

# Mini Module: Exposure Units



# Introduction to Exposure Units

Defining exposure units is a step in the public health evaluation process. During this step, if appropriate, health assessors identify exposure units to determine the areas where a person has contact with an environmental medium, such as soil or surface water.

Assessors define exposure units for each potential contaminant of concern identified in a completed or potential exposure pathway. The exposure units can be defined before or after screening, based on the nature of the data set. You will also compile data for each contaminant in each completed and potential exposure pathway (by exposure unit, if appropriate).

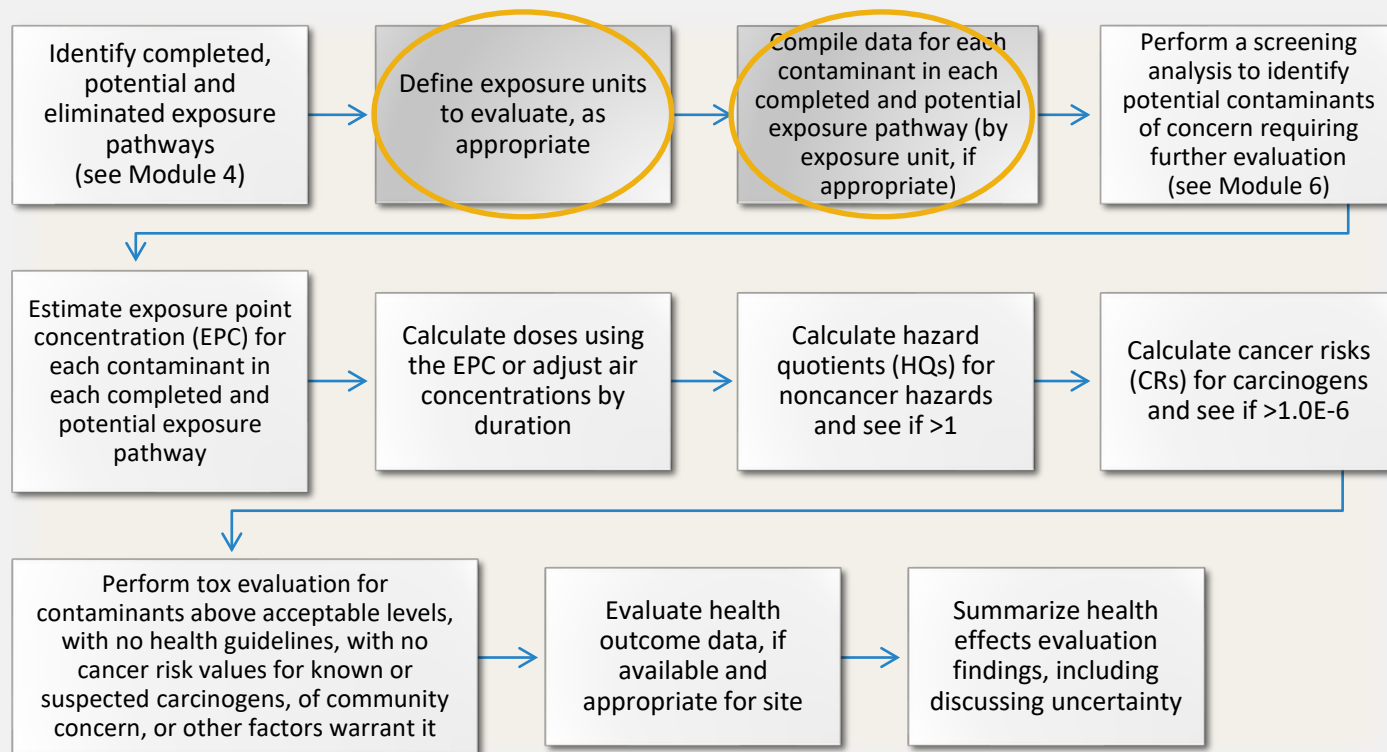
## Introduction to Exposure Units (cont.)

**This mini-module contains detailed information you will need to know for performing a public health evaluation.**

Let's look at the public health evaluation process, and see where this mini-module topic—defining exposure units and compiling data for them—fits in. As you will see, these parts of the process are circled in the flow chart on the next page.



# Steps of the Public Health Evaluation



This figure shows the overall steps involved in ATSDR's public health evaluation.

## Steps of the Public Health Evaluation (cont.)

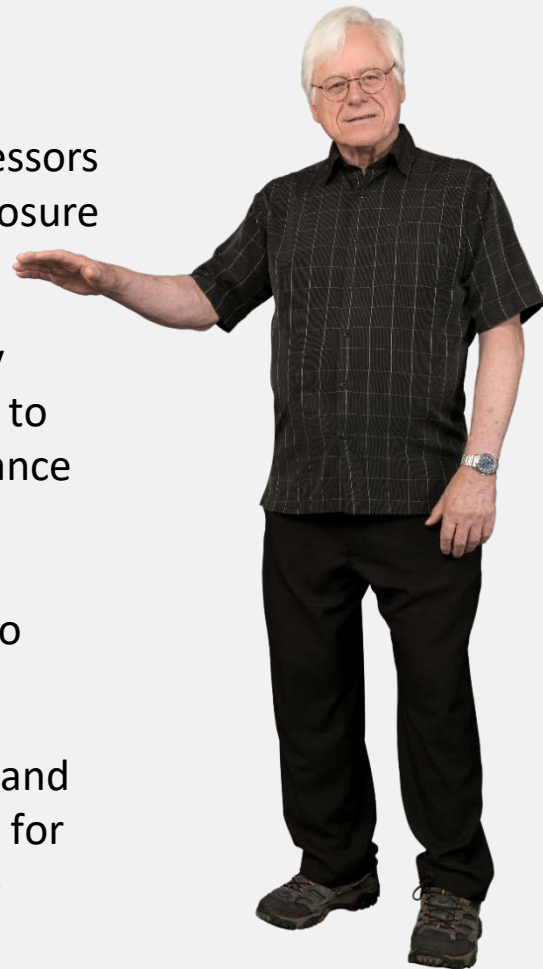
- While the PHA process has many steps, ATSDR considers there to typically be four primary technical components. These components include evaluations of the following: exposure pathways, the screening analysis, EPCs and exposure calculations, and in-depth toxicological effects.
- The sequence of steps laid out in the previous figure may differ slightly based on site-specific factors. For instance, based on site-specific information, health assessors may define an exposure unit before or after the screening analysis. With large data sets, for example, the health assessor may decide to complete the media-specific screening on the entire data set to identify potential contaminants of concern at the site, and then define appropriate exposure units for further analysis. On the other hand, for smaller or more defined data sets, the health assessor may determine it is most appropriate to define the exposure units prior to conducting the screening analysis.
- Health assessors will use professional judgement to determine when to define exposure units; however, they must define them before determining EPCs.

# Overview of Defining Exposure Units

ATSDR has developed specific guidance that teaches health assessors how to identify exposure units for a completed or potential exposure pathway.

This training will provide general information on how to identify exposure units and compile data for those. When it comes time to do your public health evaluation, always refer to “ATSDR’s Guidance on Identifying Exposure Units for the Public Health Assessment Process” in the “Resources” section of PHAST (Public Health Assessment Site Tool). Remember you need to request access to PHAST by emailing [phast@cdc.gov](mailto:phast@cdc.gov).

This guidance document outlines how to define exposure units and compile data for your specific scenarios. The Associate Director for Science (ADS) group is a good source of information if you have questions about exposure units.



# Define the Exposure Units to Evaluate

When you define exposure units, you will need to consider several factors, including the following:

- Exposure units can vary greatly in size.
- Sites may have multiple exposure units.
- Exposure units are defined by people's activities and not by available environmental data.
- An exposure unit might have never been sampled.

## Define the Exposure Units to Evaluate (cont.)

Some of the factors to be considered (continued):

- Exposure units can vary by conditions of exposure.
- Exposure units may inform environmental sampling.
- Exposure units may not be defined at all sites, depending on the nature of the data.

Refer to “ATSDR’s Guidance on Identifying Exposure Units for the Public Health Assessment Process” document (in the “Resources” section of PHAST) for more details.



## Define the Exposure Units to Evaluate (cont.2)

You should consider the following information sources when defining exposure units:

- Conceptual site model and exposure pathways analysis
- Observations made and pictures taken during site visits
- Maps and aerial photographs
- Discussions with residents, community groups, and tribal leaders
- Institutional controls (such as fishing advisories and hunting regulations)
- Physical barriers (such as fences or locked gates)
- Discussions with officials from other agencies (like EPA and state, tribal, and local health agencies)

Let's go through some examples together.

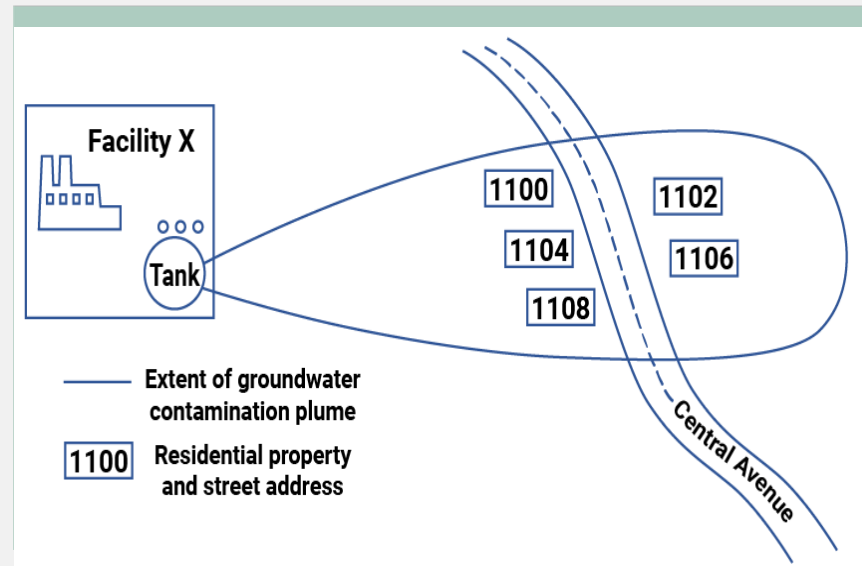
# Define the Exposure Units to Evaluate (cont.3)

**Example 1:** Five homes were built along an area that passes over a groundwater plume. The homes have unfinished basements. Indoor air samples were collected at the homes. The results suggest the potential for intrusion of volatile groundwater contaminants into the homes. Accordingly, the health assessor identified vapor intrusion as a completed exposure pathway that required further evaluation.

**How should you, as the health assessor, define the exposure units shown here?** You should designate the indoor air in each home as its own exposure unit.

**Do NOT combine them to make a single exposure unit.** The homes should be evaluated separately because

- (a) exposure units are defined by locations where people spend their time and not on contamination levels; and
- (b) each home may have unique assumptions that need to be factored into the exposure dose calculations.



## Define the Exposure Units to Evaluate (cont.4)

**Example 2:** An elementary school has a large field that is completely open for children to play before, during, and after school. The field contains four areas where contaminated fill was previously disposed. Children are known to frequent all parts of the field.

**How should you define the exposure units to evaluate?** You should define one exposure unit for the entire field of the elementary school. **Do NOT define different areas within the field as separate exposure units.** This decision is based on our knowledge that children play in different areas of the school field, rather than in just certain areas within the field.



# Define the Exposure Units to Evaluate (cont.5)

## Example 3:

Lead and arsenic were emitted from the smokestacks of a former smelter. The contaminated particles were transported via air and settled across the backyards of 20 properties in a residential neighborhood.

## How should you define the exposure units to evaluate?

You should define each residential backyard as an individual exposure unit. **Do NOT define all homes in the neighborhood as a single exposure unit.** This decision is based on the knowledge that residents spend time on their own properties.

Refer to “ATSDR’s Guidance on Identifying Exposure Units for the Public Health Assessment Process” document (in the “Resources” section of PHAST) for more details and examples.



# Define the Exposure Units to Evaluate: Practice

Now, let's use what you learned about exposure units for our classroom case study data.

For this practice, we will use our class exercises from Module 6, where we identified certain contaminants requiring further evaluation.

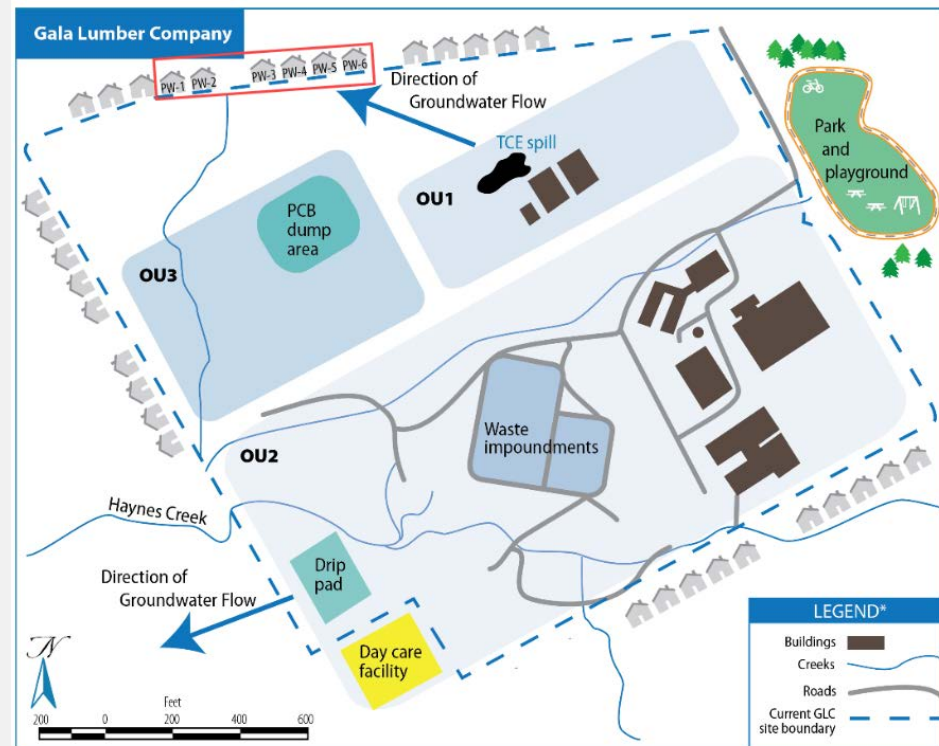
- First, we will practice together. We will use the class exercise that focused on carbon tetrachloride detected in discrete samples collected from drinking water at a private residence.
- Then, you will do a case study exercise. You will identify an exposure unit and compile the data on your own, using the data on arsenic detected in discrete soil samples collected from the daycare center.



## Practice (cont.)

Now, practice using our case study exercise.

Here's the map from Module 6, which shows the six offsite private residential well locations (PW-1 through PW-6, included within the rectangular box on the map) where carbon tetrachloride was identified as a potential contaminant of concern in groundwater during our screening analysis.



\*For privacy reasons, private well and public water intake locations cannot be indicated.

## Practice (cont.2)

**How should you define the exposure units for residents drinking this private well water?**

You would define six separate exposure units, one for each different private well. This means that PW-1, PW-2, PW-3, PW-4, PW-5, and PW-6 would all be individual exposure units. This assumes that residents obtain drinking water from their own private wells.

Remember: You would NOT combine the six private wells into a single exposure unit. This incorrectly assumes that over time, residents obtain their drinking water at random from across the six wells.

# Compile Data for Each Exposure Unit

After defining the exposure units to evaluate, you will compile the environmental sampling data for each unit. When compiling sampling data, remember to do the following:

- Separate data by each exposure unit
- Include data for completed or potential exposure pathways of concern
- Distinguish data for acute, intermediate, and chronic scenarios, if appropriate for your site
- Distinguish discrete sampling from non-discrete sampling data (see definitions in text box)
- You will always define exposure units before calculating EPCs. We talk about that in the EPC Mini-Module, which is part of Module 7.

A **discrete sample** refers to an individual environmental sample from a given point and time that is independent of other samples.

ATSDR's guidance on **non-discrete sampling** focuses on two types of non-discrete sampling: composite sampling and incremental sampling methodology (ISM). Composite sampling involves combining multiple discrete environmental samples for analysis. ISM is a structured form of composite sampling designed to characterize the overall contamination level within an area of interest, where many incremental soil samples (typically 30 or more) are collected and combined to form a single ISM sample for laboratory processing and analysis.



# Compile Data for Each Exposure Unit: Practice

Now, let's practice using our case study exercise. In the last step, you defined the exposure units—the six drinking water wells—and at real sites you will perform six separate evaluations for each of the exposure units. But for our example, we are using just carbon tetrachloride in PW-3.

You will begin by compiling data for each potential contaminant of concern and exposure pathway. For this example, we will focus on the one contaminant that exceeded its comparison value (CV) during the screening (refer to Module 6), carbon tetrachloride, and one exposure pathway, drinking water ingestion. The carbon tetrachloride data for PW-3 from Module 6 are summarized in the table here.

**Carbon Tetrachloride Sampling Results for PW3 (from January 2015 to May 2015)**

	01/15	03/15	05/15
ppb	280	260	275

Note: This example has been simplified for training purposes. We will explore only one medium for each contaminant here, but real sites often involve other pathways that add to the total dose. For example, when VOCs such as carbon tetrachloride are present in water, inhalation (e.g., via vapor intrusion) and dermal exposures can significantly contribute to the total exposure dose.

## Compile Data Practice (cont.)

Again, to keep this example simplified for training, we will focus on evaluating carbon tetrachloride for one of the six exposure units. We will use PW-3 for our example. But remember, at a real site, you would evaluate all six of the individual exposure units we identified in Step 1 (PW-1 through PW-6).

In Module 6, we saw the three sampling data points for PW-3, collected on 1/15, 3/15, and 5/15. For this example, let's say we also learned that data were collected monthly for the rest of that year. We compiled the data from 1/15, 3/15, and 5/15, with the follow-on monthly data. Here's our data compilation for PW-3:

Carbon tetrachloride sampling results in parts per billion (ppb) for PW-3 by sampling date									
1/15	3/15	5/15	6/15	7/15	8/15	9/15	10/15	11/15	12/15
280	260	275	190	210	180	220	290	265	230

1/15	3/15	5/15	6/15	7/15	8/15	9/15	10/15	11/15	12/15
280	260	275	190	210	180	220	290	265	230

# Case Study Exercise:

## Defining Exposure Units and Compiling Data

Now that you finished the class exercise on water, use what you've learned to define exposure units and compile data for them in the independent case study exercise.

As we mentioned before, this independent exercise will focus on working with the arsenic data for soil at the daycare center, which you screened in Module 6.



# Case Study Exercise: Defining Exposure Units

## 1. Define exposure units to evaluate.

### Review the site information and map.

**Site Information:** GLC used chromated copper arsenate (CCA) as a wood preservative. The CCA contained arsenic, chromium VI, and copper. The facility placed the CCA-treated lumber on an uncovered drip pad, and CCA-contaminated drippings dropped to the ground. In 2005, Sunshine Playcare Center (a daycare facility) began operating off site, next to a part of the old drip pad.

In December 2015, EPA collected 18 discrete surface soil samples to check for CCA components on the daycare center property. All samples were from the top 2 inches of soil.

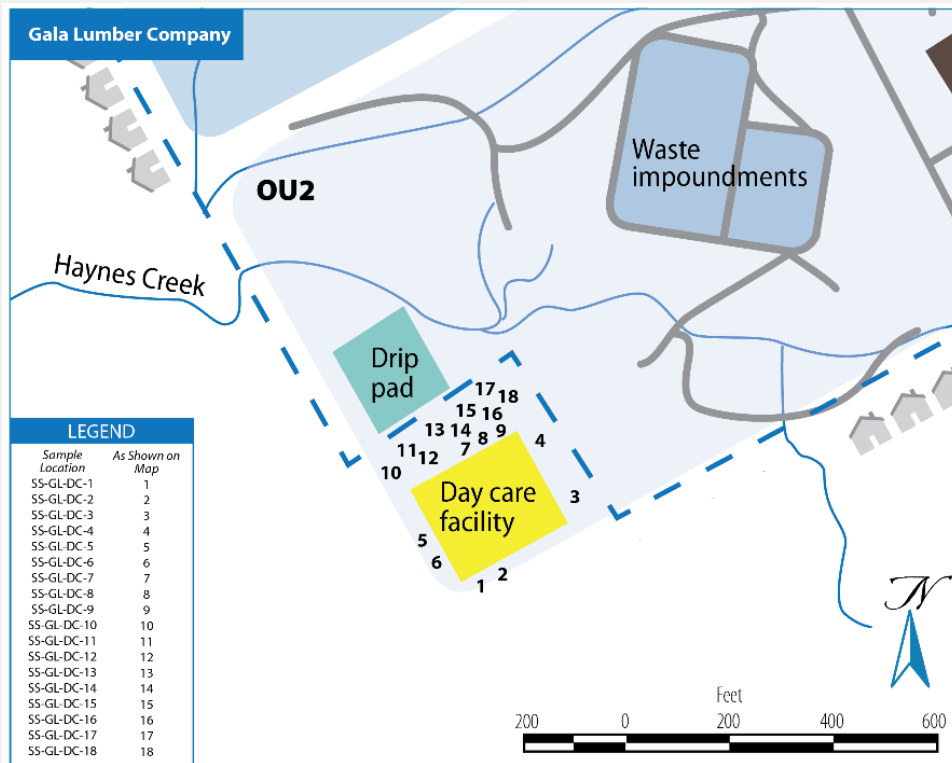
Children aged 3 months to 5 years attend the daycare, but only those  $\geq 1$  year play in the outside area. They can access all portions of the property. One or two children at the daycare likely engaged in pica behavior for acute or intermediate durations. Adults and children are present at the daycare facility for 5 days/week over a maximum of 50 weeks/year (school is closed for 2 weeks/year for holidays). Some adults work at the daycare facility for up to 25 years.

# Case Study Exercise: Defining Exposure Units (cont.)

## 1. Define exposure units to evaluate (continued).

Look at the map from your screening exercise in Module 6.

The legend shows the sample location numbers that correspond with the laboratory sampling data. All samples were collected on the daycare property.



# Case Study Exercise: Defining Exposure Units (cont.2)

## 1. Define exposure units to evaluate (continued).

Considering what you've learned, and the information provided, how should you define the exposure units for the soil at the daycare center? Choose one of the following:

- \_\_\_ A) One exposure unit for the entire outside area of the daycare center.
- \_\_\_ B) Different areas of the property as separate exposure units.

Go to the next slide for the answer.



# Case Study Exercise: Defining Exposure Units — Answer

**The correct answer is “A.”**

Option “B” is not correct because you would not define different areas of the property as separate exposure units. This decision is based on our knowledge that children may access all portions of the daycare property.



# Case Study Exercise: Compiling Data

## 2. Compile data for each exposure unit.

Now you will compile data for the single exposure unit you defined in Step 1 (the entire outside area of the daycare center).

For this exercise you will focus on arsenic, which exceeded its CV in soil during the screening case study exercise (refer to Module 6). You will compile the arsenic concentration data for these surface soil samples from Module 6 into the table here.

Go to the next slide for the answer.

Note: Remember that this exercise has been simplified for training. At real sites, you need to make sure you compile data for each exposure unit, considering data for each potential contaminant of concern and exposure pathway of interest.

### Surface Soil Sampling Results for Off-Site Daycare Center

Sample Location	Date Sampled	Arsenic (mg/kg)
SSGL-DC-1	12/12/15	
SSGL-DC-2	12/12/15	
SSGL-DC-3	12/12/15	
SSGL-DC-4	12/12/15	
SSGL-DC-5	12/12/15	
SSGL-DC-6	12/12/15	
SSGL-DC-7	12/13/15	
SSGL-DC-8	12/13/15	
SSGL-DC-9	12/13/15	
SSGL-DC-10	12/13/15	
SSGL-DC-11	12/13/15	
SSGL-DC-12	12/13/15	
SSGL-DC-13	12/14/15	
SSGL-DC-14	12/14/15	
SSGL-DC-15	12/14/15	
SSGL-DC-16	12/14/15	
SSGL-DC-17	12/14/15	
SSGL-DC-18	12/14/15	



## Case Study Exercise: Compiling Data — Answer

### 2. Compile data for each exposure unit (continued).

We compiled the arsenic data for these surface soil samples from Module 6 into the table shown here.

Compare your answers to this table to see how you did.

Surface Soil Sampling Results for Off-Site Daycare Center

Sample Location	Date Sampled	Arsenic (mg/kg)
SS-GL-DC-1	12/12/15	1.3
SS-GL-DC-2	12/12/15	350
SS-GL-DC-3	12/12/15	400
SS-GL-DC-4	12/12/15	2.6
SS-GL-DC-5	12/12/15	31
SS-GL-DC-6	12/12/15	350
SS-GL-DC-7	12/13/15	560
SS-GL-DC-8	12/13/15	280
SS-GL-DC-9	12/13/15	290
SS-GL-DC-10	12/13/15	550
SS-GL-DC-11	12/13/15	520
SS-GL-DC-12	12/13/15	460
SS-GL-DC-13	12/14/15	840
SS-GL-DC-14	12/14/15	1,020
SS-GL-DC-15	12/14/15	950
SS-GL-DC-16	12/14/15	430
SS-GL-DC-17	12/14/15	360
SS-GL-DC-18	12/14/15	270

# End of Exposure Units

Congratulations!

You finished this mini-module on exposure units.



For more information, contact ATSDR  
1-800-CDC-INFO (232-4636)  
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