at different concentrations. All of these samples are prepared with the unknown blood samples. In addition to these samples, there is a water blank prepared with the standards. Absolute responses and their retention times from the lowest calibrator are evaluated from the previous run to verify method and instrument performance.

a. Accuracy

Absolute accuracy is evaluated by blind analysis of independently prepared certified proficiency test (PT) materials. Certified standard reference materials from the National Institute of Standards & Technology (NIST) are the first choice for independent validation of method accuracy. However, NIST only certifies a few of the VOCs that are measured. For example, NIST does not produce a reference standard for benzene. Because the issue of NIST traceability has long been recognized as a limitation with organic standards, we use reference materials from companies who are accredited with International Organization for Standardization (ISO) Guide 34 certification. Guide 34 is recognized by NIST, the international reference material body and other government agencies. PT samples and calibration standards are checked against the currently validated reference standard set. If a concentration for a compound in the PT sample or calibration standard is found to differ by more than 15% from the reference standard, then a validation standard containing the compound in question along with a control compound is formulated using a NIST or Guide 34 material to verify and correct the inaccuracy.

The PT results are evaluated by a PT Coordinator. Five PT samples are analyzed twice a year using the same method described for unknown samples. The analysis passes proficiency testing if >80% of the results deviate <25% from the known value. If an analyte fails to meet these minimum PT criteria, it fails the test. Blood sample results are not reported for those analytes that do not successfully pass proficiency testing.

Accuracy is also verified by spiked recovery from blood. Because blood is an unstable matrix, no standard reference material is available. Thus, it is necessary to prepare these samples in-house using the intermediate standard solutions. The accuracy basis for this method is established by determining the recovery of spiked blood samples. The percent recoveries fall between 75 and 125%.

Relative accuracy is evaluated upon comparison of characterized QC mean values with those obtained on each run. Error in relative accuracy should not exceed the precision of the characterized QC samples. If such error occurs, the source of error is identified and the data corresponding to the analyte with the failed QC is not reported.

b. Precision

Precision is evaluated using the QC sample results. Two different pools of quality control material are used, one at a low and the other at a high concentration. Expected precision ranges for the QC samples are established for a new QC batch by performing at least 20 separate analyses extending over different samples, batches, days, and instruments. One instrument characterizes no more than 2 samples from one ampule per day. The mean, standard deviations (i.e., within run, among run, and overall), and control limits are determined from this QC characterization data set. Individual quality control charts for the characterization runs are created, examined, and quality control limits are used to verify assay precision and accuracy on a daily basis. Relative standard deviations for the QC samples are in most cases less than 15%. Standard deviations are larger for analytes with high background levels in the bovine serum.

c. Analytical Specificity

Analytical specificity is established by comparing the ratios of the areas (or height) of analyte ion chromatographic peaks with those of confirmation ions along with GC retention times relative to the ISTD ion.

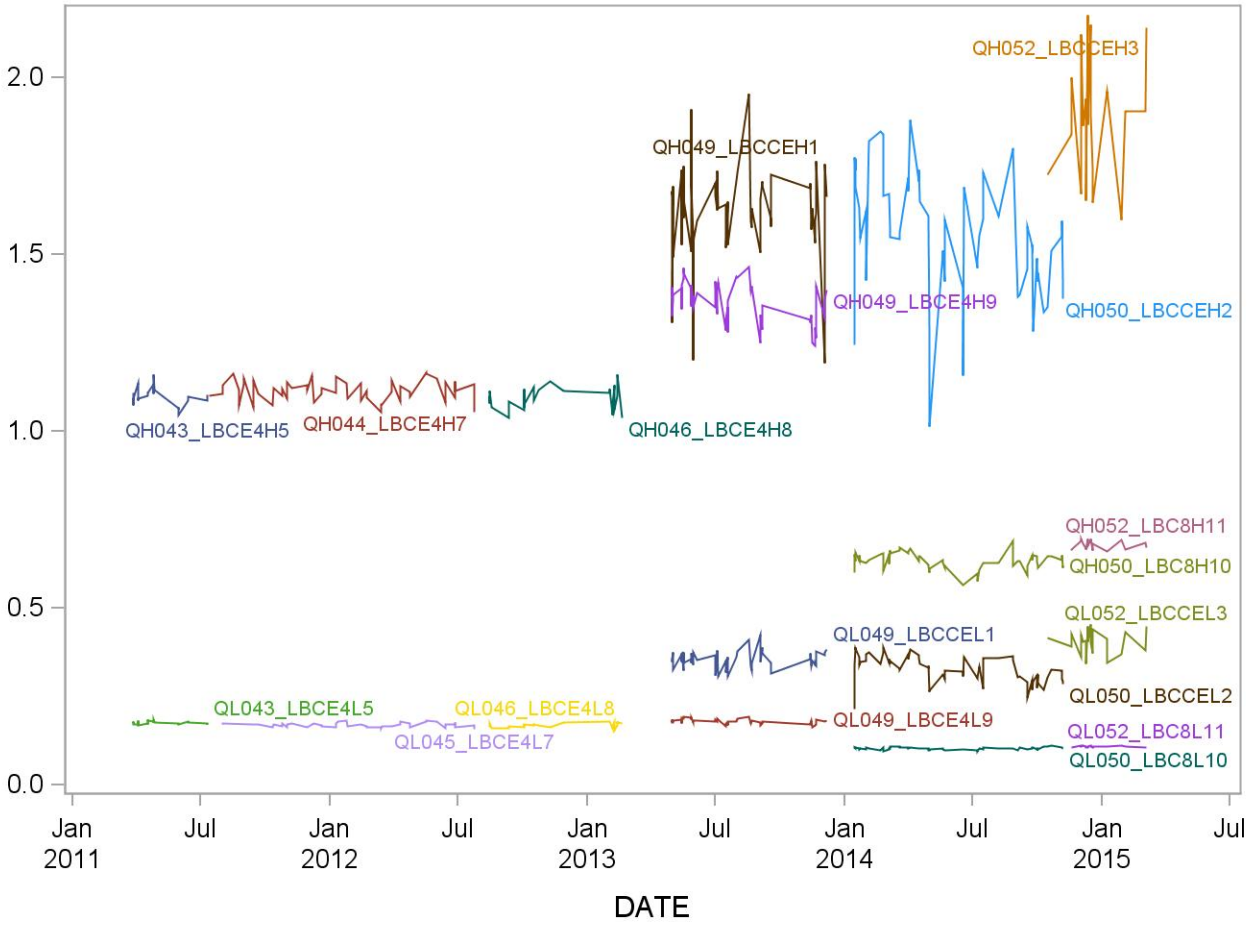
Additional steps taken to achieve analytical specificity involves removing interfering compounds from the sample analysis system. Interferences that have their source in the measurement apparatus itself are examined by measuring instrument blanks. All materials and reagents used for this assay are screened and treated to remove possible interferences as described above in Section 4. The presence of co-eluting interferences is monitored by using water blanks.

9. Summary Statistics and Graphs

See following pages.

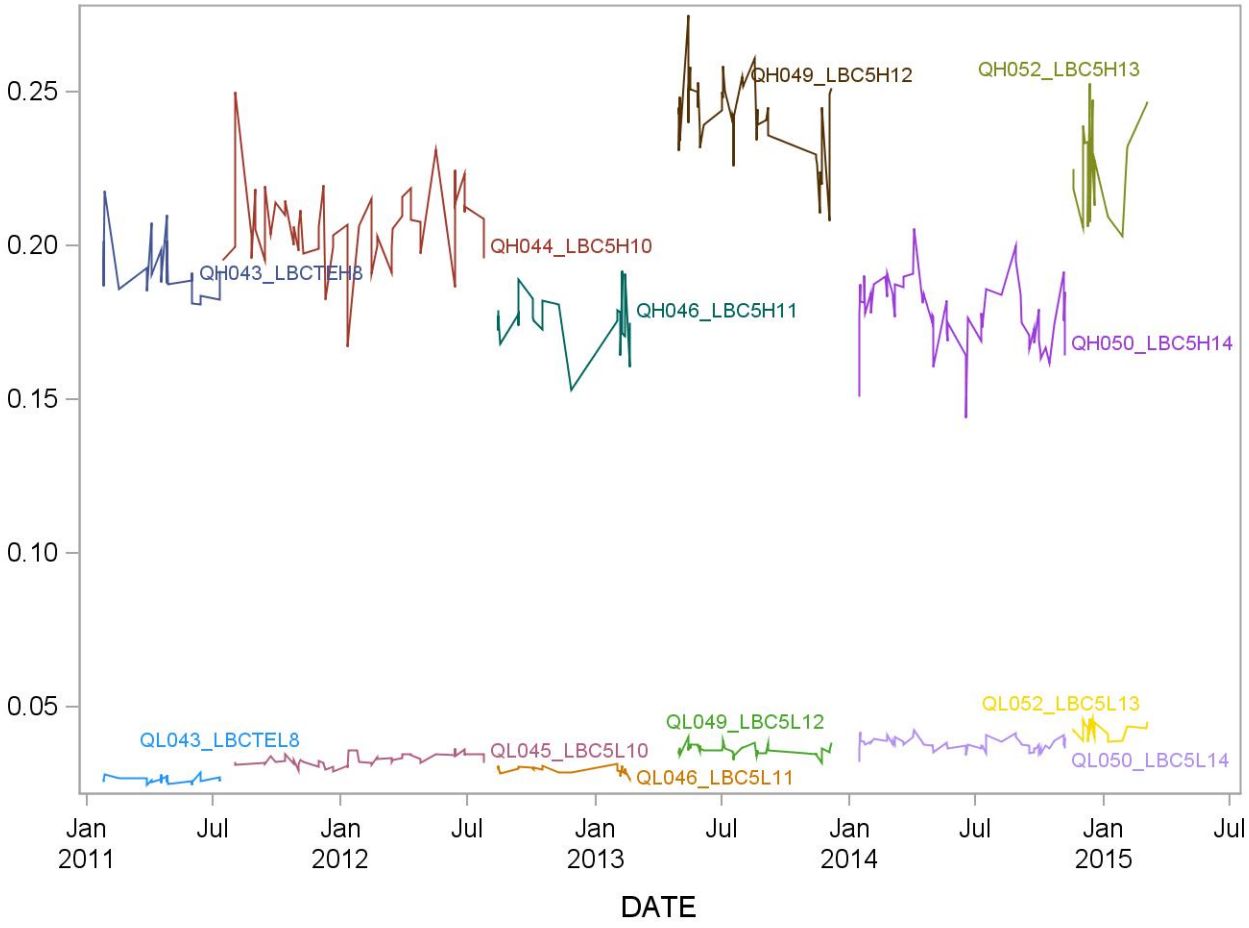
2011-2012 Summary Statistics and QC Chart for Blood 1,1,1,2-Tetrachloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCE4H5	22	28MAR11	11JUL11	1.0993	0.0254	2.3
QL043_LBCE4L5	23	28MAR11	11JUL11	0.1764	0.0045	2.6
QH044_LBCE4H7	52	14JUL11	24JUL12	1.1139	0.0286	2.6
QL045_LBCE4L7	49	02AUG11	24JUL12	0.1701	0.0060	3.5
QH046_LBCE4H8	27	14AUG12	19FEB13	1.0940	0.0337	3.1
QL046_LBCE4L8	26	14AUG12	19FEB13	0.1697	0.0069	4.1
QH049_LBCCEH1	54	30APR13	06DEC13	1.6279	0.1329	8.2
QL049_LBCCEL1	54	30APR13	06DEC13	0.3547	0.0243	6.9
QH049_LBCE4H9	51	30APR13	06DEC13	1.3660	0.0576	4.2
QL049_LBCE4L9	51	30APR13	06DEC13	0.1804	0.0070	3.9
QH050_LBC8H10	60	14JAN14	06NOV14	0.6328	0.0229	3.6
QL050_LBC8L10	60	14JAN14	06NOV14	0.1034	0.0033	3.2
QH050_LBCCEH2	63	14JAN14	06NOV14	1.5570	0.1735	11.1
QL050_LBCCEL2	63	14JAN14	06NOV14	0.3267	0.0385	11.8
QH052_LBCCEH3	19	15OCT14	05MAR15	1.8840	0.1807	9.6
QL052_LBCCEL3	20	15OCT14	05MAR15	0.4044	0.0336	8.3
QH052_LBC8H11	18	18NOV14	05MAR15	0.6784	0.0135	2.0
QL052_LBC8L11	19	18NOV14	05MAR15	0.1088	0.0021	1.9



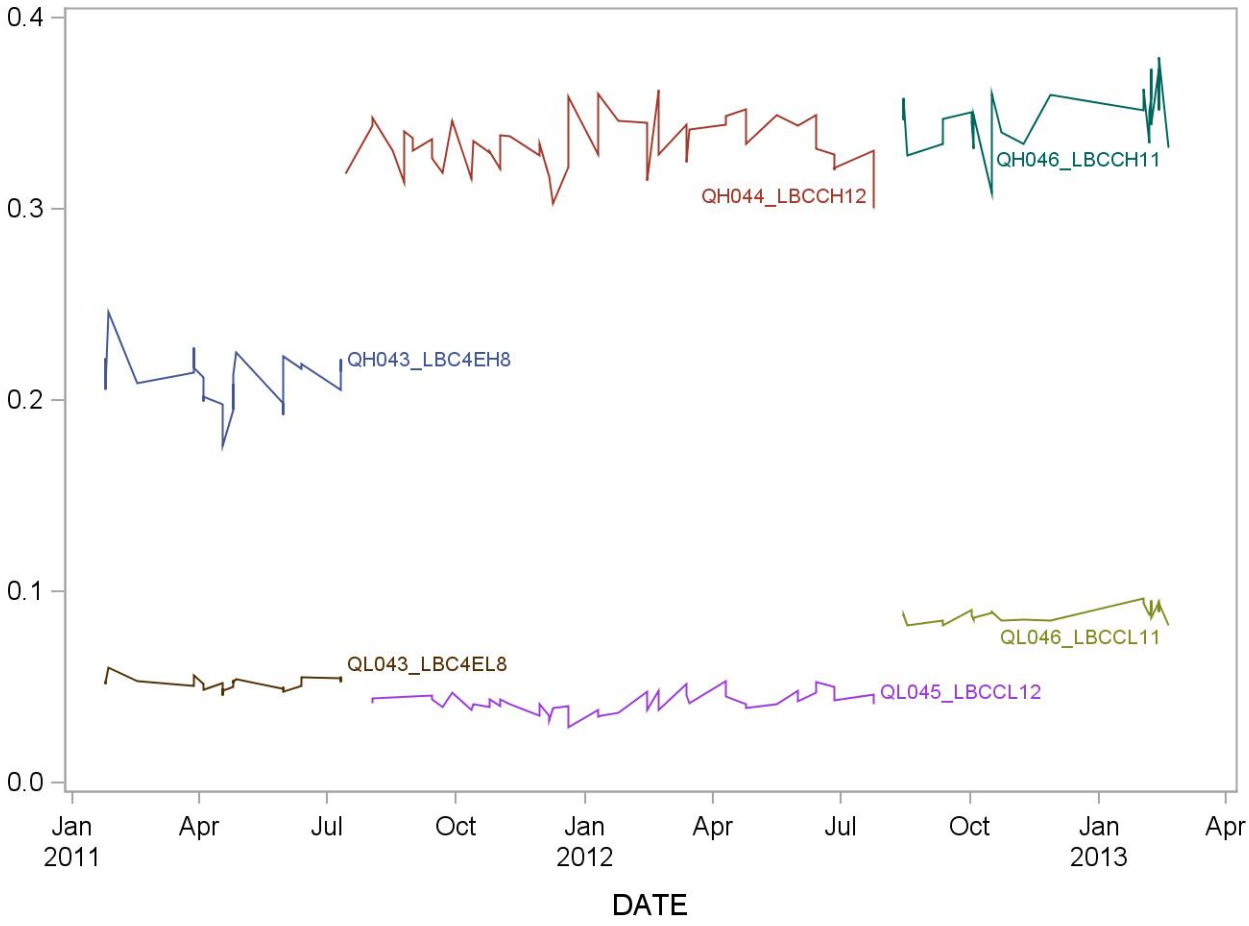
2011-2012 Summary Statistics and QC Chart for Blood 1,1,1-Trichloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCTEH8	26	24JAN11	11JUL11	0.19188	0.00918	4.8
QL043_LBCTEL8	27	24JAN11	11JUL11	0.02644	0.00103	3.9
QH044_LBC5H10	51	14JUL11	24JUL12	0.20605	0.01285	6.2
QL045_LBC5L10	48	02AUG11	24JUL12	0.03285	0.00178	5.4
QH046_LBC5H11	27	14AUG12	19FEB13	0.17638	0.00872	4.9
QL046_LBC5L11	26	14AUG12	19FEB13	0.02956	0.00125	4.2
QH049_LBC5H12	51	30APR13	06DEC13	0.24174	0.01238	5.1
QL049_LBC5L12	51	30APR13	06DEC13	0.03607	0.00169	4.7
QH050_LBC5H14	62	14JAN14	06NOV14	0.17837	0.01110	6.2
QL050_LBC5L14	62	14JAN14	06NOV14	0.03803	0.00197	5.2
QH052_LBC5H13	18	18NOV14	05MAR15	0.22643	0.01622	7.2
QL052_LBC5L13	19	18NOV14	05MAR15	0.04267	0.00260	6.1



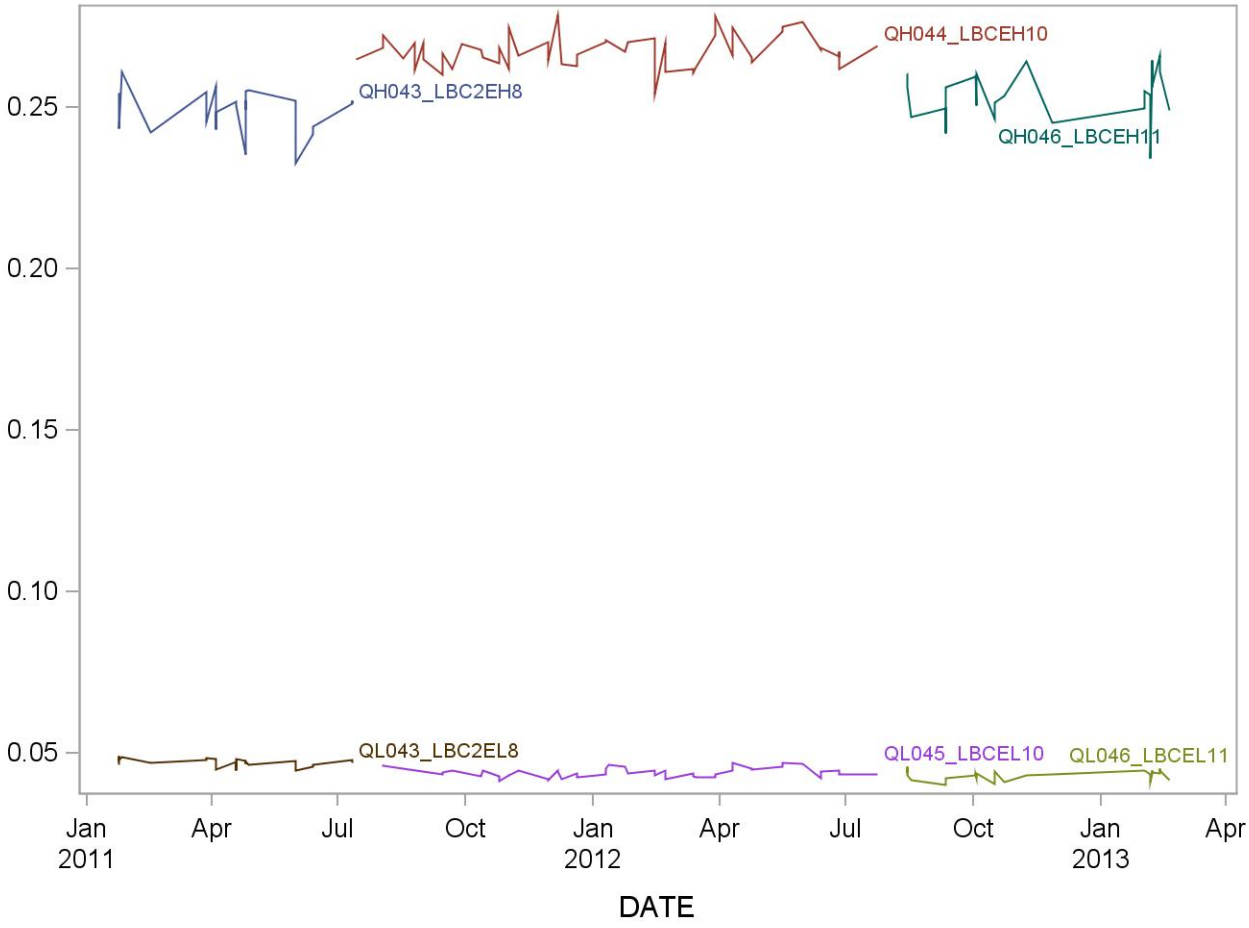
2011-2012 Summary Statistics and QC Chart for Blood 1,1,2,2-Tetrachloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC4EH8	27	24JAN11	11JUL11	0.20941	0.01446	6.9
QL043_LBC4EL8	28	24JAN11	11JUL11	0.05220	0.00299	5.7
QH044_LBCCH12	48	14JUL11	24JUL12	0.33370	0.01398	4.2
QL045_LBCCL12	45	02AUG11	24JUL12	0.04222	0.00524	12.4
QH046_LBCCH11	27	14AUG12	19FEB13	0.34821	0.01578	4.5
QL046_LBCCL11	26	14AUG12	19FEB13	0.08835	0.00397	4.5



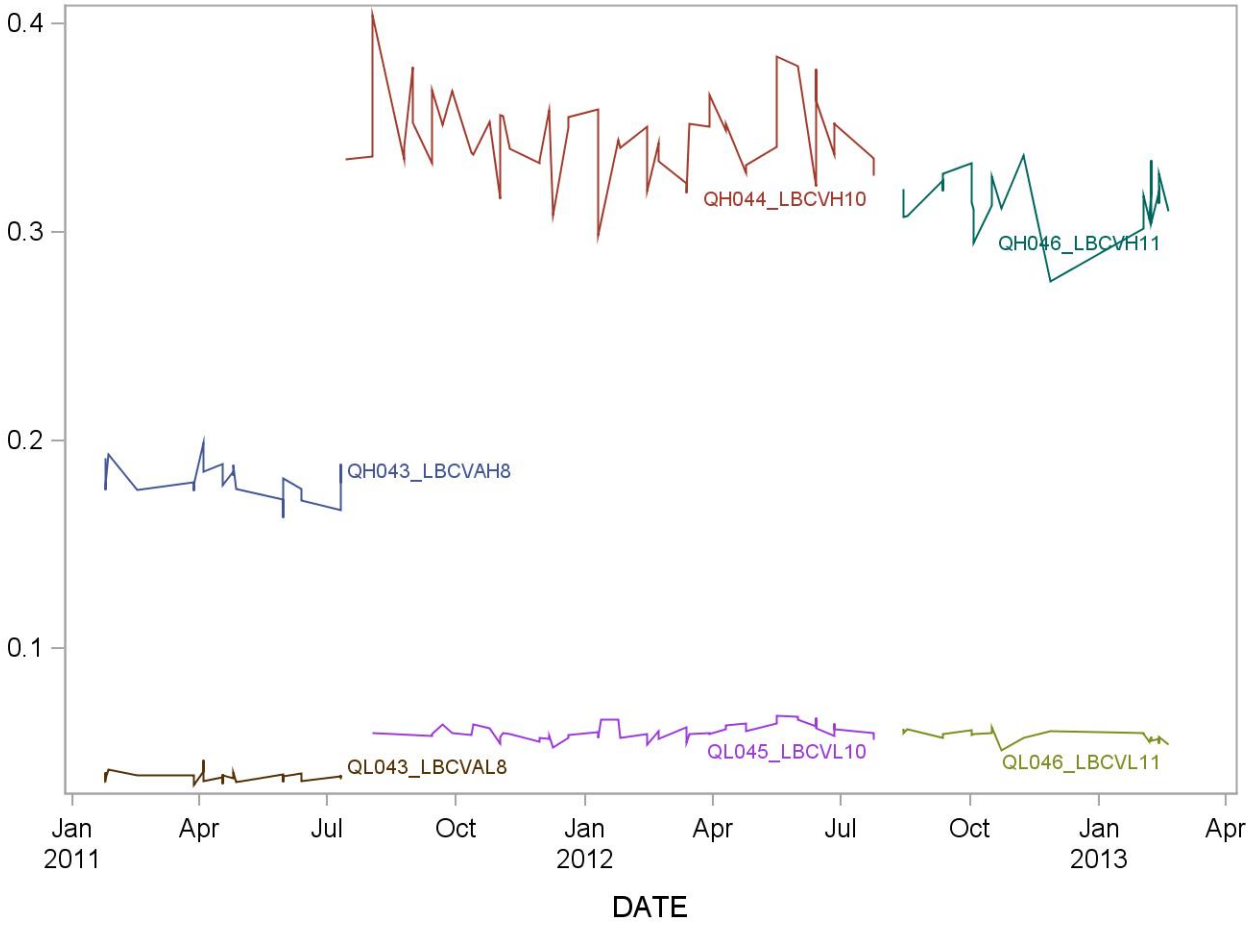
2011-2012 Summary Statistics and QC Chart for Blood 1,1,2-Tricholorethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC2EH8	27	24JAN11	11JUL11	0.24894	0.00638	2.6
QL043_LBC2EL8	28	24JAN11	11JUL11	0.04705	0.00121	2.6
QH044_LBCEH10	52	14JUL11	24JUL12	0.26731	0.00498	1.9
QL045_LBCEL10	49	02AUG11	24JUL12	0.04396	0.00149	3.4
QH046_LBCEH11	27	14AUG12	19FEB13	0.25458	0.00765	3.0
QL046_LBCEL11	26	14AUG12	19FEB13	0.04308	0.00149	3.5



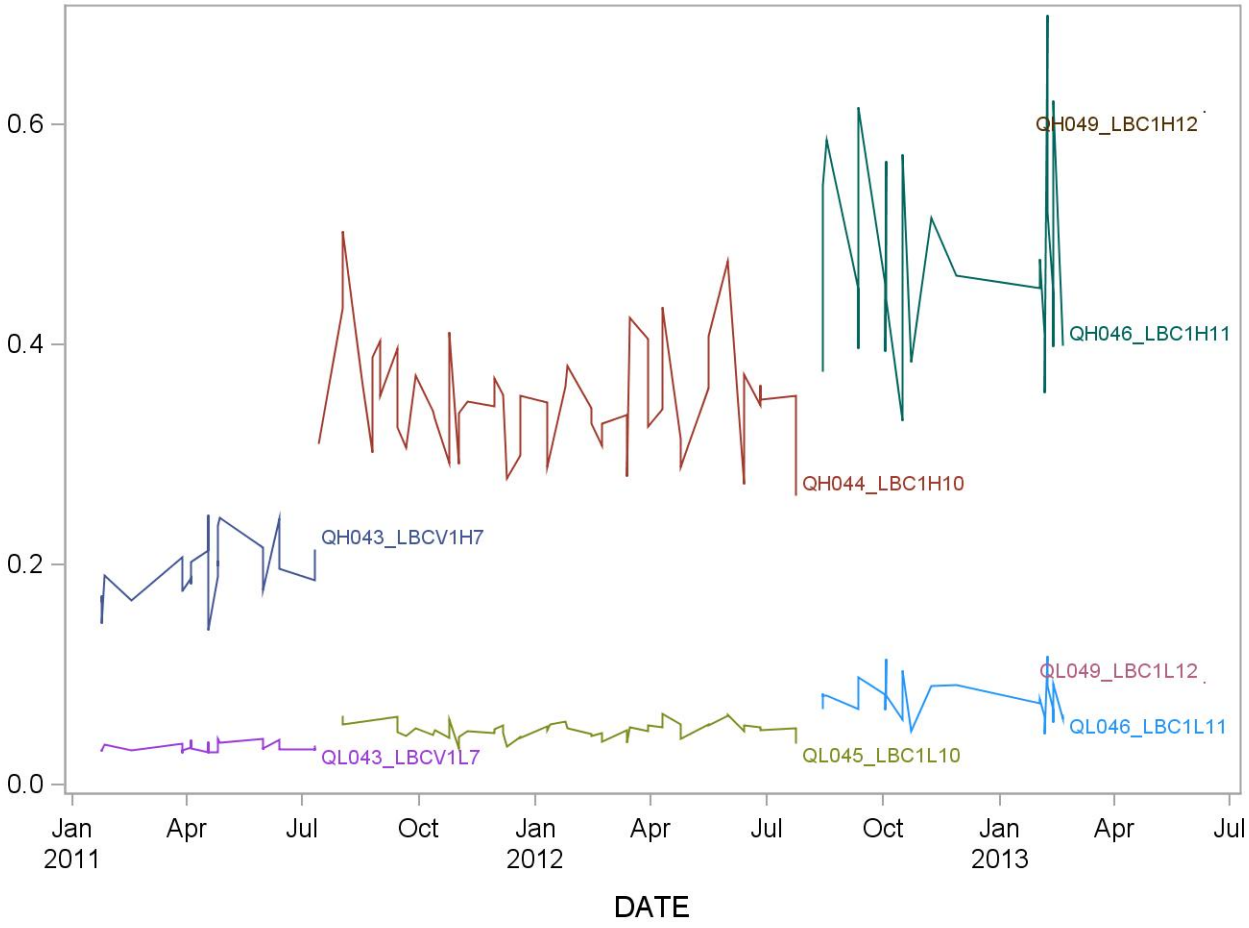
2011-2012 Summary Statistics and QC Chart for Blood 1,1-Dichloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCVAH8	27	24JAN11	11JUL11	0.18127	0.00819	4.5
QL043_LBCVAL8	28	24JAN11	11JUL11	0.03871	0.00243	6.3
QH044_LBCVH10	52	14JUL11	24JUL12	0.34556	0.01981	5.7
QL045_LBCVL10	50	02AUG11	24JUL12	0.06023	0.00360	6.0
QH046_LBCVH11	27	14AUG12	19FEB13	0.31477	0.01291	4.1
QL046_LBCVL11	26	14AUG12	19FEB13	0.05827	0.00258	4.4



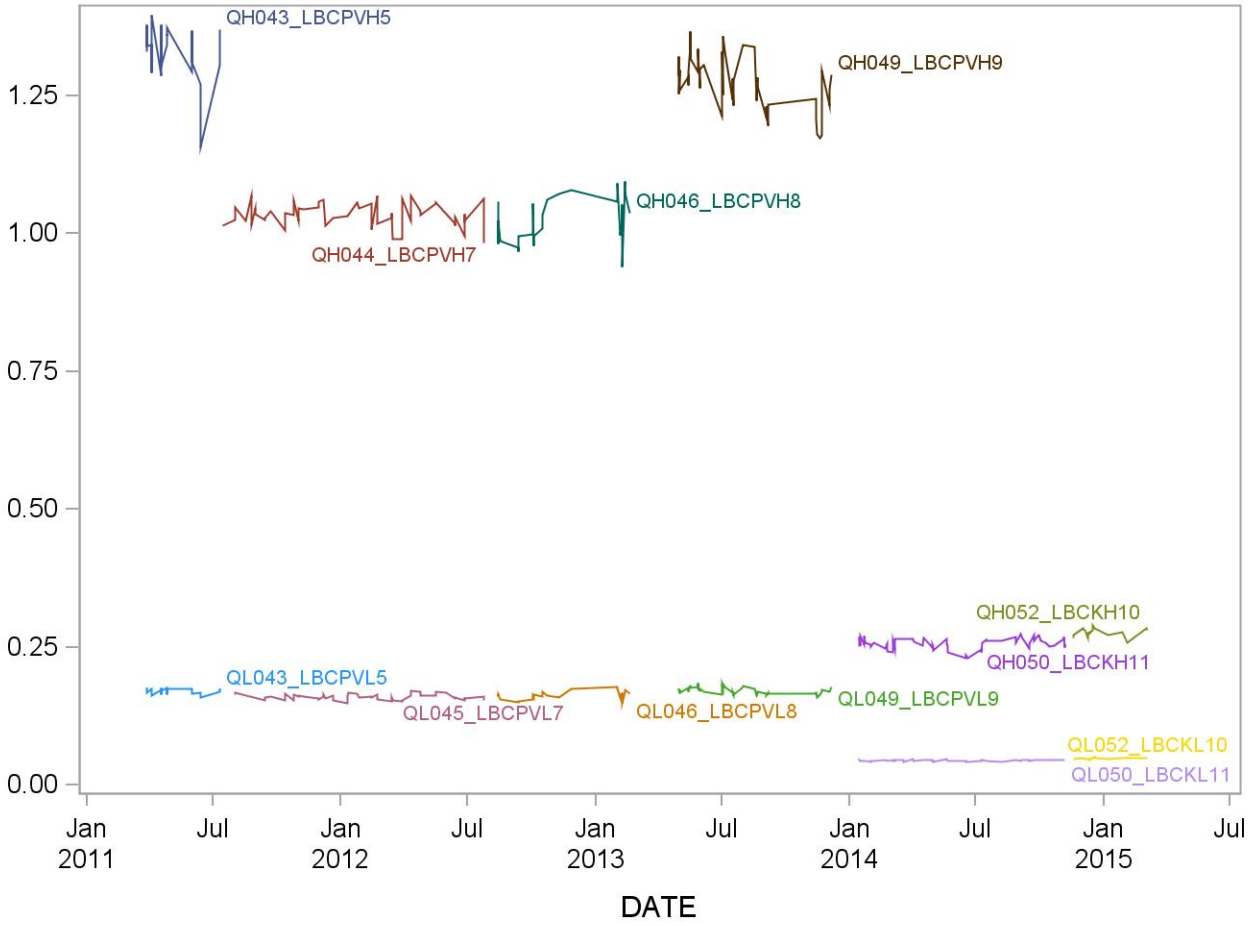
2011-2012 Summary Statistics and QC Chart for Blood 1,1-Dichloroethene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCV1H7	27	24JAN11	11JUL11	0.19511	0.02684	13.8
QL043_LBCV1L7	28	24JAN11	11JUL11	0.03452	0.00402	11.6
QH044_LBC1H10	53	14JUL11	24JUL12	0.35067	0.05017	14.3
QL045_LBC1L10	50	02AUG11	24JUL12	0.05020	0.00717	14.3
QH046_LBC1H11	28	14AUG12	19FEB13	0.47959	0.09563	19.9
QL046_LBC1L11	27	14AUG12	19FEB13	0.07875	0.01838	23.3



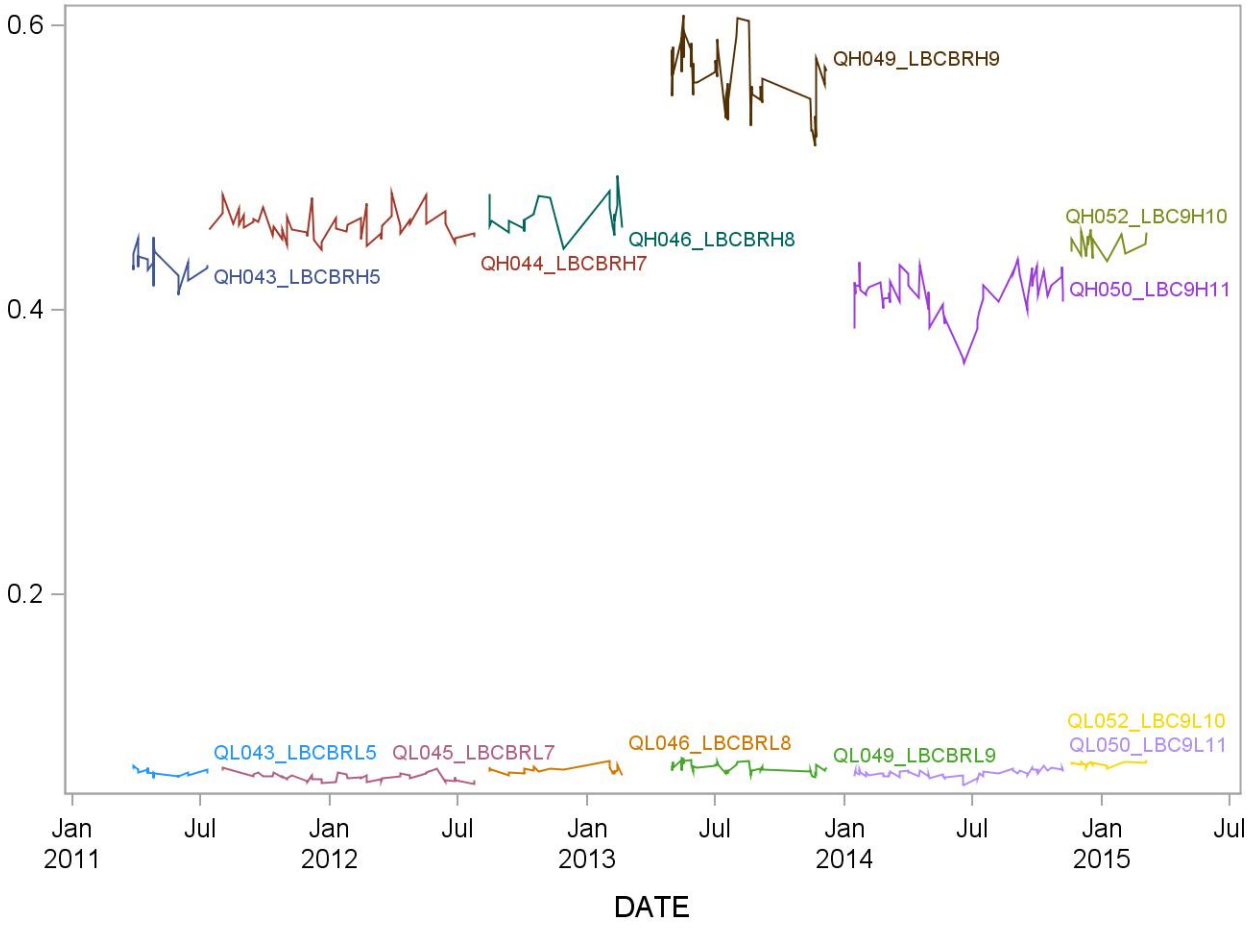
2011-2012 Summary Statistics and QC Chart for Blood 1,2,3-Trichloropropane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCPVH5	22	28MAR11	11JUL11	1.33100	0.05256	3.9
QL043_LBCPVL5	23	28MAR11	11JUL11	0.17049	0.00502	2.9
QH044_LBCPVH7	51	14JUL11	24JUL12	1.03393	0.02124	2.1
QL045_LBCPVL7	48	02AUG11	24JUL12	0.15978	0.00525	3.3
QH046_LBCPVH8	27	14AUG12	19FEB13	1.02580	0.04220	4.1
QL046_LBCPVL8	26	14AUG12	19FEB13	0.16342	0.00756	4.6
QH049_LBCPVH9	50	30APR13	06DEC13	1.27487	0.04849	3.8
QL049_LBCPVL9	50	30APR13	06DEC13	0.17143	0.00606	3.5
QH050_LBCKH11	62	14JAN14	06NOV14	0.25696	0.01038	4.0
QL050_LBCKL11	62	14JAN14	06NOV14	0.04471	0.00126	2.8
QH052_LBCKH10	18	18NOV14	05MAR15	0.27733	0.00756	2.7
QL052_LBCKL10	19	18NOV14	05MAR15	0.04834	0.00124	2.6



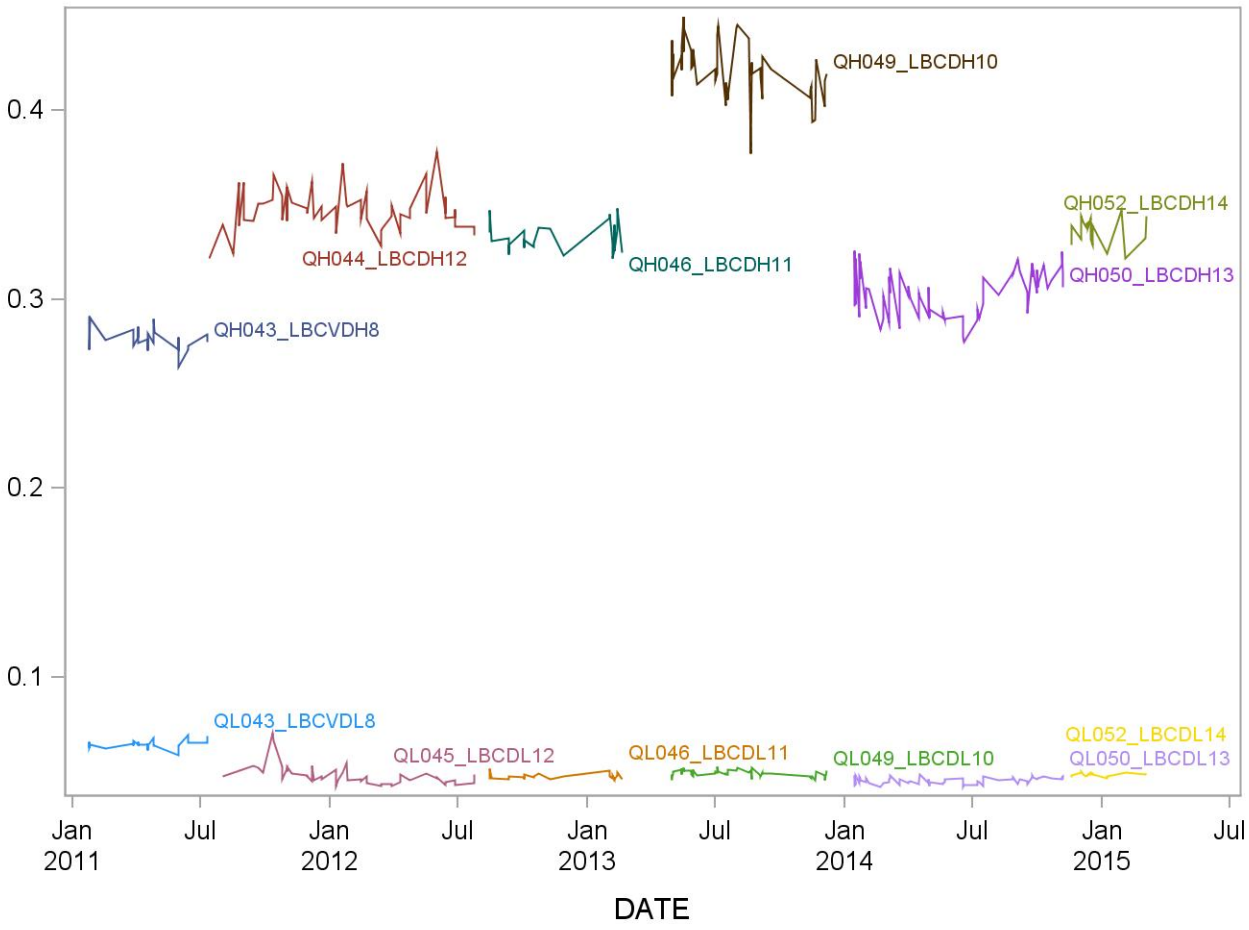
2011-2012 Summary Statistics and QC Chart for Blood 1,2-Dibromoethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCBRH5	22	28MAR11	11JUL11	0.43216	0.01077	2.5
QL043_LBCBRL5	23	28MAR11	11JUL11	0.07510	0.00220	2.9
QH044_LBCBRH7	52	14JUL11	24JUL12	0.45997	0.00955	2.1
QL045_LBCBRL7	49	02AUG11	24JUL12	0.07150	0.00257	3.6
QH046_LBCBRH8	27	14AUG12	19FEB13	0.46684	0.01214	2.6
QL046_LBCBRL8	26	14AUG12	19FEB13	0.07655	0.00234	3.1
QH049_LBCBRH9	51	30APR13	06DEC13	0.56511	0.02318	4.1
QL049_LBCBRL9	51	30APR13	06DEC13	0.07844	0.00347	4.4
QH050_LBC9H11	62	14JAN14	06NOV14	0.41064	0.01580	3.8
QL050_LBC9L11	62	14JAN14	06NOV14	0.07416	0.00267	3.6
QH052_LBC9H10	18	18NOV14	05MAR15	0.44663	0.00750	1.7
QL052_LBC9L10	19	18NOV14	05MAR15	0.08093	0.00155	1.9



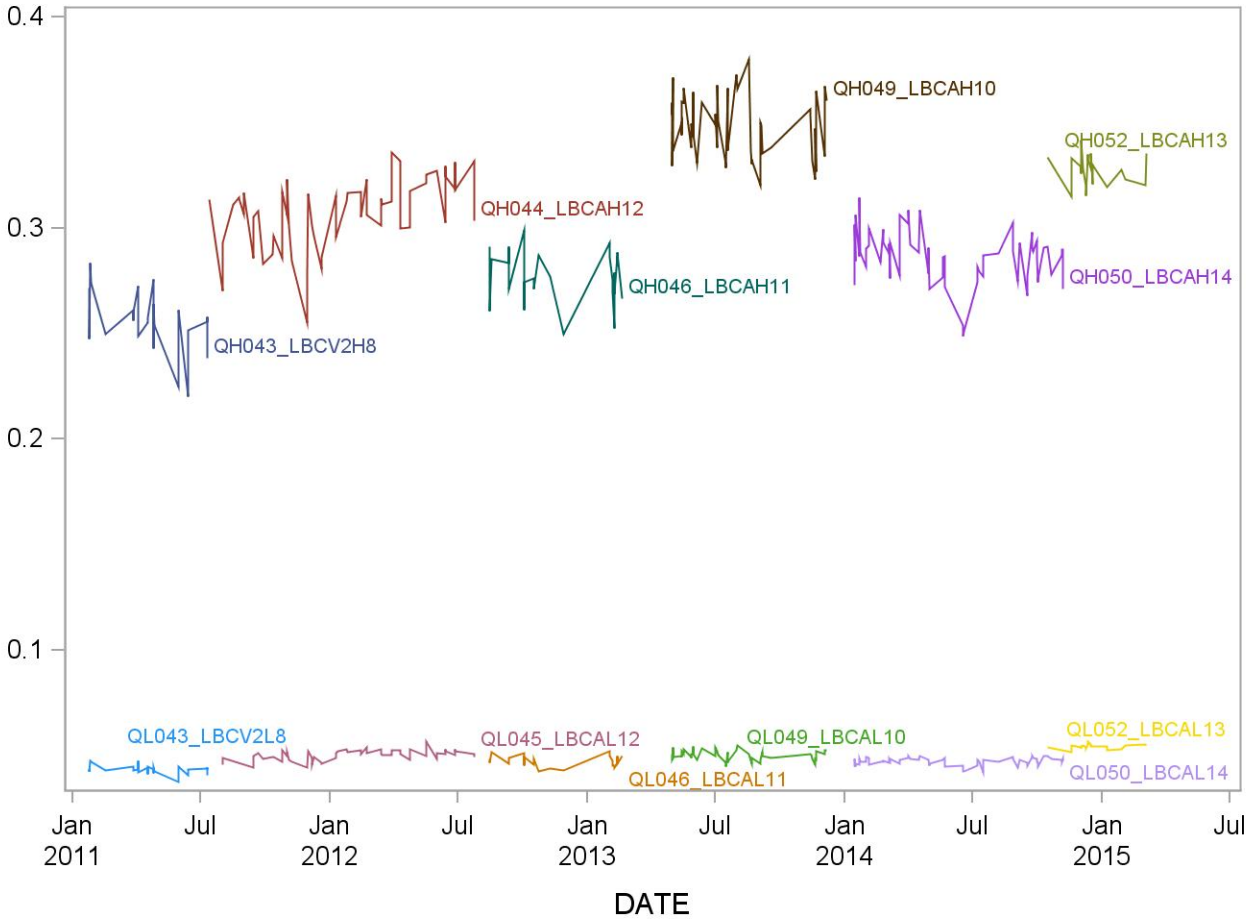
2011-2012 Summary Statistics and QC Chart for Blood 1,2-Dichlorobenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCVDH8	27	24JAN11	11JUL11	0.27965	0.00596	2.1
QL043_LBCVDL8	28	24JAN11	11JUL11	0.06470	0.00206	3.2
QH044_LBCDH12	53	14JUL11	24JUL12	0.34718	0.01108	3.2
QL045_LBCDL12	50	02AUG11	24JUL12	0.04798	0.00527	11.0
QH046_LBCDH11	26	14AUG12	19FEB13	0.33384	0.00818	2.5
QL046_LBCDL11	25	14AUG12	19FEB13	0.04765	0.00150	3.2
QH049_LBCDH10	51	30APR13	06DEC13	0.42135	0.01510	3.6
QL049_LBCDL10	51	30APR13	06DEC13	0.04921	0.00178	3.6
QH050_LBCDH13	63	14JAN14	06NOV14	0.30328	0.01216	4.0
QL050_LBCDL13	63	14JAN14	06NOV14	0.04533	0.00175	3.9
QH052_LBCDH14	18	18NOV14	05MAR15	0.33626	0.00712	2.1
QL052_LBCDL14	19	18NOV14	05MAR15	0.04856	0.00091	1.9



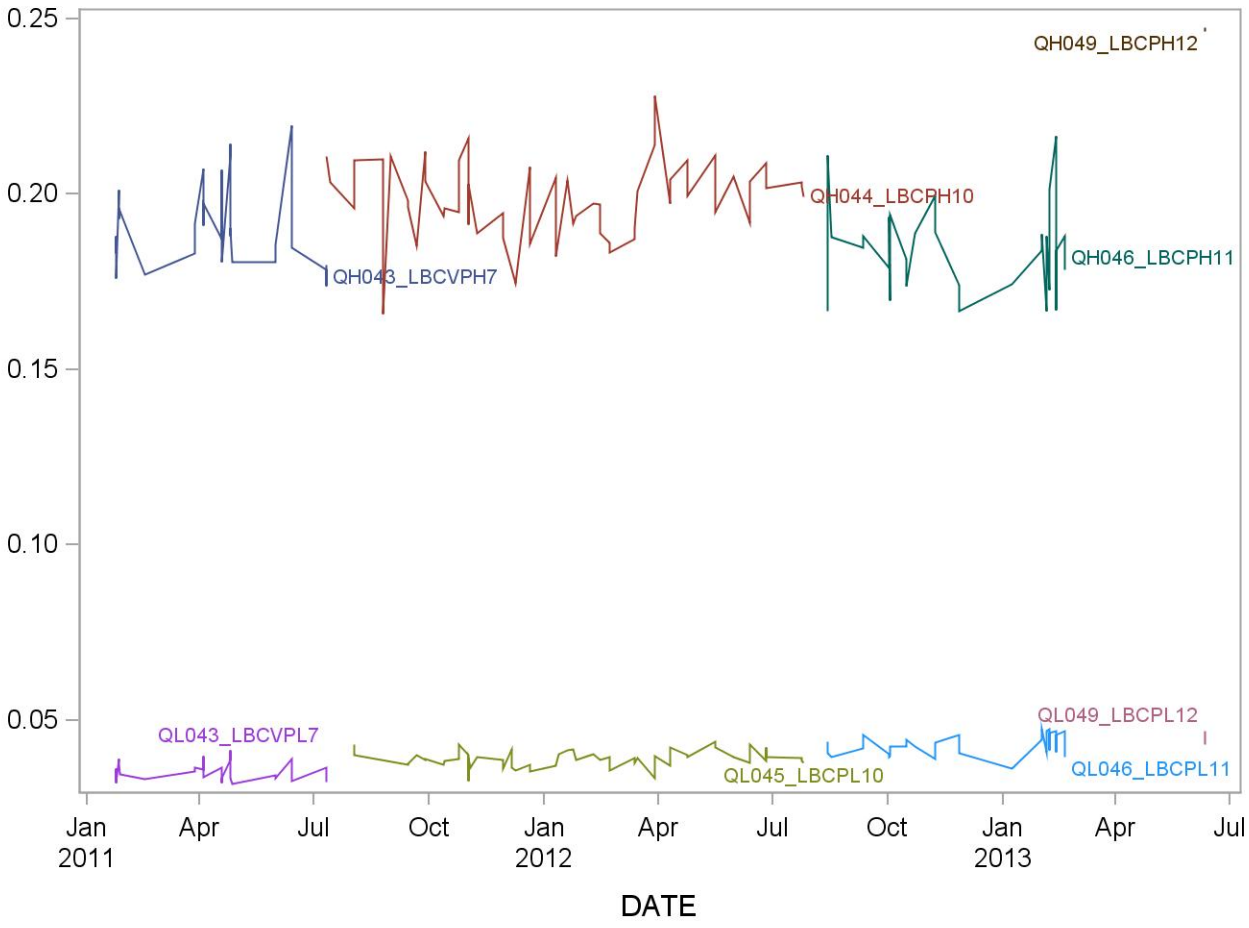
2011-2012 Summary Statistics and QC Chart for Blood 1,2-Dichloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCV2H8	28	24JAN11	11JUL11	0.25543	0.01455	5.7
QL043_LBCV2L8	29	24JAN11	11JUL11	0.04336	0.00213	4.9
QH044_LBCAH12	55	14JUL11	24JUL12	0.30700	0.01685	5.5
QL045_LBCAL12	52	02AUG11	24JUL12	0.05015	0.00259	5.2
QH046_LBCAH11	27	14AUG12	19FEB13	0.27702	0.01244	4.5
QL046_LBCAL11	26	14AUG12	19FEB13	0.04723	0.00261	5.5
QH049_LBCAH10	54	30APR13	06DEC13	0.34821	0.01466	4.2
QL049_LBCAL10	54	30APR13	06DEC13	0.05015	0.00234	4.7
QH050_LBCAH14	63	14JAN14	06NOV14	0.28577	0.01303	4.6
QL050_LBCAL14	63	14JAN14	06NOV14	0.04733	0.00183	3.9
QH052_LBCAH13	20	15OCT14	05MAR15	0.32744	0.00730	2.2
QL052_LBCAL13	21	15OCT14	05MAR15	0.05433	0.00109	2.0



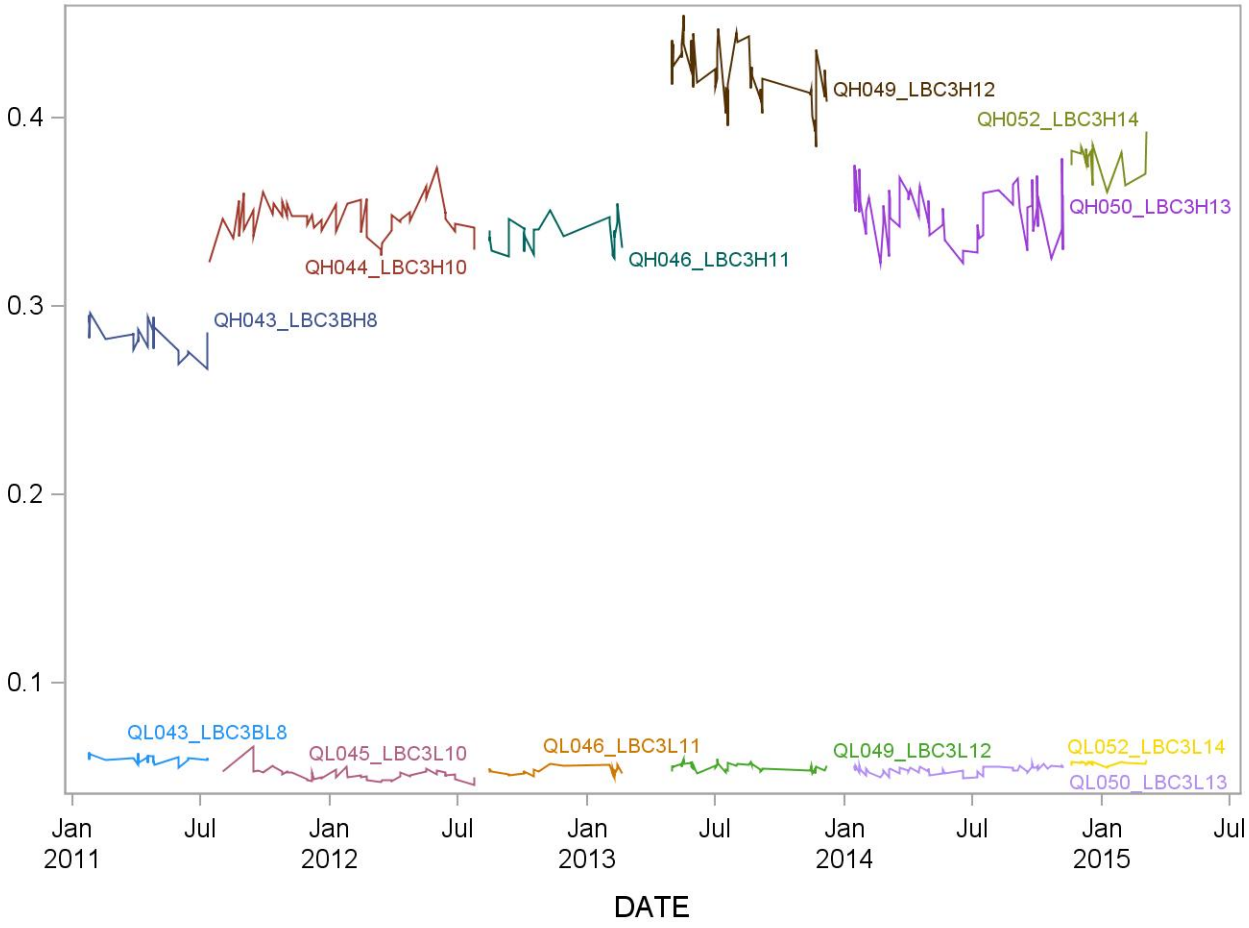
2011-2012 Summary Statistics and QC Chart for Blood 1,2-Dichloropropane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCVPH7	29	24JAN11	11JUL11	0.19023	0.01200	6.3
QL043_LBCVPL7	30	24JAN11	11JUL11	0.03512	0.00258	7.4
QH044_LBCPH10	57	11JUL11	26JUL12	0.19906	0.01089	5.5
QL045_LBCPL10	56	02AUG11	26JUL12	0.03903	0.00230	5.9
QH046_LBCPH11	31	14AUG12	19FEB13	0.18421	0.01238	6.7
QL046_LBCPL11	29	14AUG12	19FEB13	0.04295	0.00310	7.2
QH049_LBCPH12	2	11JUN13	11JUN13	0.24700	0.00071	0.3
QL049_LBCPL12	2	11JUN13	11JUN13	0.04500	0.00283	6.3



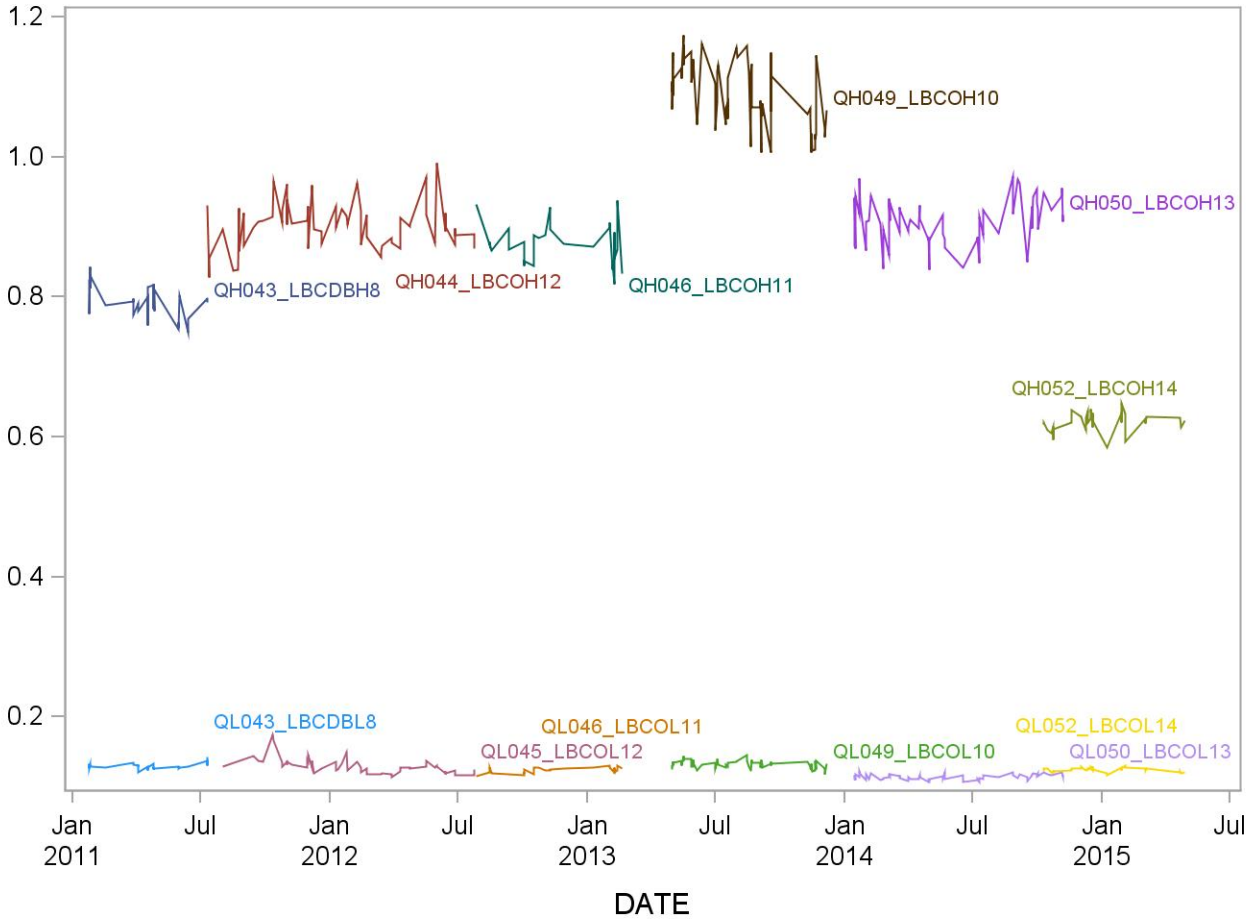
2011-2012 Summary Statistics and QC Chart for Blood 1,3-Dichlorobenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC3BH8	27	24JAN11	11JUL11	0.28341	0.00780	2.8
QL043_LBC3BL8	28	24JAN11	11JUL11	0.05951	0.00192	3.2
QH044_LBC3H10	52	14JUL11	24JUL12	0.34645	0.00950	2.7
QL045_LBC3L10	49	02AUG11	24JUL12	0.05132	0.00318	6.2
QH046_LBC3H11	26	14AUG12	19FEB13	0.33809	0.00822	2.4
QL046_LBC3L11	26	14AUG12	19FEB13	0.05349	0.00195	3.7
QH049_LBC3H12	51	30APR13	06DEC13	0.42397	0.01624	3.8
QL049_LBC3L12	51	30APR13	06DEC13	0.05558	0.00189	3.4
QH050_LBC3H13	61	14JAN14	06NOV14	0.34964	0.01387	4.0
QL050_LBC3L13	61	14JAN14	06NOV14	0.05376	0.00187	3.5
QH052_LBC3H14	18	18NOV14	05MAR15	0.37770	0.00840	2.2
QL052_LBC3L14	19	18NOV14	05MAR15	0.05732	0.00105	1.8



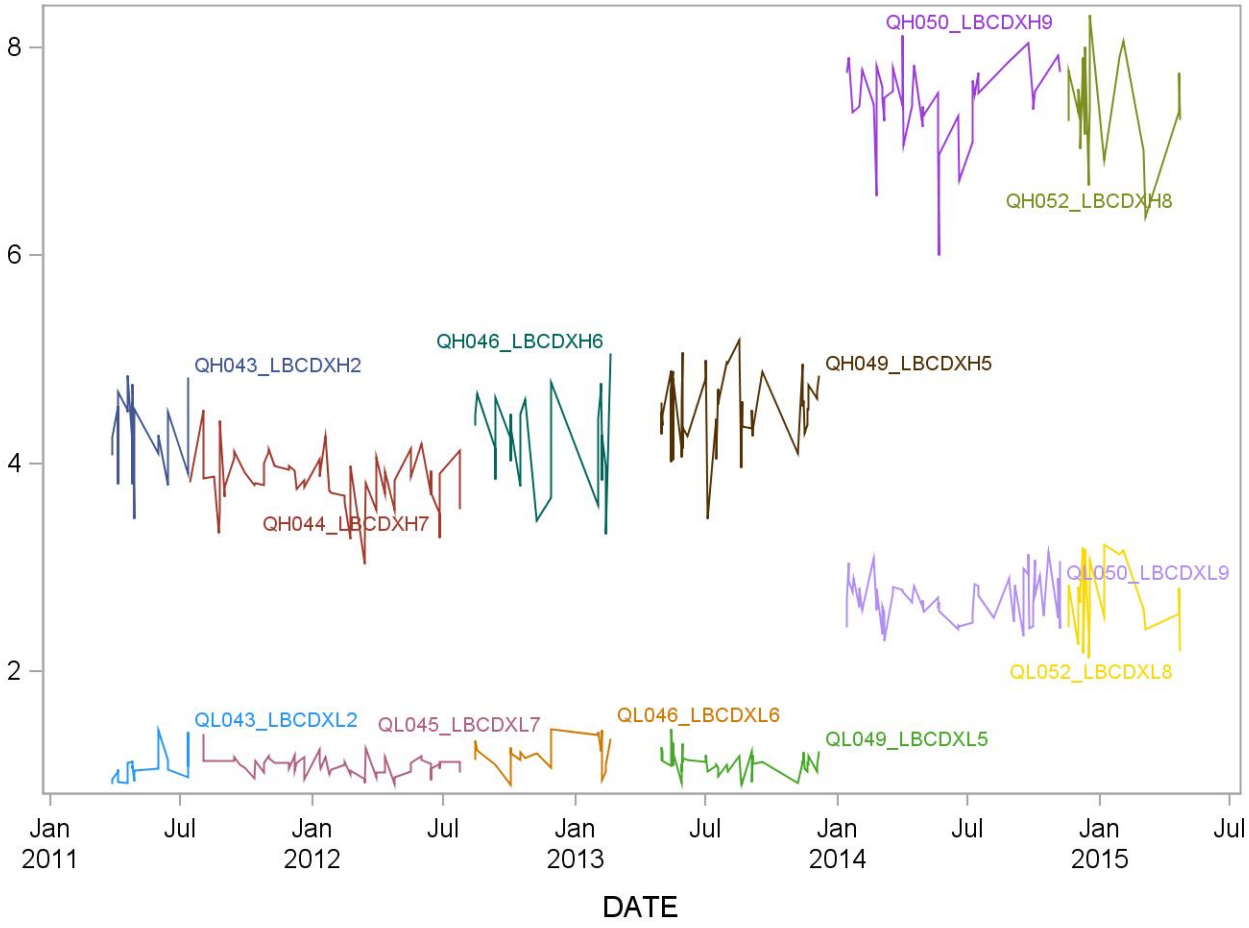
2011-2012 Summary Statistics and QC Chart for Blood 1,4-Dichlorobenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCDBH8	31	24JAN11	11JUL11	0.79311	0.02370	3.0
QL043_LBCDBL8	32	24JAN11	11JUL11	0.12957	0.00413	3.2
QH044_LBCOH12	60	11JUL11	24JUL12	0.90196	0.03315	3.7
QL045_LBCOL12	54	02AUG11	24JUL12	0.12966	0.01132	8.7
QH046_LBCOH11	30	26JUL12	19FEB13	0.87752	0.02937	3.3
QL046_LBCOL11	30	26JUL12	19FEB13	0.12368	0.00431	3.5
QH049_LBCOH10	64	30APR13	06DEC13	1.09071	0.04792	4.4
QL049_LBCOL10	64	30APR13	06DEC13	0.13247	0.00563	4.2
QH050_LBCOH13	67	14JAN14	06NOV14	0.90769	0.03407	3.8
QL050_LBCOL13	67	14JAN14	06NOV14	0.11476	0.00397	3.5
QH052_LBCOH14	35	09OCT14	28APR15	0.62161	0.01343	2.2
QL052_LBCOL14	36	09OCT14	28APR15	0.12449	0.00312	2.5



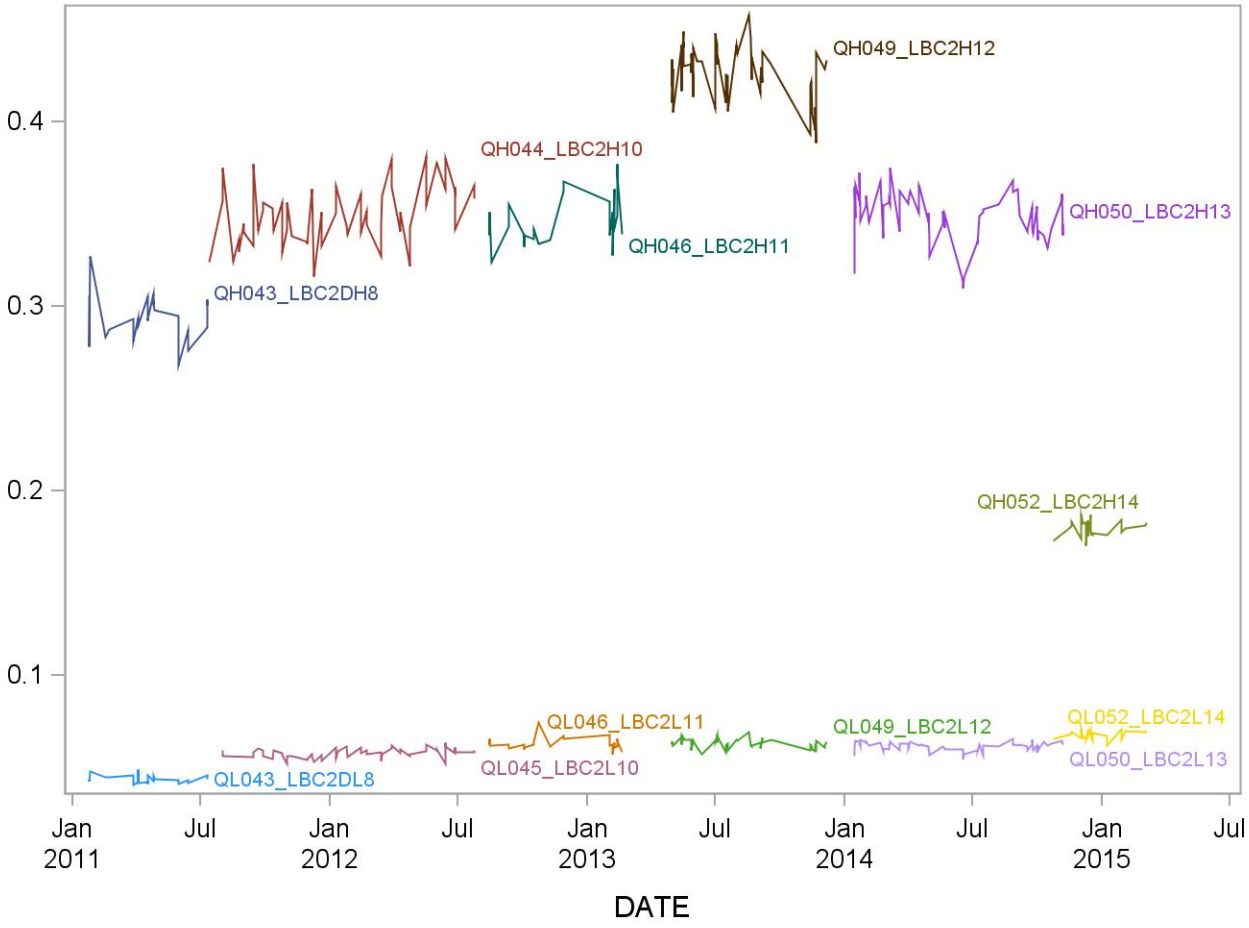
2011-2012 Summary Statistics and QC Chart for Blood 1,4-Dioxane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCDXH2	23	28MAR11	11JUL11	4.30677	0.38292	8.9
QL043_LBCDXL2	24	28MAR11	11JUL11	1.06907	0.12934	12.1
QH044_LBCDXH7	55	14JUL11	24JUL12	3.82906	0.28285	7.4
QL045_LBCDXL7	51	02AUG11	24JUL12	1.09086	0.09194	8.4
QH046_LBCDXH6	27	14AUG12	19FEB13	4.24386	0.44176	10.4
QL046_LBCDXL6	25	14AUG12	19FEB13	1.20081	0.14231	11.9
QH049_LBCDXH5	51	30APR13	06DEC13	4.51591	0.34266	7.6
QL049_LBCDXL5	51	30APR13	06DEC13	1.11761	0.10855	9.7
QH050_LBCDXH9	42	14JAN14	06NOV14	7.46855	0.40018	5.4
QL050_LBCDXL9	62	14JAN14	06NOV14	2.69840	0.21009	7.8
QH052_LBCDXH8	22	18NOV14	23APR15	7.42635	0.47722	6.4
QL052_LBCDXL8	23	18NOV14	23APR15	2.68872	0.35471	13.2



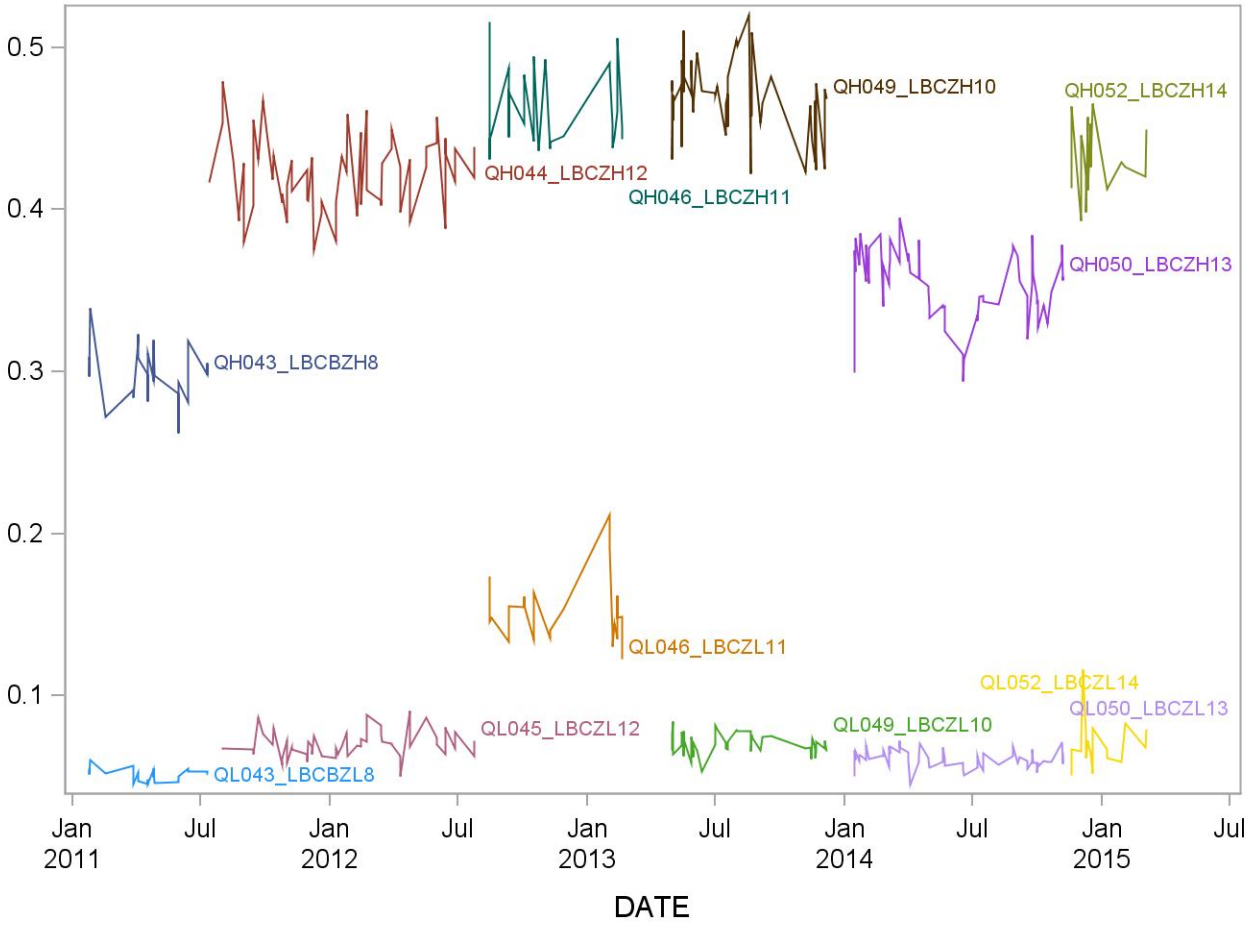
2011-2012 Summary Statistics and QC Chart for Blood 2,5-Dimethylfuran (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC2DH8	28	24JAN11	11JUL11	0.29328	0.01218	4.2
QL043_LBC2DL8	29	24JAN11	11JUL11	0.04394	0.00198	4.5
QH044_LBC2H10	54	14JUL11	24JUL12	0.35011	0.01658	4.7
QL045_LBC2L10	51	02AUG11	24JUL12	0.05799	0.00267	4.6
QH046_LBC2H11	28	14AUG12	19FEB13	0.34686	0.01337	3.9
QL046_LBC2L11	27	14AUG12	19FEB13	0.06317	0.00342	5.4
QH049_LBC2H12	53	30APR13	06DEC13	0.42627	0.01483	3.5
QL049_LBC2L12	54	30APR13	06DEC13	0.06329	0.00253	4.0
QH050_LBC2H13	63	14JAN14	06NOV14	0.34882	0.01386	4.0
QL050_LBC2L13	63	14JAN14	06NOV14	0.06177	0.00243	3.9
QH052_LBC2H14	20	23OCT14	05MAR15	0.17977	0.00470	2.6
QL052_LBC2L14	21	23OCT14	05MAR15	0.06794	0.00235	3.5



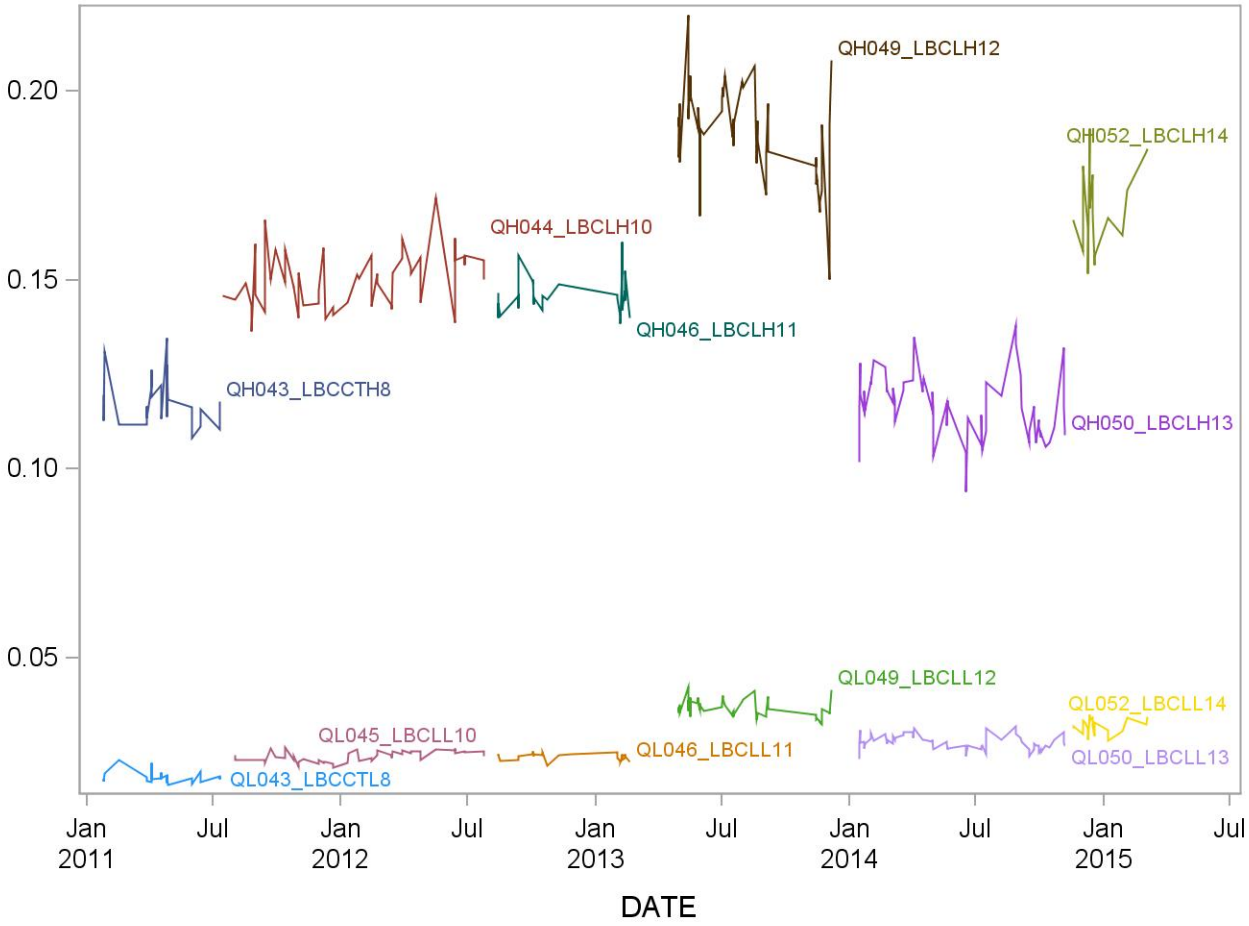
2011-2012 Summary Statistics and QC Chart for Blood Benzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCBZH8	27	24JAN11	11JUL11	0.29987	0.01715	5.7
QL043_LBCBZL8	28	24JAN11	11JUL11	0.05115	0.00389	7.6
QH044_LBCZH12	58	14JUL11	24JUL12	0.42186	0.02329	5.5
QL045_LBCZL12	53	02AUG11	24JUL12	0.07018	0.00813	11.6
QH046_LBCZH11	28	14AUG12	19FEB13	0.46281	0.02402	5.2
QL046_LBCZL11	25	14AUG12	19FEB13	0.15170	0.01924	12.7
QH049_LBCZH10	53	30APR13	06DEC13	0.46697	0.02273	4.9
QL049_LBCZL10	52	30APR13	06DEC13	0.07041	0.00606	8.6
QH050_LBCZH13	63	14JAN14	06NOV14	0.35407	0.02206	6.2
QL050_LBCZL13	63	14JAN14	06NOV14	0.06125	0.00552	9.0
QH052_LBCZH14	17	18NOV14	05MAR15	0.43092	0.02203	5.1
QL052_LBCZL14	19	18NOV14	05MAR15	0.07025	0.01407	20.0



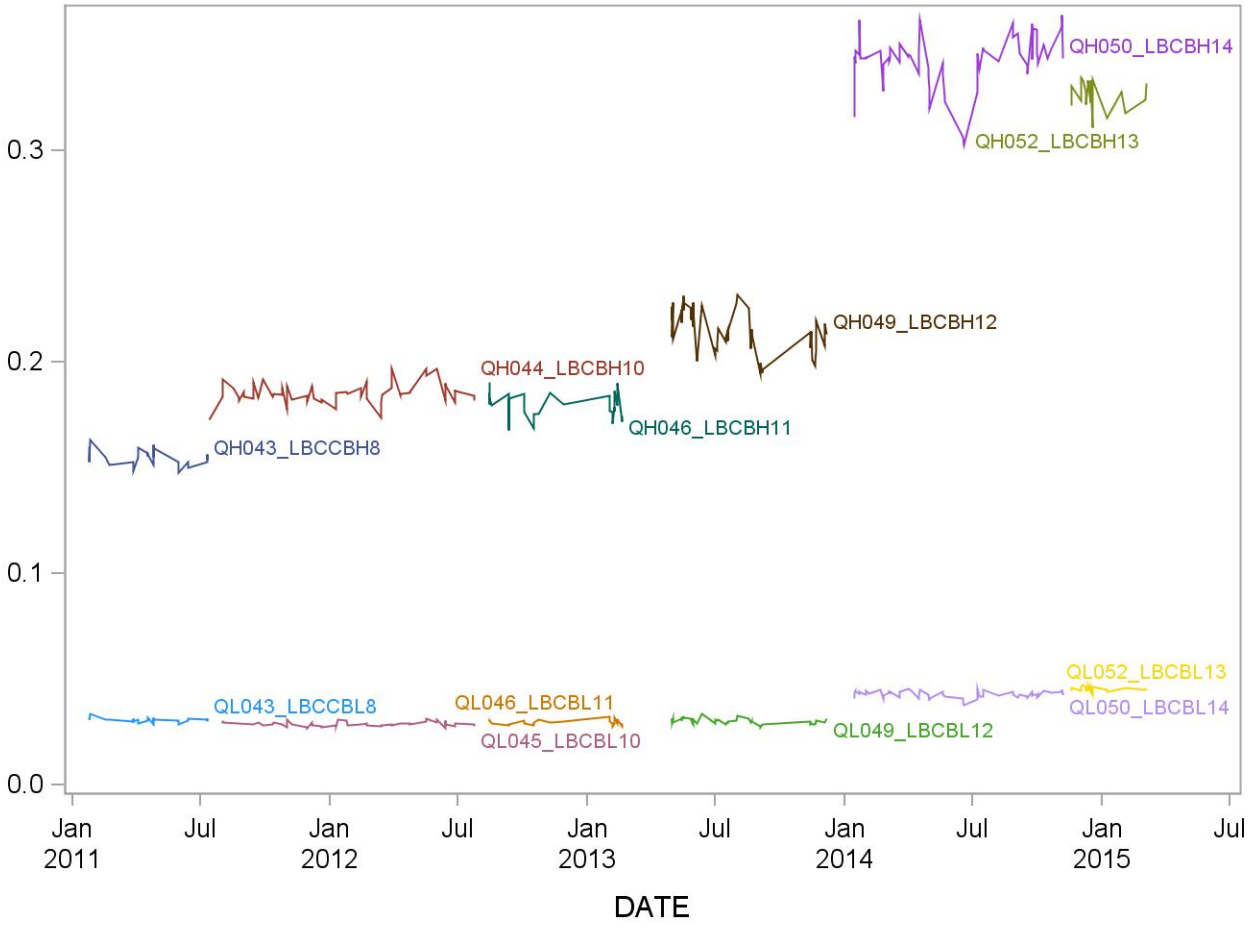
2011-2012 Summary Statistics and QC Chart for Blood Carbon Tetrachloride (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCCTH8	27	24JAN11	11JUL11	0.11747	0.00641	5.5
QL043_LBCCTL8	28	24JAN11	11JUL11	0.01844	0.00150	8.1
QH044_LBCLH10	49	14JUL11	24JUL12	0.15011	0.00752	5.0
QL045_LBCLL10	46	02AUG11	24JUL12	0.02406	0.00142	5.9
QH046_LBCLH11	26	14AUG12	19FEB13	0.14596	0.00525	3.6
QL046_LBCLL11	26	14AUG12	19FEB13	0.02390	0.00092	3.9
QH049_LBCLH12	51	30APR13	06DEC13	0.18974	0.01214	6.4
QL049_LBCLL12	51	30APR13	06DEC13	0.03672	0.00228	6.2
QH050_LBCLH13	62	14JAN14	06NOV14	0.11662	0.00846	7.3
QL050_LBCLL13	62	14JAN14	06NOV14	0.02775	0.00191	6.9
QH052_LBCLH14	18	18NOV14	05MAR15	0.16905	0.01108	6.6
QL052_LBCLL14	19	18NOV14	05MAR15	0.03202	0.00206	6.4



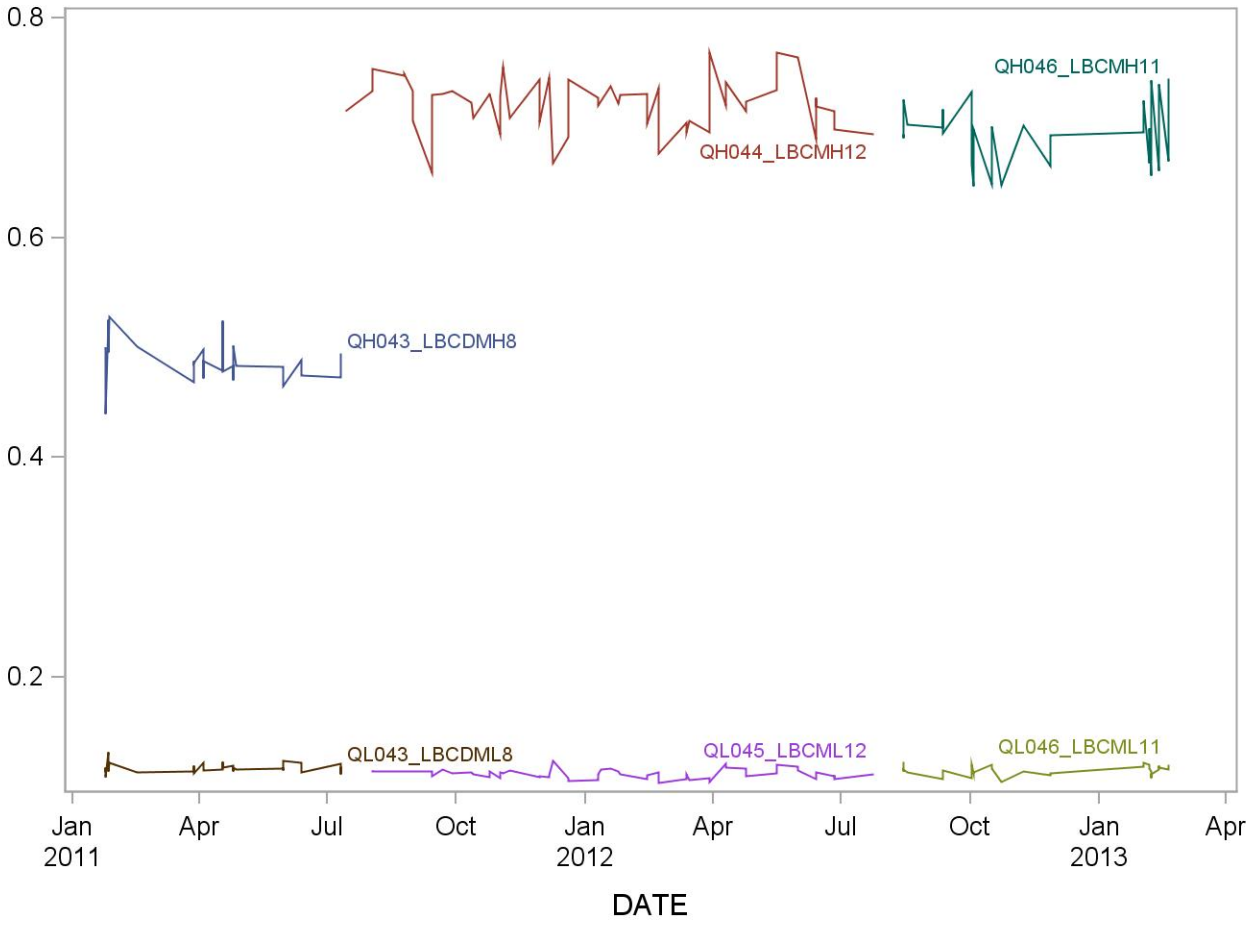
2011-2012 Summary Statistics and QC Chart for Blood Chlorobenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCCBH8	26	24JAN11	11JUL11	0.15456	0.00390	2.5
QL043_LBCCBL8	27	24JAN11	11JUL11	0.03074	0.00106	3.5
QH044_LBCBH10	53	14JUL11	24JUL12	0.18526	0.00497	2.7
QL045_LBCBL10	50	02AUG11	24JUL12	0.02879	0.00109	3.8
QH046_LBCBH11	28	14AUG12	19FEB13	0.17956	0.00588	3.3
QL046_LBCBL11	27	14AUG12	19FEB13	0.02971	0.00116	3.9
QH049_LBCBH12	52	30APR13	06DEC13	0.21497	0.01058	4.9
QL049_LBCBL12	52	30APR13	06DEC13	0.03025	0.00134	4.4
QH050_LBCBH14	62	14JAN14	06NOV14	0.34203	0.01286	3.8
QL050_LBCBL14	62	14JAN14	06NOV14	0.04297	0.00158	3.7
QH052_LBCBH13	18	18NOV14	05MAR15	0.32628	0.00699	2.1
QL052_LBCBL13	19	18NOV14	05MAR15	0.04551	0.00116	2.6



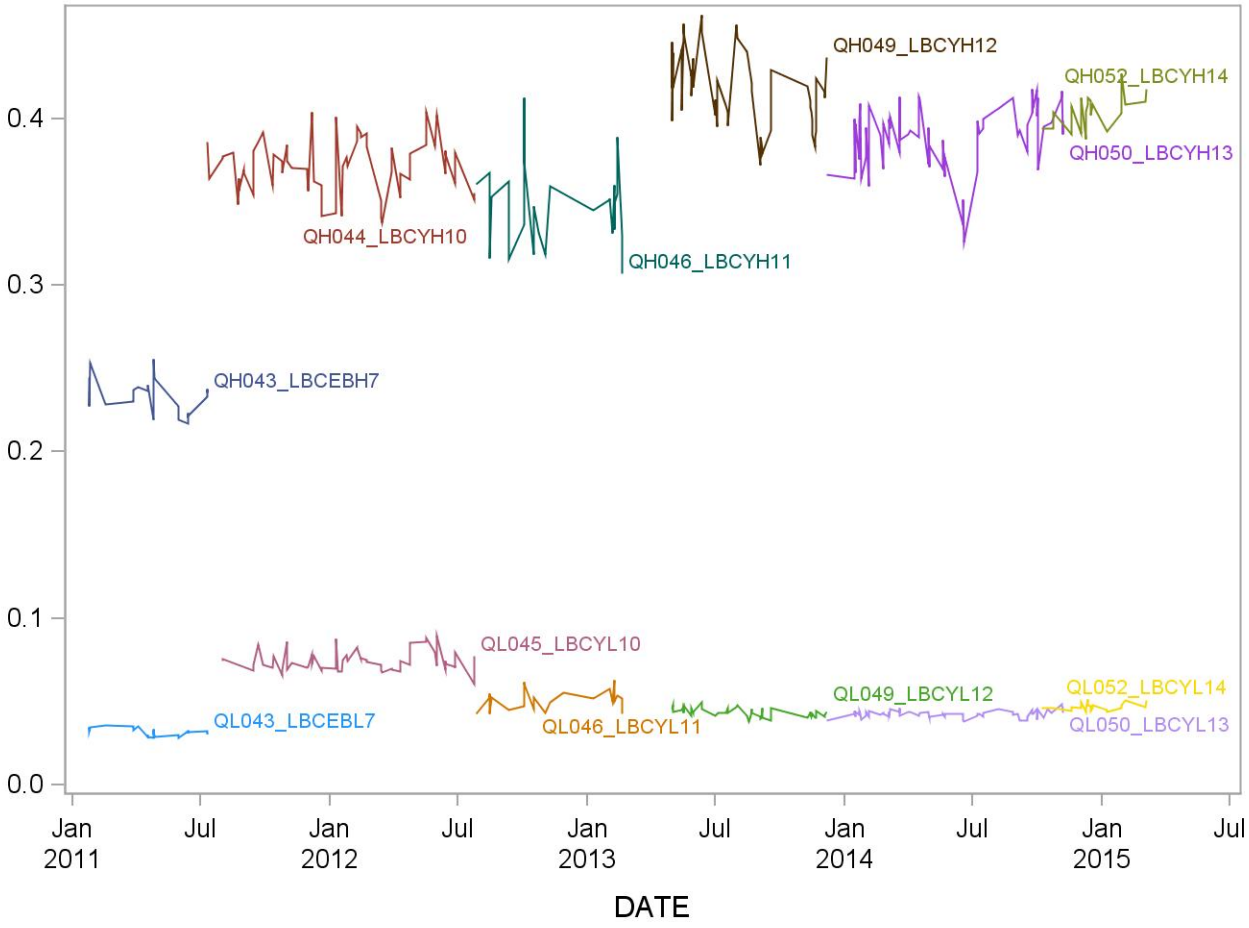
2011-2012 Summary Statistics and QC Chart for Blood Dibromomethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCDMH8	29	24JAN11	11JUL11	0.48652	0.01908	3.9
QL043_LBCDML8	30	24JAN11	11JUL11	0.11755	0.00448	3.8
QH044_LBCMH12	53	14JUL11	24JUL12	0.72161	0.02378	3.3
QL045_LBCML12	51	02AUG11	24JUL12	0.11180	0.00432	3.9
QH046_LBCMH11	29	14AUG12	19FEB13	0.69390	0.02903	4.2
QL046_LBCML11	28	14AUG12	19FEB13	0.11500	0.00468	4.1



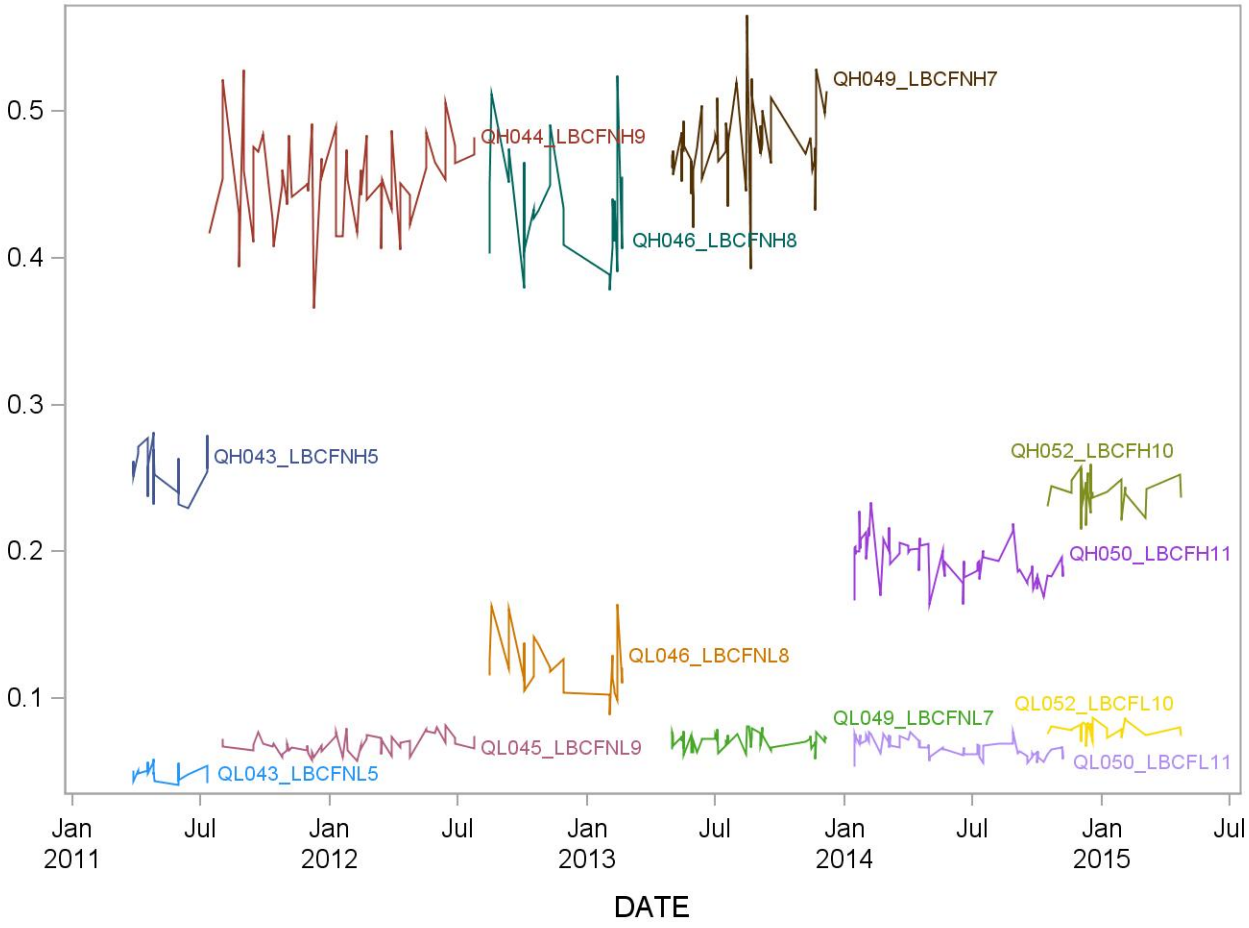
2011-2012 Summary Statistics and QC Chart for Blood Ethylbenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCEBH7	24	24JAN11	11JUL11	0.23424	0.01064	4.5
QL043_LBCEBL7	25	24JAN11	11JUL11	0.03184	0.00231	7.3
QH044_LBCYH10	61	11JUL11	24JUL12	0.37151	0.01636	4.4
QL045_LBCYL10	56	02AUG11	24JUL12	0.07436	0.00624	8.4
QH046_LBCYH11	29	26JUL12	19FEB13	0.34803	0.02315	6.7
QL046_LBCYL11	24	26JUL12	19FEB13	0.05123	0.00583	11.4
QH049_LBCYH12	53	30APR13	06DEC13	0.41677	0.02263	5.4
QL049_LBCYL12	49	30APR13	06DEC13	0.04363	0.00270	6.2
QH050_LBCYH13	66	06DEC13	06NOV14	0.38911	0.01904	4.9
QL050_LBCYL13	67	06DEC13	06NOV14	0.04281	0.00211	4.9
QH052_LBCYH14	20	07OCT14	05MAR15	0.40425	0.01013	2.5
QL052_LBCYL14	22	07OCT14	05MAR15	0.04698	0.00221	4.7



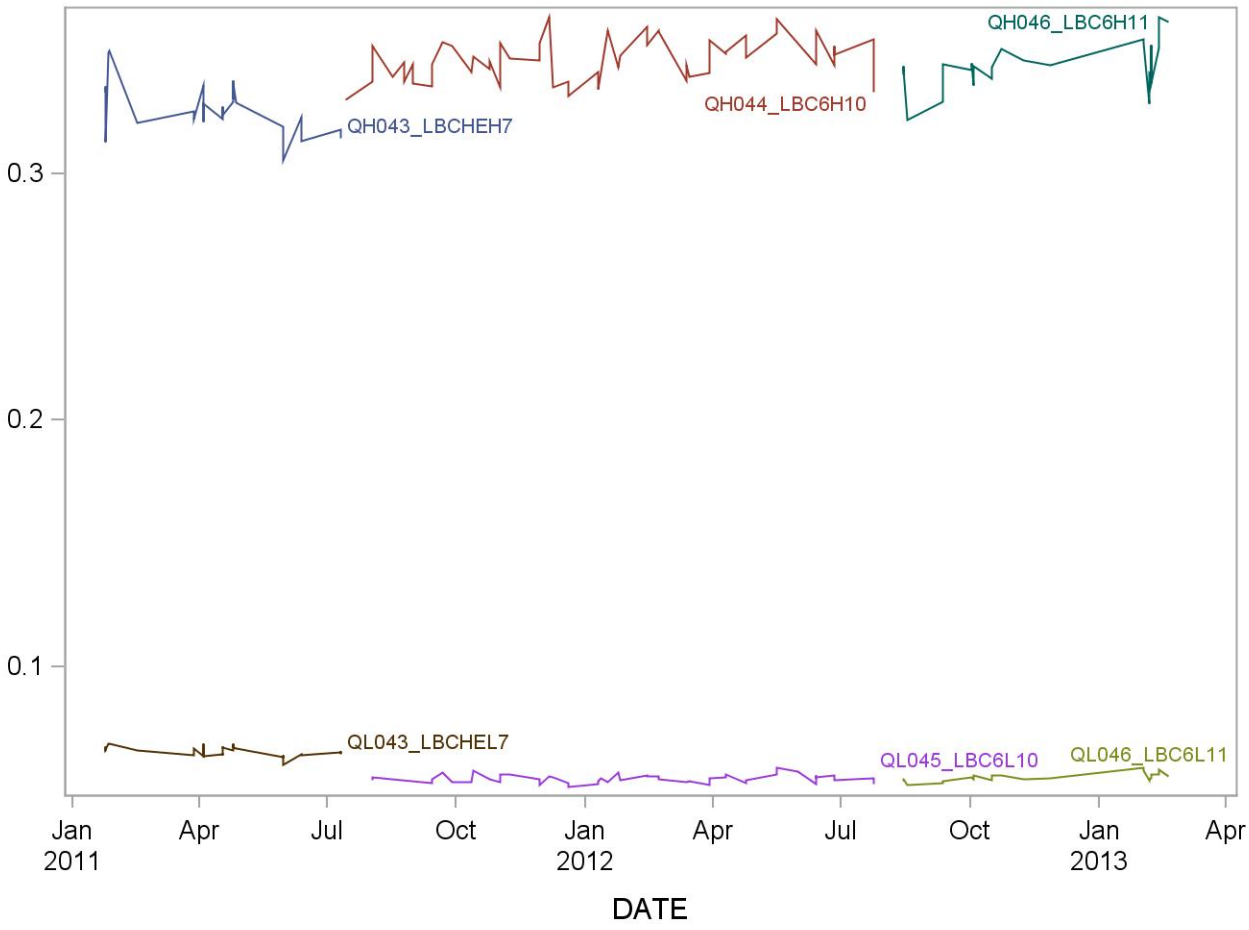
2011-2012 Summary Statistics and QC Chart for Blood Furan (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCFNH5	20	28MAR11	11JUL11	0.2576	0.0166	6.5
QL043_LBCFNL5	21	28MAR11	11JUL11	0.0500	0.0050	9.9
QH044_LBCFNH9	55	14JUL11	24JUL12	0.4532	0.0318	7.0
QL045_LBCFNL9	53	02AUG11	24JUL12	0.0690	0.0060	8.8
QH046_LBCFNH8	28	14AUG12	19FEB13	0.4352	0.0373	8.6
QL046_LBCFNL8	27	14AUG12	19FEB13	0.1229	0.0199	16.2
QH049_LBCFNH7	61	30APR13	06DEC13	0.4774	0.0272	5.7
QL049_LBCFNL7	62	30APR13	06DEC13	0.0714	0.0051	7.1
QH050_LBCFH11	71	14JAN14	06NOV14	0.1946	0.0144	7.4
QL050_LBCFL11	71	14JAN14	06NOV14	0.0673	0.0060	9.0
QH052_LBCFH10	27	15OCT14	23APR15	0.2395	0.0123	5.1
QL052_LBCFL10	28	15OCT14	23APR15	0.0786	0.0051	6.4



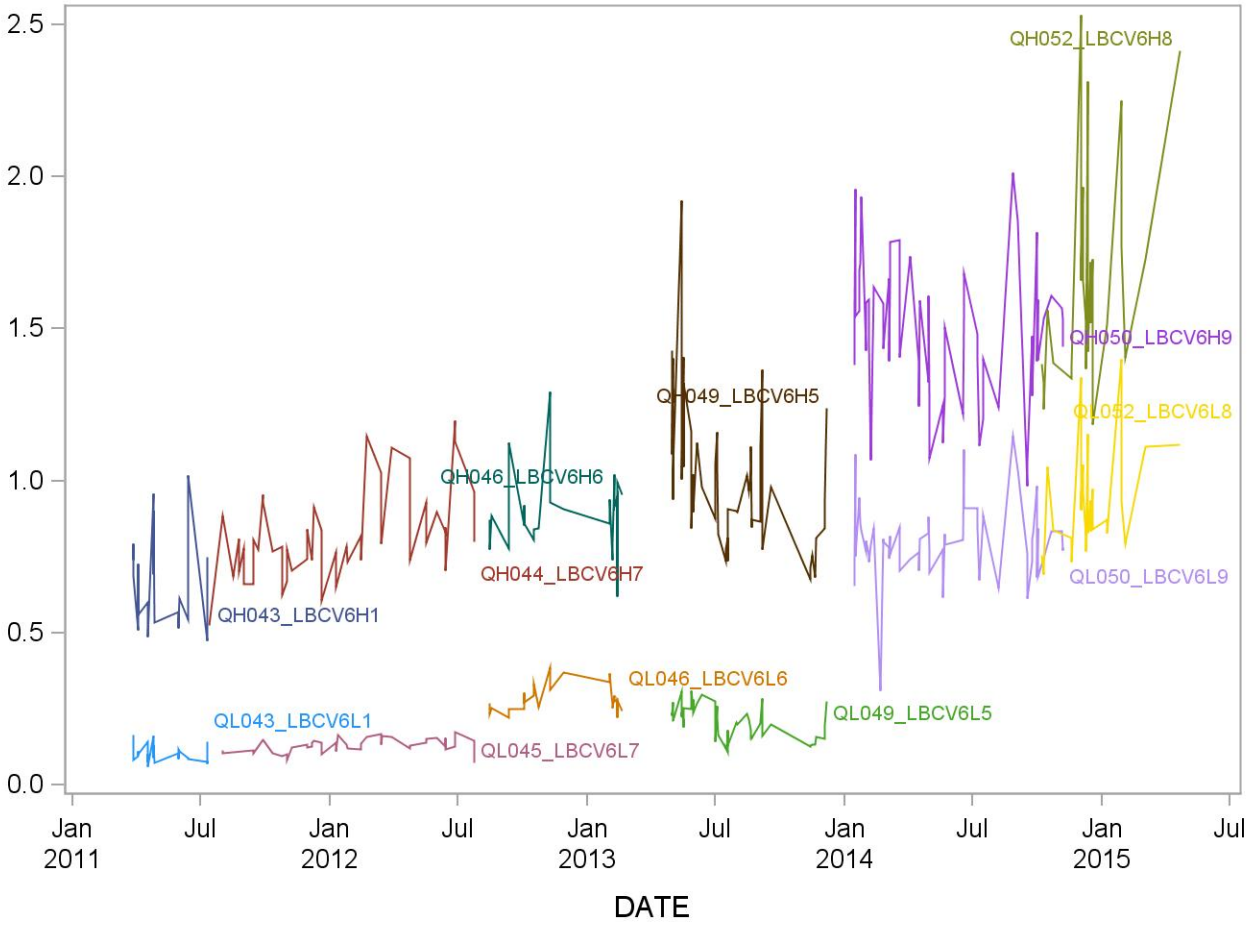
2011-2012 Summary Statistics and QC Chart for Blood Hexachloroethane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCHEH7	28	24JAN11	11JUL11	0.32561	0.01044	3.2
QL043_LBCHEL7	29	24JAN11	11JUL11	0.06559	0.00206	3.1
QH044_LBC6H10	53	14JUL11	24JUL12	0.34648	0.00854	2.5
QL045_LBC6L10	50	02AUG11	24JUL12	0.05435	0.00167	3.1
QH046_LBC6H11	27	14AUG12	19FEB13	0.34368	0.00994	2.9
QL046_LBC6L11	26	14AUG12	19FEB13	0.05499	0.00165	3.0



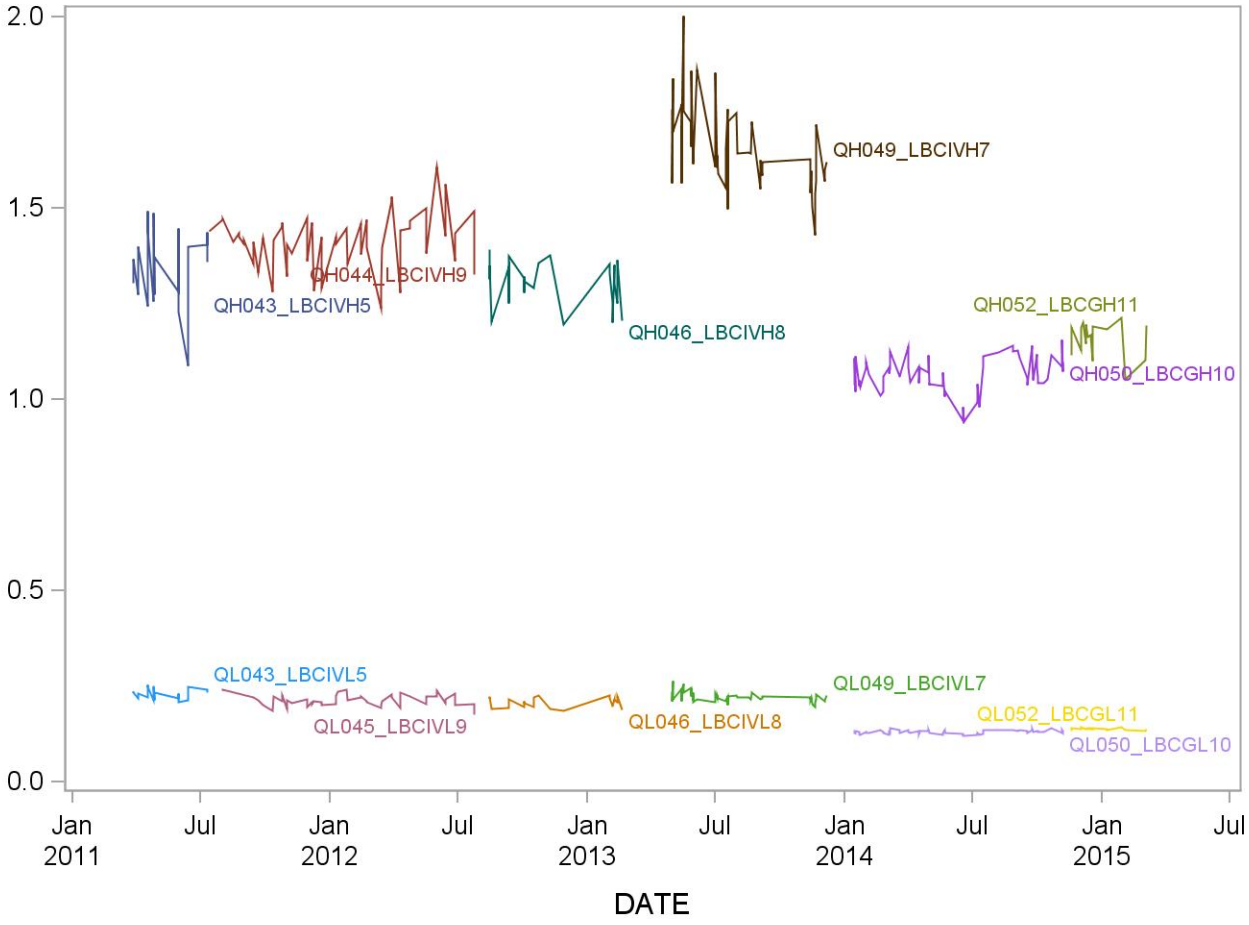
2011-2012 Summary Statistics and QC Chart for Blood Hexane (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCV6H1	23	28MAR11	11JUL11	0.65357	0.15244	23.3
QL043_LBCV6L1	24	28MAR11	11JUL11	0.10507	0.02847	27.1
QH044_LBCV6H7	47	14JUL11	24JUL12	0.81855	0.14730	18.0
QL045_LBCV6L7	45	02AUG11	24JUL12	0.13021	0.02352	18.1
QH046_LBCV6H6	27	14AUG12	19FEB13	0.89438	0.12586	14.1
QL046_LBCV6L6	26	14AUG12	19FEB13	0.28354	0.04431	15.6
QH049_LBCV6H5	52	30APR13	06DEC13	1.00531	0.22866	22.7
QL049_LBCV6L5	52	30APR13	06DEC13	0.20781	0.05454	26.2
QH050_LBCV6H9	60	14JAN14	06NOV14	1.48563	0.23193	15.6
QL050_LBCV6L9	60	14JAN14	06NOV14	0.80144	0.12745	15.9
QH052_LBCV6H8	27	07OCT14	21APR15	1.65504	0.35931	21.7
QL052_LBCV6L8	28	07OCT14	21APR15	0.92289	0.17687	19.2



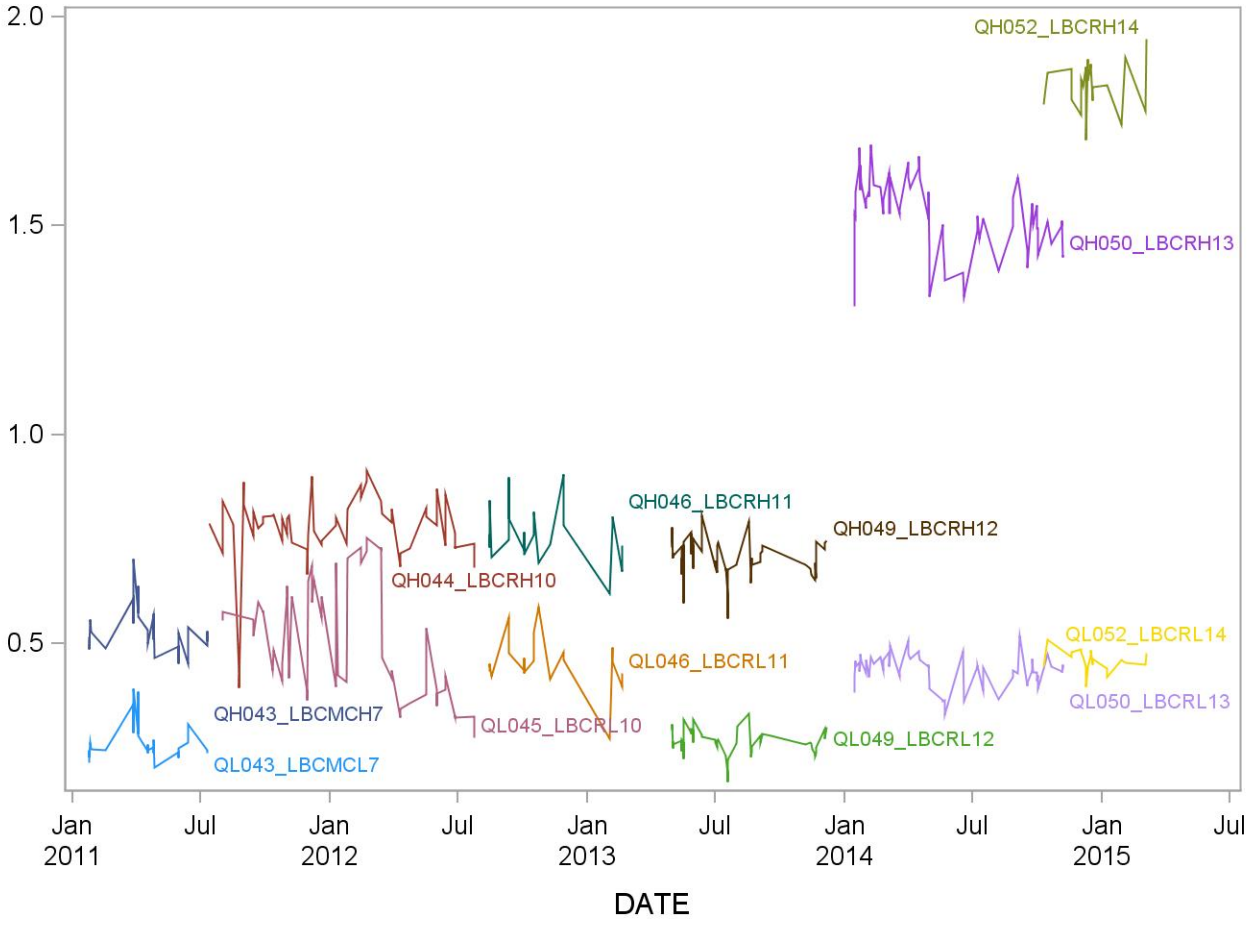
2011-2012 Summary Statistics and QC Chart for Blood Isopropylbenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCIVH5	23	28MAR11	11JUL11	1.35459	0.09847	7.3
QL043_LBCIVL5	23	28MAR11	11JUL11	0.23212	0.01343	5.8
QH044_LBCIVH9	52	14JUL11	24JUL12	1.41253	0.07380	5.2
QL045_LBCIVL9	49	02AUG11	24JUL12	0.21428	0.01473	6.9
QH046_LBCIVH8	27	14AUG12	19FEB13	1.30296	0.05731	4.4
QL046_LBCIVL8	26	14AUG12	19FEB13	0.20882	0.01312	6.3
QH049_LBCIVH7	51	30APR13	06DEC13	1.67536	0.12317	7.4
QL049_LBCIVL7	51	30APR13	06DEC13	0.22445	0.01439	6.4
QH050_LBCGH10	62	14JAN14	06NOV14	1.06580	0.04690	4.4
QL050_LBCGL10	62	14JAN14	06NOV14	0.13102	0.00476	3.6
QH052_LBCGH11	18	18NOV14	05MAR15	1.15878	0.04306	3.7
QL052_LBCGL11	19	18NOV14	05MAR15	0.13893	0.00273	2.0



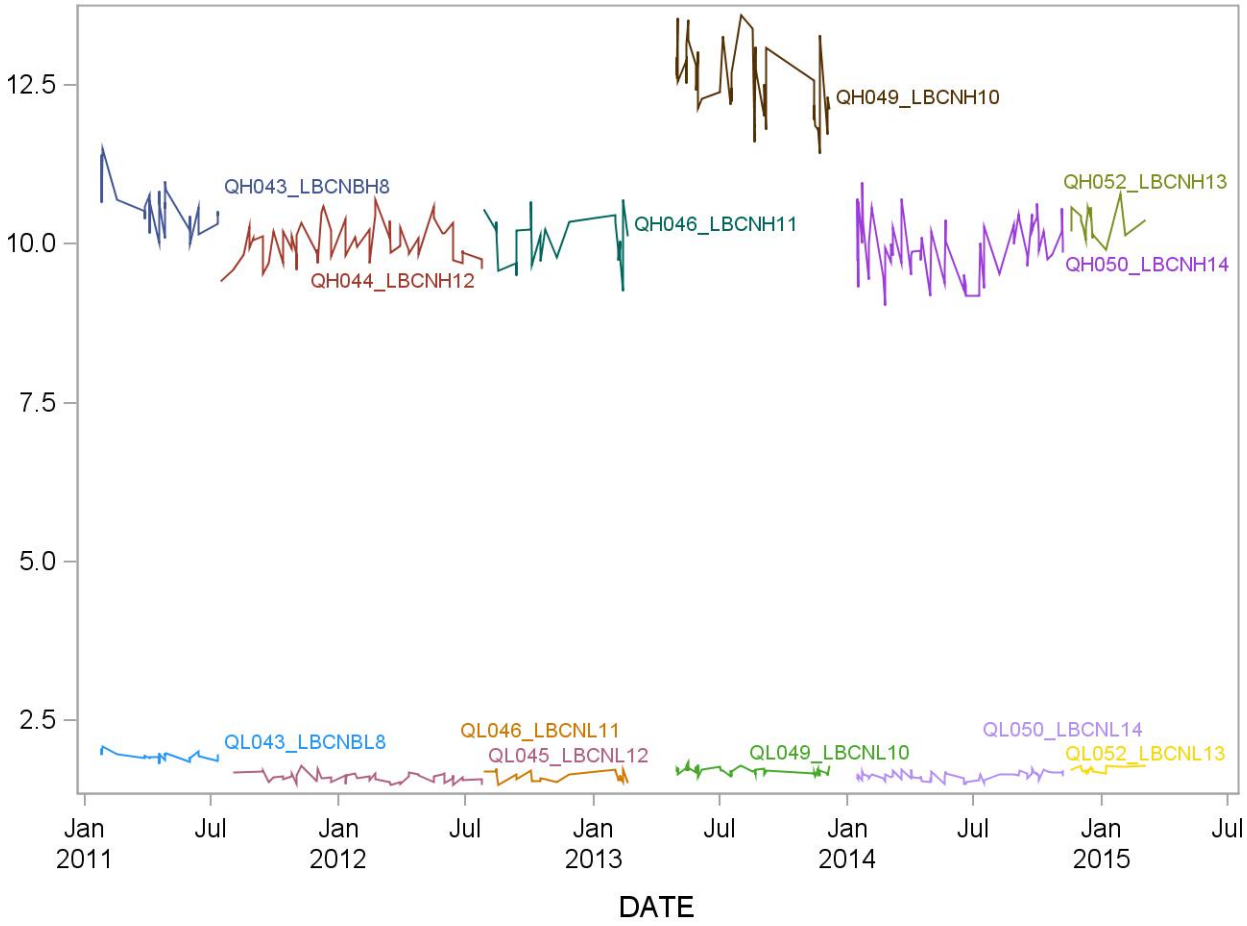
2011-2012 Summary Statistics and QC Chart for Blood Methylene Chloride(ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCMCH7	28	24JAN11	11JUL11	0.53128	0.05493	10.3
QL043_LBCMCL7	29	24JAN11	11JUL11	0.26370	0.04492	17.0
QH044_LBCRH10	56	14JUL11	24JUL12	0.77504	0.08986	11.6
QL045_LBCRL10	53	02AUG11	24JUL12	0.50318	0.13906	27.6
QH046_LBCRH11	22	14AUG12	19FEB13	0.75962	0.06794	8.9
QL046_LBCRL11	21	14AUG12	19FEB13	0.45382	0.06304	13.9
QH049_LBCRH12	55	30APR13	06DEC13	0.70463	0.04568	6.5
QL049_LBCRL12	55	30APR13	06DEC13	0.26461	0.03107	11.7
QH050_LBCRH13	66	14JAN14	06NOV14	1.52603	0.08792	5.8
QL050_LBCRL13	66	14JAN14	06NOV14	0.43632	0.03695	8.5
QH052_LBCRH14	20	09OCT14	05MAR15	1.83633	0.06065	3.3
QL052_LBCRL14	21	09OCT14	05MAR15	0.45875	0.02475	5.4



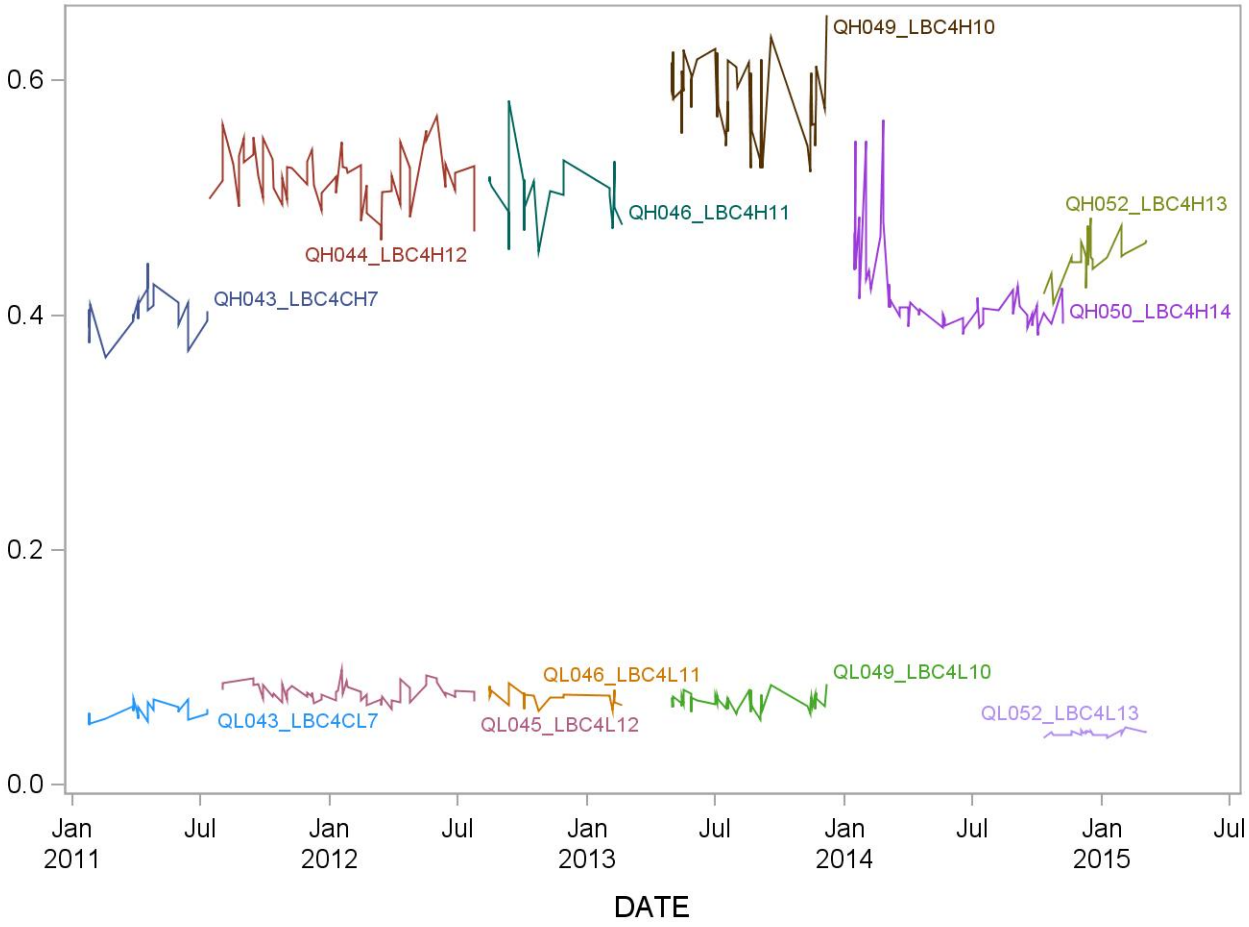
2011-2012 Summary Statistics and QC Chart for Blood Nitrobenzene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCNBH8	27	24JAN11	11JUL11	10.57521	0.36423	3.4
QL043_LBCNBL8	28	24JAN11	11JUL11	1.94492	0.05772	3.0
QH044_LBCNH12	55	14JUL11	24JUL12	10.02181	0.29510	2.9
QL045_LBCNL12	52	02AUG11	24JUL12	1.59749	0.06774	4.2
QH046_LBCNH11	28	26JUL12	19FEB13	10.07363	0.37499	3.7
QL046_LBCNL11	27	26JUL12	19FEB13	1.62066	0.07728	4.8
QH049_LBCNH10	51	30APR13	06DEC13	12.60694	0.56445	4.5
QL049_LBCNL10	51	30APR13	06DEC13	1.70706	0.05414	3.2
QH050_LBCNH14	63	14JAN14	06NOV14	9.93885	0.45454	4.6
QL050_LBCNL14	63	14JAN14	06NOV14	1.62243	0.06368	3.9
QH052_LBCNH13	18	18NOV14	05MAR15	10.34369	0.22242	2.2
QL052_LBCNL13	19	18NOV14	05MAR15	1.73131	0.04000	2.3



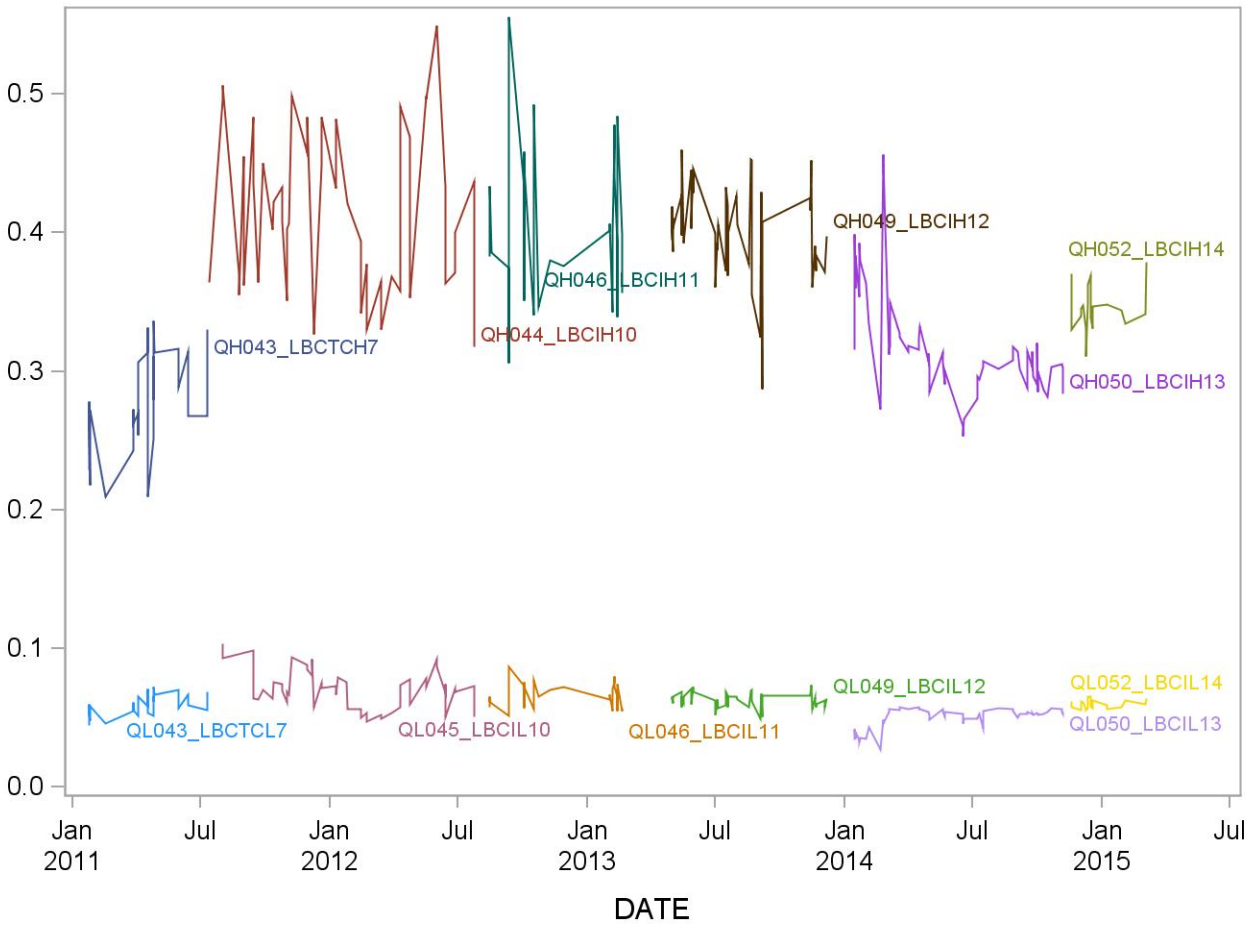
2011-2012 Summary Statistics and QC Chart for Blood Tetrachloroethene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC4CH7	25	24JAN11	11JUL11	0.40296	0.01733	4.3
QL043_LBC4CL7	26	24JAN11	11JUL11	0.06269	0.00673	10.7
QH044_LBC4H12	56	14JUL11	24JUL12	0.51841	0.02335	4.5
QL045_LBC4L12	53	02AUG11	24JUL12	0.07891	0.00719	9.1
QH046_LBC4H11	24	14AUG12	19FEB13	0.50285	0.02753	5.5
QL046_LBC4L11	23	14AUG12	19FEB13	0.07469	0.00649	8.7
QH049_LBC4H10	49	30APR13	06DEC13	0.58665	0.03342	5.7
QL049_LBC4L10	49	30APR13	06DEC13	0.07094	0.00685	9.7
QH050_LBC4H14	59	14JAN14	06NOV14	0.41833	0.03900	9.3
QH052_LBC4H13	22	09OCT14	05MAR15	0.44992	0.01802	4.0
QL052_LBC4L13	23	09OCT14	05MAR15	0.04451	0.00219	4.9



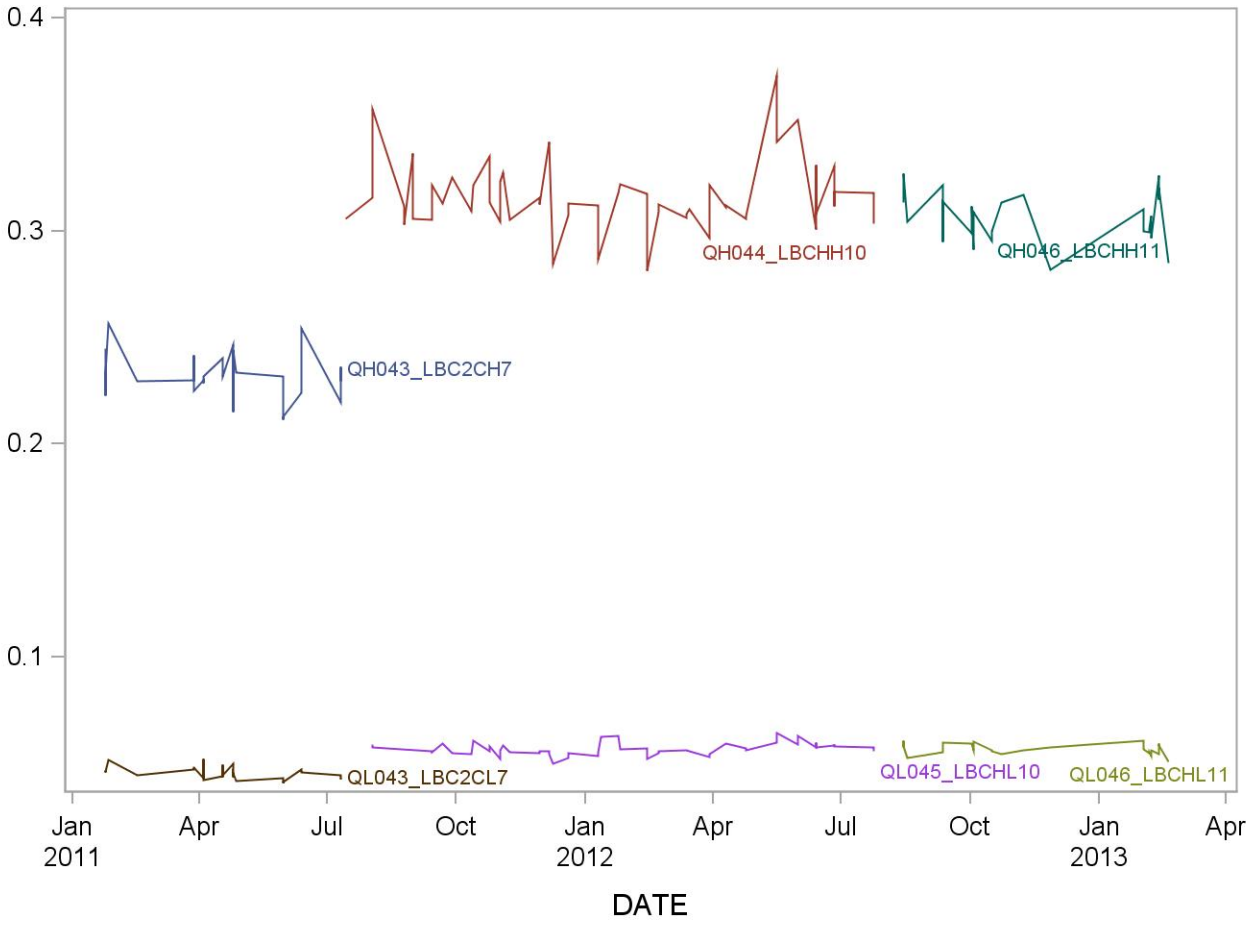
2011-2012 Summary Statistics and QC Chart for Blood Trichloroethene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCTCH7	27	24JAN11	11JUL11	0.27730	0.03678	13.3
QL043_LBCTCL7	28	24JAN11	11JUL11	0.05932	0.00751	12.7
QH044_LBCIH10	51	14JUL11	24JUL12	0.41437	0.05749	13.9
QL045_LBCIL10	49	02AUG11	24JUL12	0.07046	0.01390	19.7
QH046_LBCIH11	28	14AUG12	19FEB13	0.40577	0.05690	14.0
QL046_LBCIL11	27	14AUG12	19FEB13	0.06646	0.00916	13.8
QH049_LBCIH12	49	30APR13	06DEC13	0.40066	0.03380	8.4
QL049_LBCIL12	50	30APR13	06DEC13	0.06293	0.00540	8.6
QH050_LBCIH13	60	14JAN14	06NOV14	0.31704	0.03912	12.3
QL050_LBCIL13	60	14JAN14	06NOV14	0.05046	0.00743	14.7
QH052_LBCIH14	18	18NOV14	05MAR15	0.34554	0.01672	4.8
QL052_LBCIL14	19	18NOV14	05MAR15	0.05962	0.00324	5.4



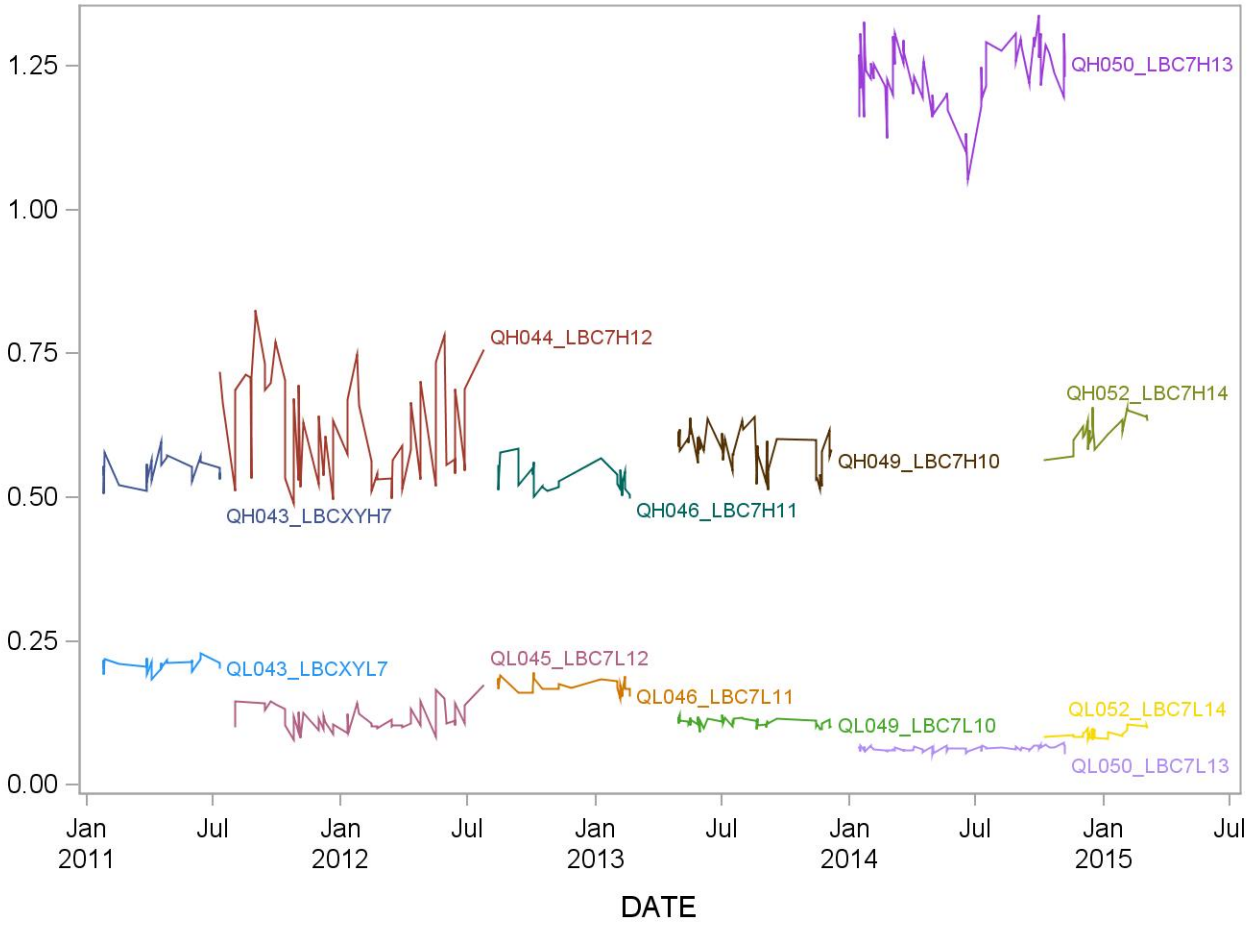
2011-2012 Summary Statistics and QC Chart for Blood cis-1,2-Dichloroethene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC2CH7	27	24JAN11	11JUL11	0.23251	0.01131	4.9
QL043_LBC2CL7	28	24JAN11	11JUL11	0.04552	0.00296	6.5
QH044_LBCHH10	53	14JUL11	24JUL12	0.31583	0.01668	5.3
QL045_LBCHL10	51	02AUG11	24JUL12	0.05683	0.00291	5.1
QH046_LBCHH11	27	14AUG12	19FEB13	0.30640	0.01167	3.8
QL046_LBCHL11	26	14AUG12	19FEB13	0.05678	0.00256	4.5



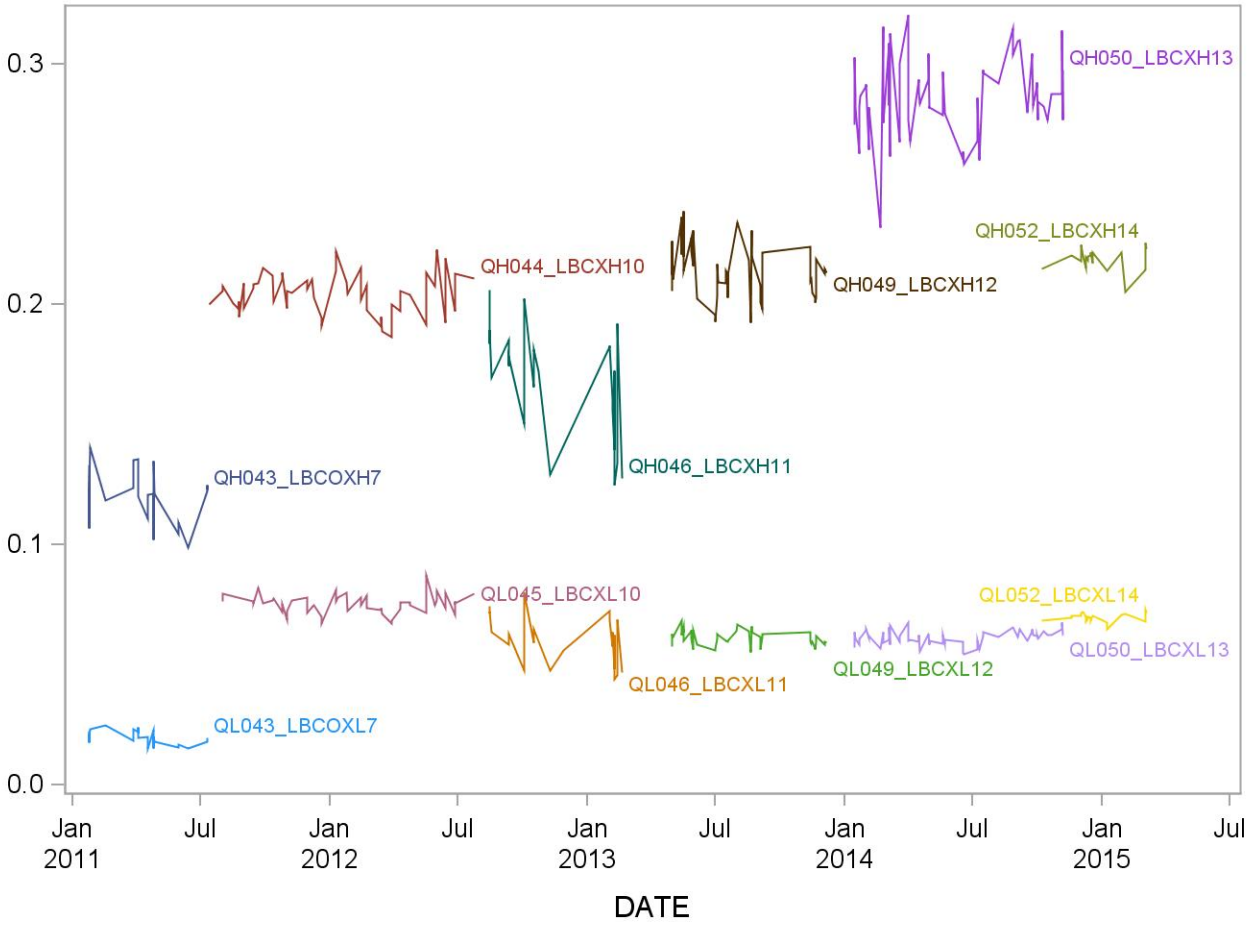
2011-2012 Summary Statistics and QC Chart for Blood m-/p-Xylene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCXYH7	22	24JAN11	11JUL11	0.54947	0.02281	4.2
QL043_LBCXYL7	23	24JAN11	11JUL11	0.20929	0.01064	5.1
QH044_LBC7H12	56	11JUL11	24JUL12	0.62347	0.09350	15.0
QL045_LBC7L12	51	02AUG11	24JUL12	0.11578	0.02178	18.8
QH046_LBC7H11	29	14AUG12	19FEB13	0.53140	0.02274	4.3
QL046_LBC7L11	28	14AUG12	19FEB13	0.17084	0.01185	6.9
QH049_LBC7H10	54	30APR13	06DEC13	0.58273	0.03425	5.9
QL049_LBC7L10	54	30APR13	06DEC13	0.10890	0.00706	6.5
QH050_LBC7H13	67	14JAN14	06NOV14	1.23636	0.05624	4.5
QL050_LBC7L13	67	14JAN14	06NOV14	0.06330	0.00439	6.9
QH052_LBC7H14	23	07OCT14	05MAR15	0.61555	0.02641	4.3
QL052_LBC7L14	24	07OCT14	05MAR15	0.09020	0.00838	9.3



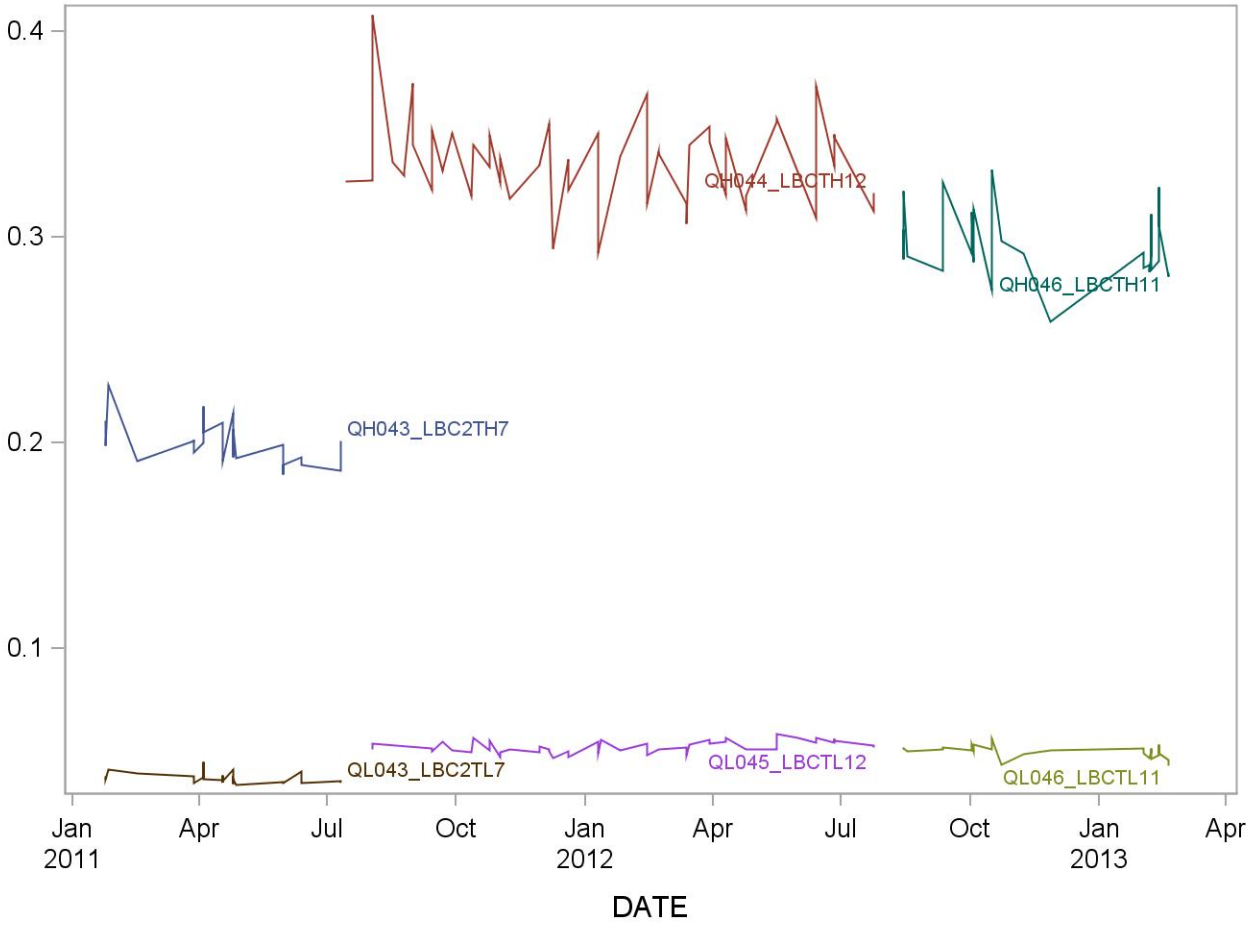
2011-2012 Summary Statistics and QC Chart for Blood o-Xylene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBCOXH7	24	24JAN11	11JUL11	0.12082	0.01153	9.5
QL043_LBCOXL7	25	24JAN11	11JUL11	0.01954	0.00306	15.6
QH044_LBCXH10	54	14JUL11	24JUL12	0.20458	0.00835	4.1
QL045_LBCXL10	50	02AUG11	24JUL12	0.07542	0.00394	5.2
QH046_LBCXH11	26	14AUG12	19FEB13	0.16855	0.02251	13.4
QL046_LBCXL11	25	14AUG12	19FEB13	0.06132	0.01003	16.4
QH049_LBCXH12	51	30APR13	06DEC13	0.21524	0.01174	5.5
QL049_LBCXL12	51	30APR13	06DEC13	0.06117	0.00302	4.9
QH050_LBCXH13	65	14JAN14	06NOV14	0.28629	0.01674	5.8
QL050_LBCXL13	65	14JAN14	06NOV14	0.06142	0.00287	4.7
QH052_LBCXH14	19	07OCT14	05MAR15	0.21880	0.00467	2.1
QL052_LBCXL14	21	07OCT14	05MAR15	0.06983	0.00178	2.5



2011-2012 Summary Statistics and QC Chart for Blood trans-1,2-Dichloroethene (ng/mL)

Lot	N	Start Date	End Date	Mean	Standard Deviation	Coefficient of Variation
QH043_LBC2TH7	27	24JAN11	11JUL11	0.19990	0.01018	5.1
QL043_LBC2TL7	28	24JAN11	11JUL11	0.03672	0.00260	7.1
QH044_LBCTH12	51	14JUL11	24JUL12	0.33681	0.02076	6.2
QL045_LBCTL12	48	02AUG11	24JUL12	0.05216	0.00288	5.5
QH046_LBCTH11	28	14AUG12	19FEB13	0.29631	0.01726	5.8
QL046_LBCTL11	27	14AUG12	19FEB13	0.04973	0.00306	6.1



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