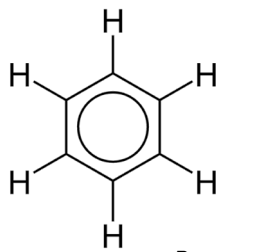
How to Build a Bucket Air Quality Monitor

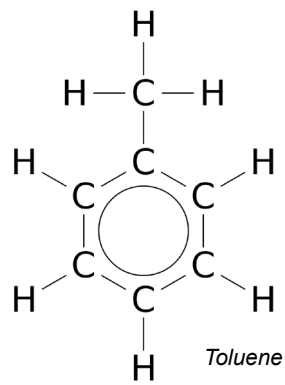
What is the Bucket Air Monitor?

The "bucket" is a low-cost, community-friendly air sampler that helps people measure toxic chemicals such as benzene and hydrogen sulfide in their air.

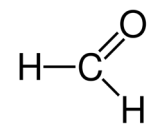
The bucket is a “whole air” sampler. It tests ambient air, in other words, the outside air that we breathe. When you take a bucket sample, you “grab” a sample snapshot of the air around you at that exact point in time and place. You can send your sample to a lab to test for **volatile organic compounds.**



Benzene



Toluene



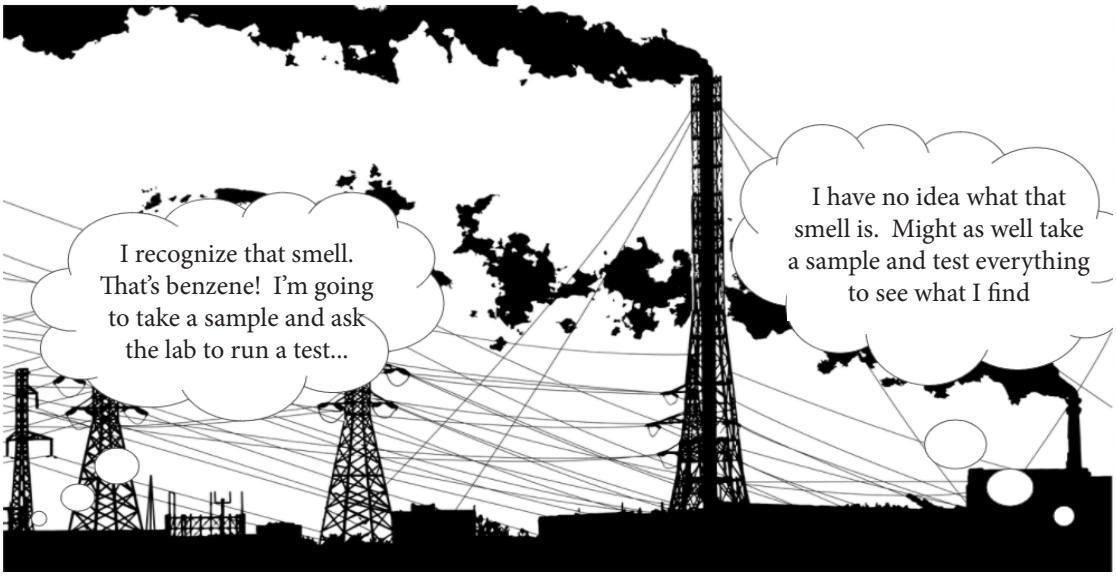
Formaldehyde

Volatile organic compounds are **gases** that enter the air through industrial processes. They commonly occur from industries such as oil refineries and busy roads but can occur naturally. While some VOCs are harmless, others can cause cancer or other health problems and are classified as **hazardous air pollutants (HAPs)**

The bucket can be used to identify VOCs (volatile organic compounds) in your air:

- Toluene
- Benzene
- Acrylic acid
- Hexane
- Chloroform
- Xylenes
- Methanol
- Vinyl acetate
- Styrene
- Isophorone
- Formaldehyde
- Ethylene oxide
- Carbonyl sulfide
- Hydrogen sulfide
- Methylene chloride

It can be used to test for up to 97 compounds! You can use it to test for a specific chemical, or you can test for a range of chemicals to see what's in your air.



"The best analogy for the bucket is that old thing called a polaroid camera. If you take a picture, it's taking a sample at that particular time." *- Azibuike Akaba, co-author of the CBE Bucket Brigade Manual*

Images courtesy of Pixabay, Wikimedia Commons

A tool for community air sampling

The bucket is a way for you to take control of your air and push for change in your community.

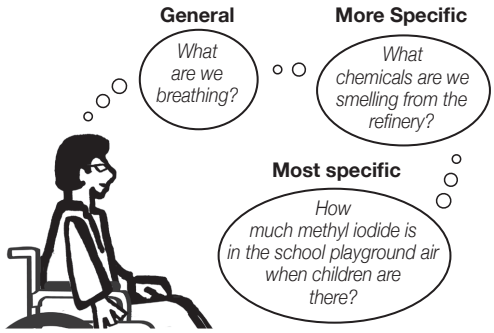
Will closing my windows help?

Does that sour smell mean the air is unsafe to breathe?

What's causing my son's asthma? The power plant? The highway?

A way to take control of the narrative

Buckets allow us to measure chemicals that are often under-regulated and in some cases, not regulated at all!



There was a pollution spike at 6 pm, but the official report didn't capture it.

I don't trust the factory to report their own emissions

This hazardous waste report is three years old.

An organizing tool for change

Buckets exist at the intersection of local organizing, community science, and health advocacy.

We can organize with friends and neighbors

We can identify the chemicals we are breathing

We can push for regulatory change.

Adapted from Statistics for Action Air Quality Manual and groundWork, Friends of the Earth South Africa 2003 Community Air Monitoring Report

"The bucket is a self-empowering tool allowing you to take control of campaigning. You don't have to depend on information from industry or government." - *Bobby Peek, founder of groundWork, Friends of the Earth South Africa*

Bongani Mthembu, South Durban Community Environmental Alliance (SDCEA)

Buckets are very useful for:

- Seeing exactly what's in the air that we breathe at a given time
- Responding to spike pollution events such as spills and fires
- Getting data that helps you get the attention of regulators
- Deciding if you need to move forward with an air study
- Tracking ongoing pollution in the absence of other monitoring
- Community ownership of scientific information

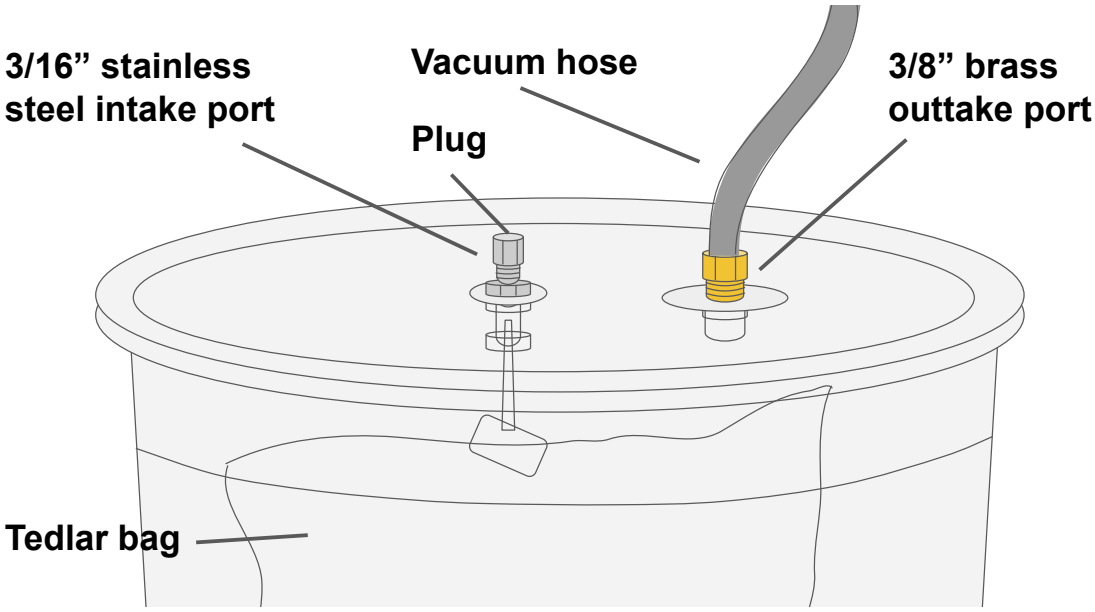
Buckets are less useful for:

- Capturing everything that might be in your air
- Real-time continuous fenceline monitoring
- Looking at things that are not toxic gases
- Getting results without wider advocacy

The bucket does not test for:

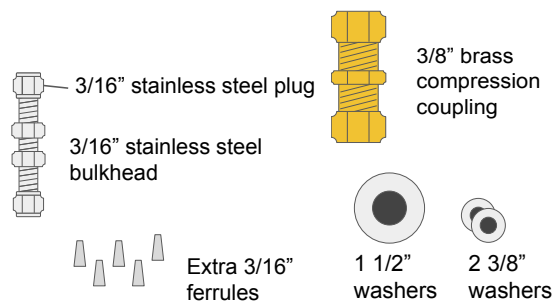
- Particulates (PM)
- Toxins that attach themselves to particulates (dioxins)
- Radiation
- Heavy metals
- Nitrogen oxides
- Methane or ethane

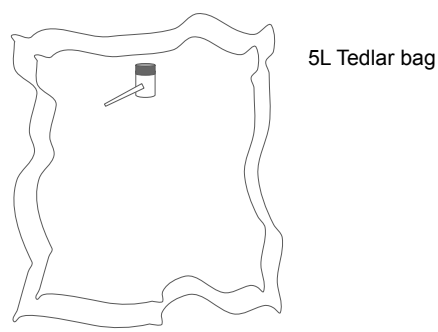
How to Build a Bucket Air Monitor

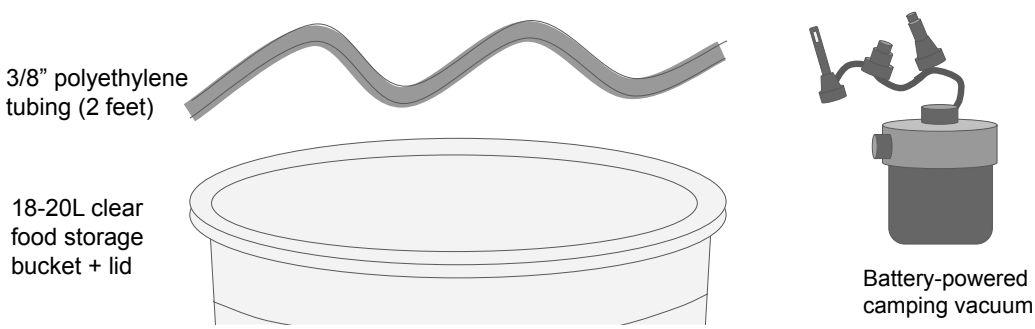


Parts List

- 3/16” stainless steel bulkhead
- 3/16” stainless steel plug
- Extra 3/16” ferrules
- 1 1/2” washers
- 2 3/8” washers
- 3/8” brass compression coupling
- 18-20L clear food storage bucket + lid
- 3/8” polyethylene tube (2 feet)
- Battery-powered camping vacuum
- 5L Tedlar bag

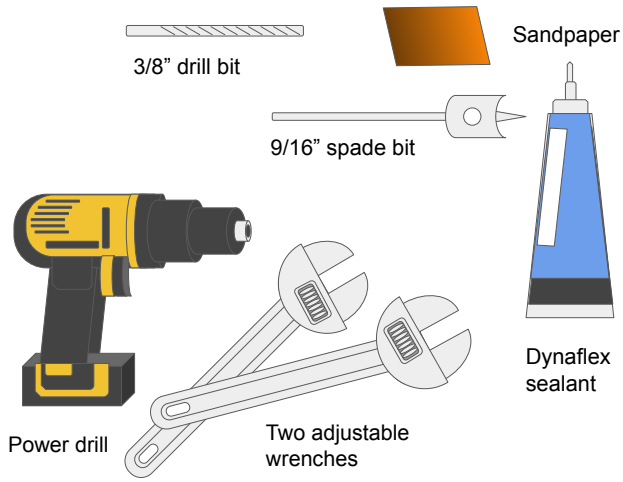






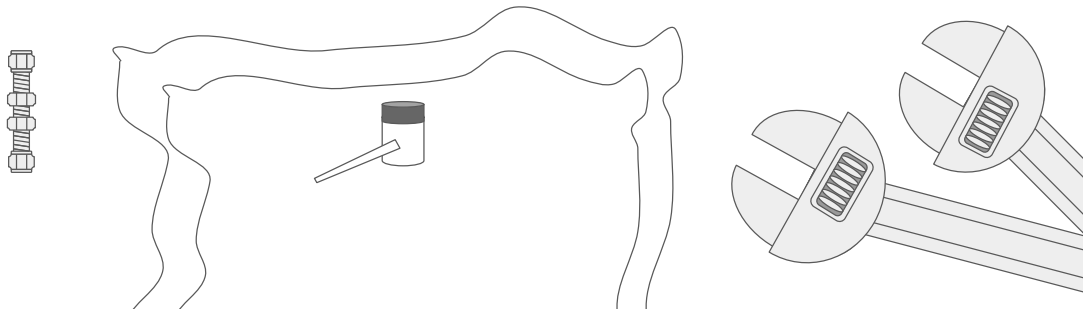
Tool List

- Power drill
- Two adjustable wrenches
- 3/8” drill bit
- 9/16” spade bit
- Sandpaper
- Dynaflex sealant

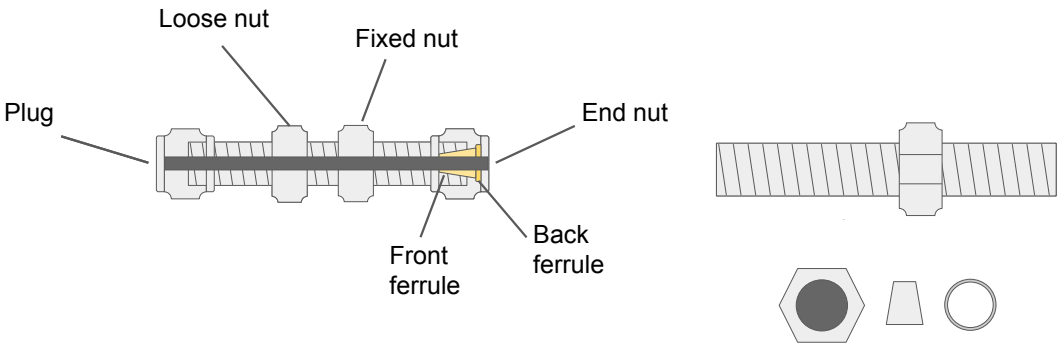


Step 1: Set up the Tedlar bag

Before you start assembling the bucket, you’ll need to set up the 3/16” stainless steel bulkhead so you can make an airtight seal with the Tedlar bag. You’ll need the bulkhead, the Tedlar bag, and two adjustable wrenches.

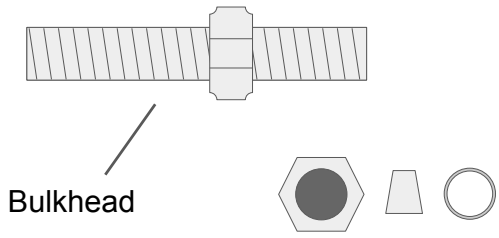


Take apart the bulkhead. Set aside everything but the end nut and ferrule.

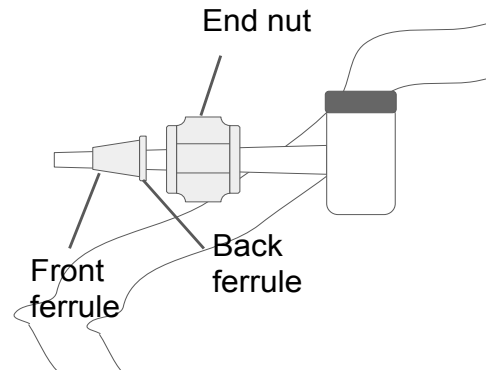


Step 2: Attach the nut and ferrule to the Tedlar bag

Slide the end nut and ferrules over the nose on the Tedlar bag. The front and back ferrule should fit loosely. You'll need to tighten it to get it to catch.



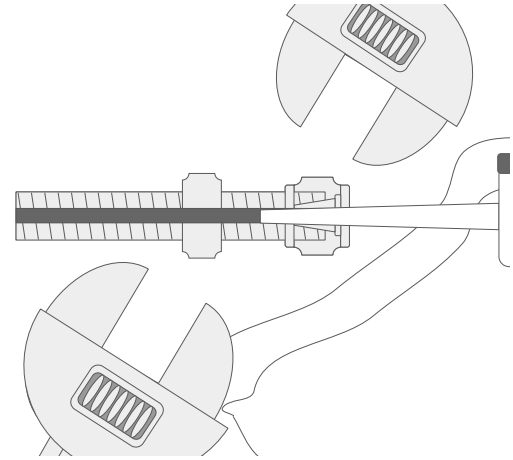
3/16" nut with front and back ferrule



Step 3: Attach the bulkhead, tighten against the fixed nut

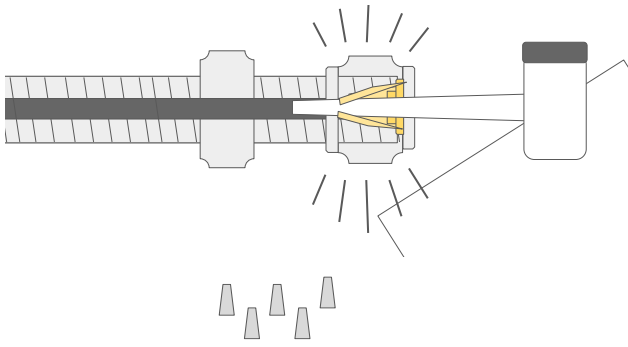
Now that the nut and ferrule are attached to the Tedlar bag, use the adjustable wrenches to tighten it a half-turn, or until the ferrule catches.

As the ferrule is crushed, it "bites" into the soft tubing, compressing slightly to make a firm seal that will hold the bag in place.



DON'T OVERTIGHTEN

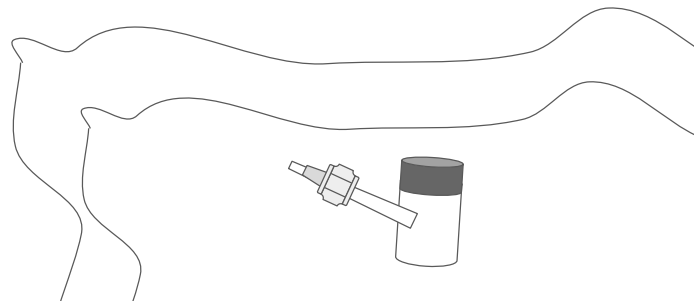
If you overtighten, you won't be able to get the bag on and off



If you "overcrush" your ferrule, no worries! You can just cut the end of the polypropylene tube and use a new ferrule on the next bag.

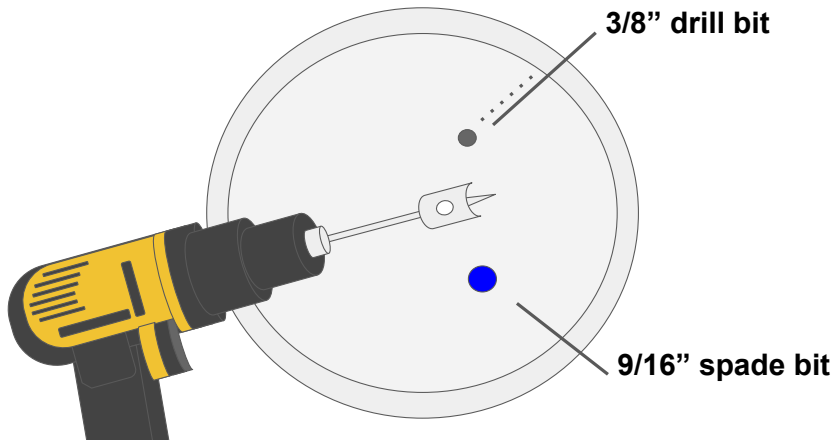
Extra 3/16" ferrules

Slide the nut and ferrule off and set the bag aside. We'll re-attach it to the bulkhead once we're ready to assemble the lid.

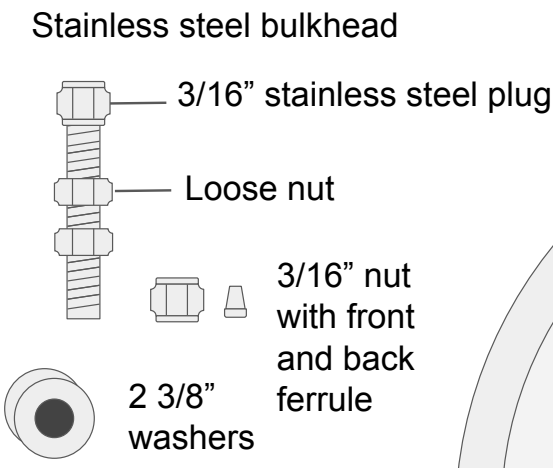


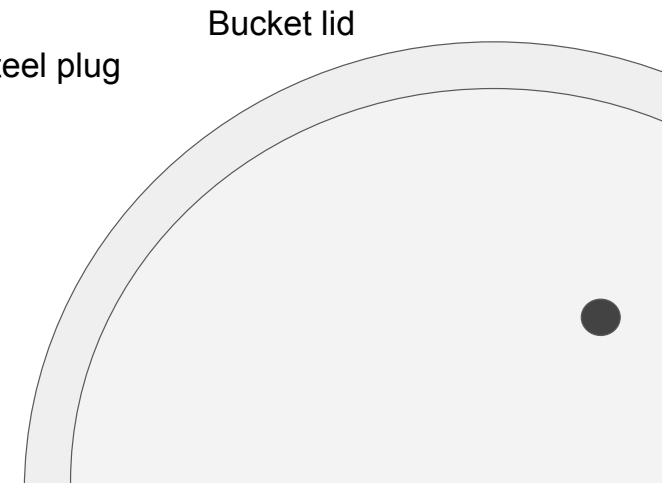
Step 4: Drill two holes in the bucked lid

The first hole is set 2-3” away from the edge of the lid. Use the 3/8” bit. The second hole is drilled with the 9/16” spade bit and can go anywhere.

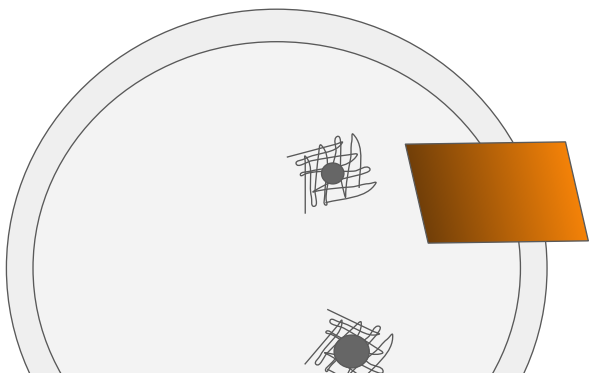


Step 5: Gather parts for the intake port





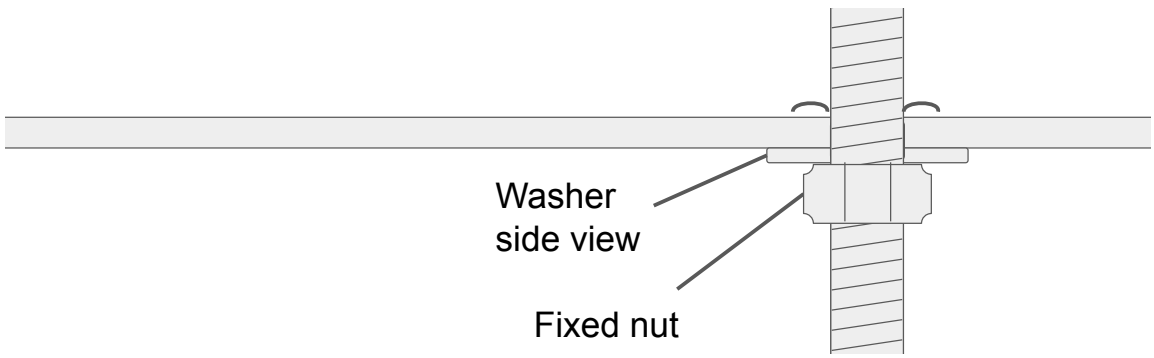
Step 6: Scuff the holes with sandpaper



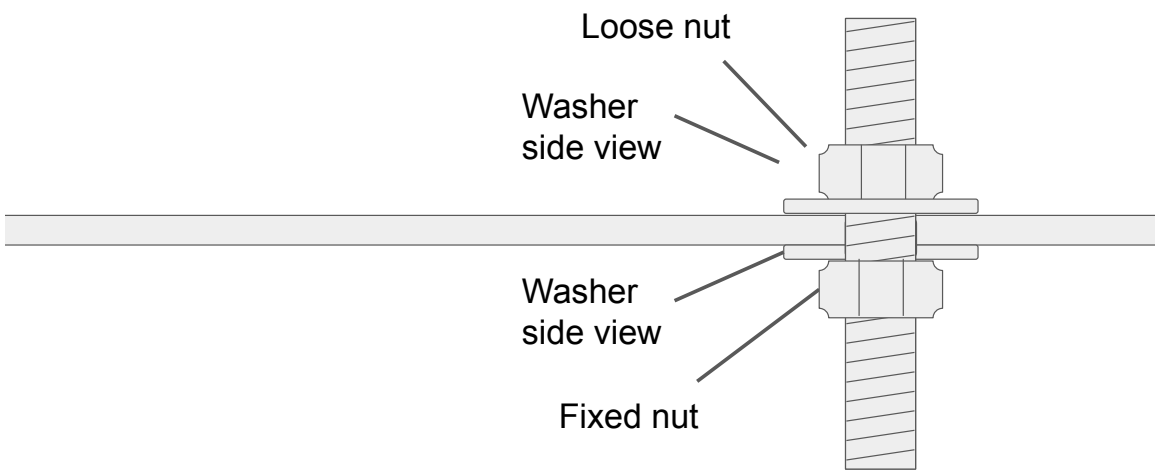
Step 7: Attach the bulkhead to the lid

The bulkhead is designed to mount to a solid surface like the bucket lid. Apply a small amount of sealant to the scuffed edges of the 3/8” hole.

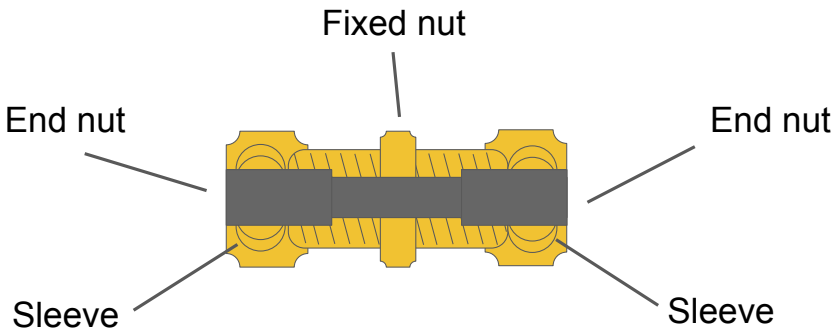
Lay the bottom washer in place. It should sit flush with the underside of the lid. Slide the bulkhead through the hole and press firmly against the washer.



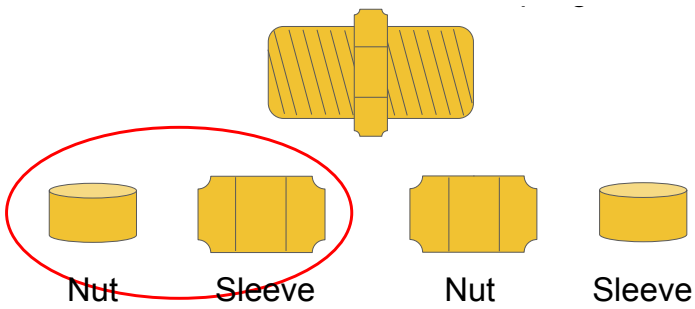
Lay the top washer in place the same way. Connect the loose nut to the top and screw into place. Tighten the nuts.



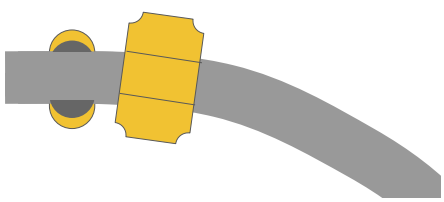
Step 9: Take apart the 3/8” brass coupling



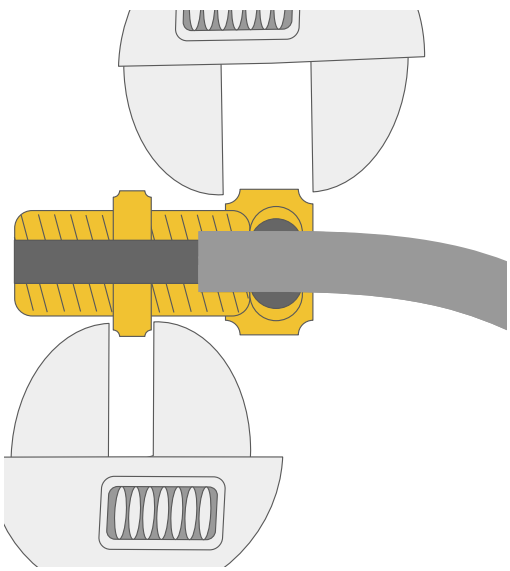
Set aside the nut and sleeve. The coupling is designed to attach a tube to either side. We only have one tube, so we’re only using one nut.

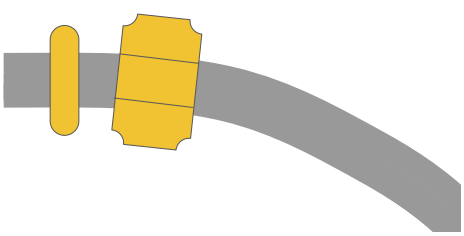


Step 10: Attach the tube. Slide the tube through the nut and sleeve. Leave 1/2” of tube on the other side. Screw the coupling so it fits tightly.



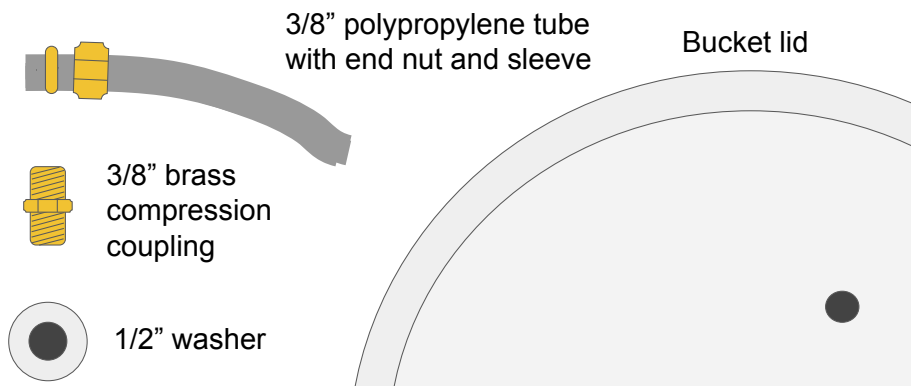
Use the adjustable wrenches to crush the sleeve. Once the sleeve is attached, it’s on for good! Unscrew the coupling and set aside the tube.





Step 13: Gather parts for the outtake port

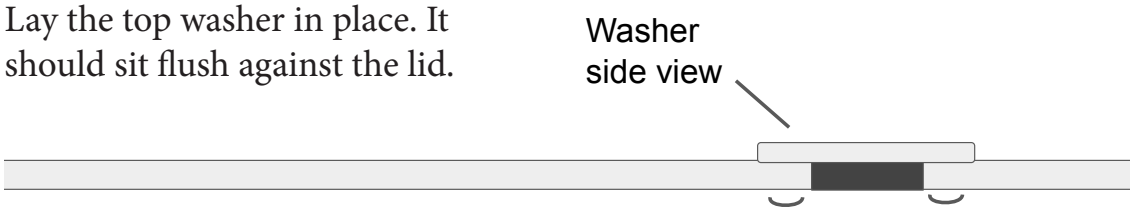
Time to attach the coupling to the bucket lid! Like the bulkhead, the coupling is designed to be mounted to a fixed surface.



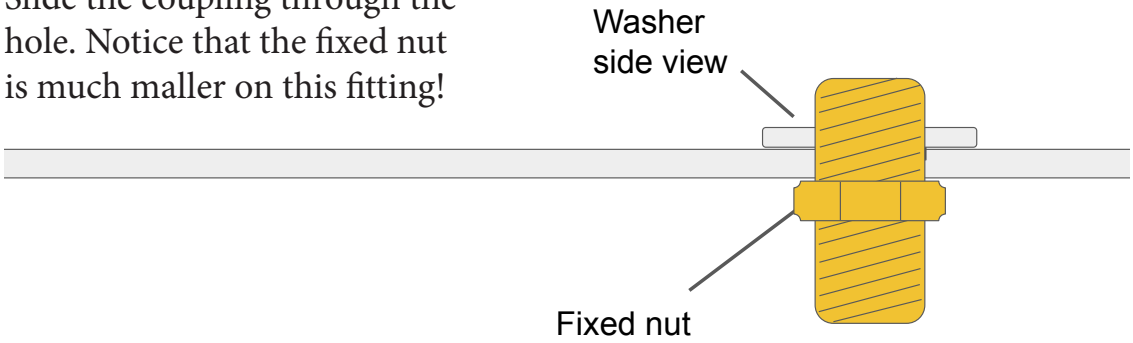
Step 12: Attach the brass coupling to the bucket lid

Apply a small amount of sealant to the scuffed edges of the 9/16” hole.

Lay the top washer in place. It should sit flush against the lid.

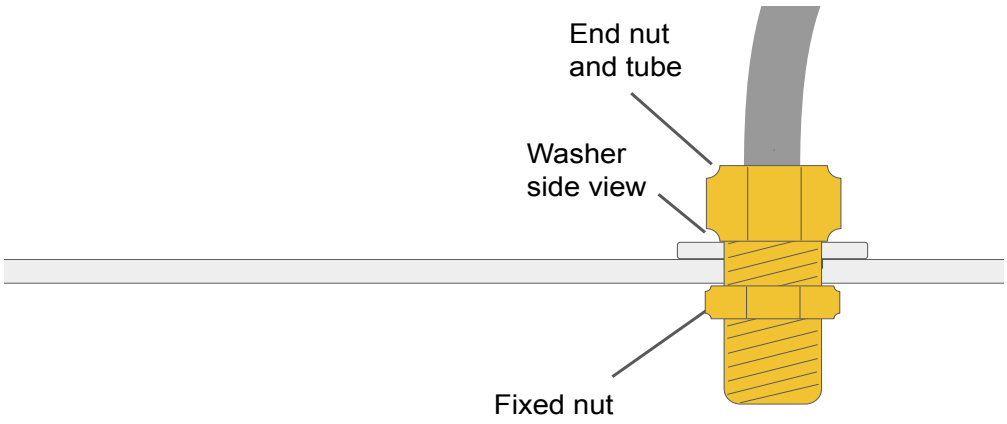


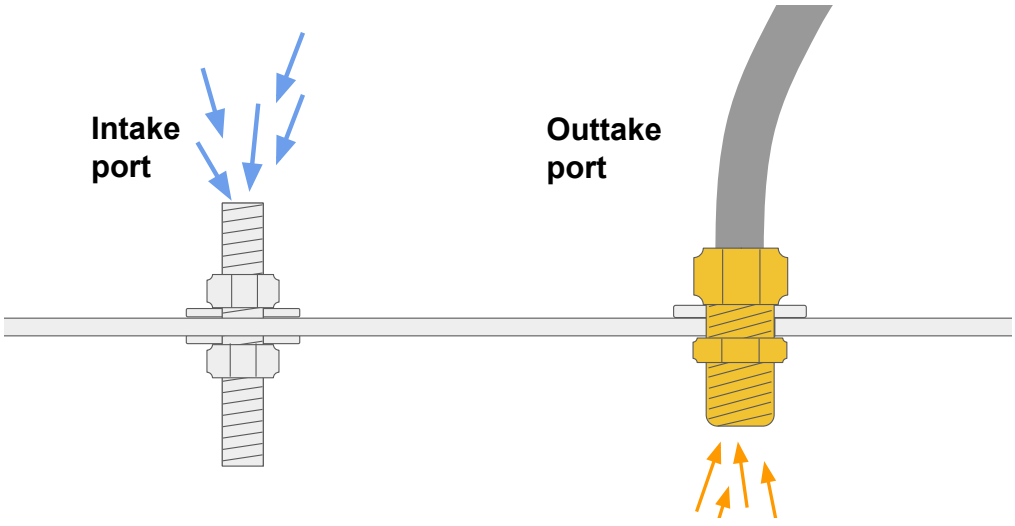
Slide the coupling through the hole. Notice that the fixed nut is much maller on this fitting!

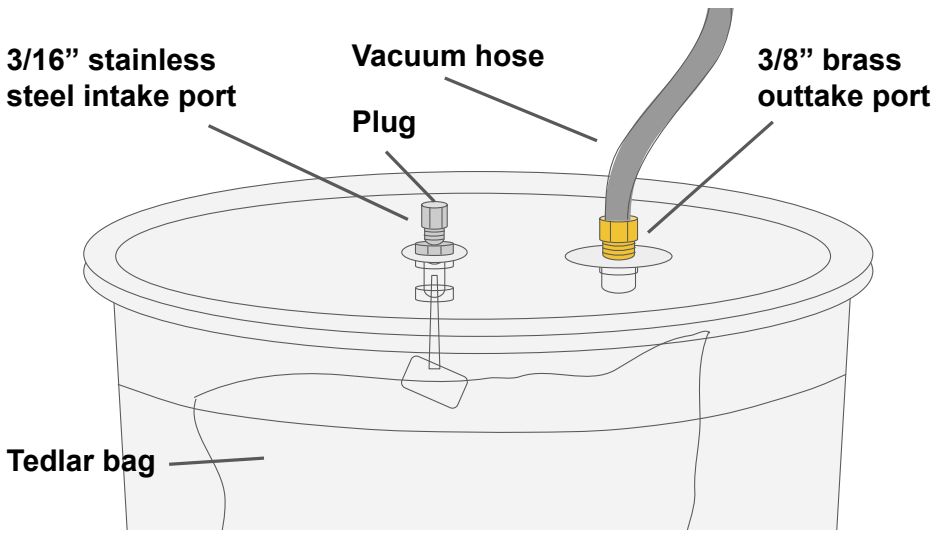


Step 13: Attach the tube to the outtake port.

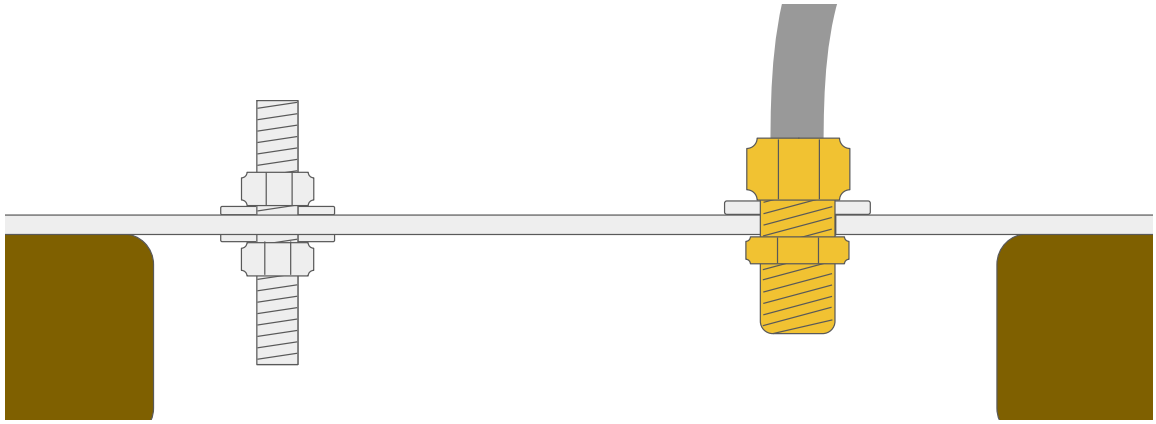
There is no loose nut on the outtake port, only the fixed nut and washer.





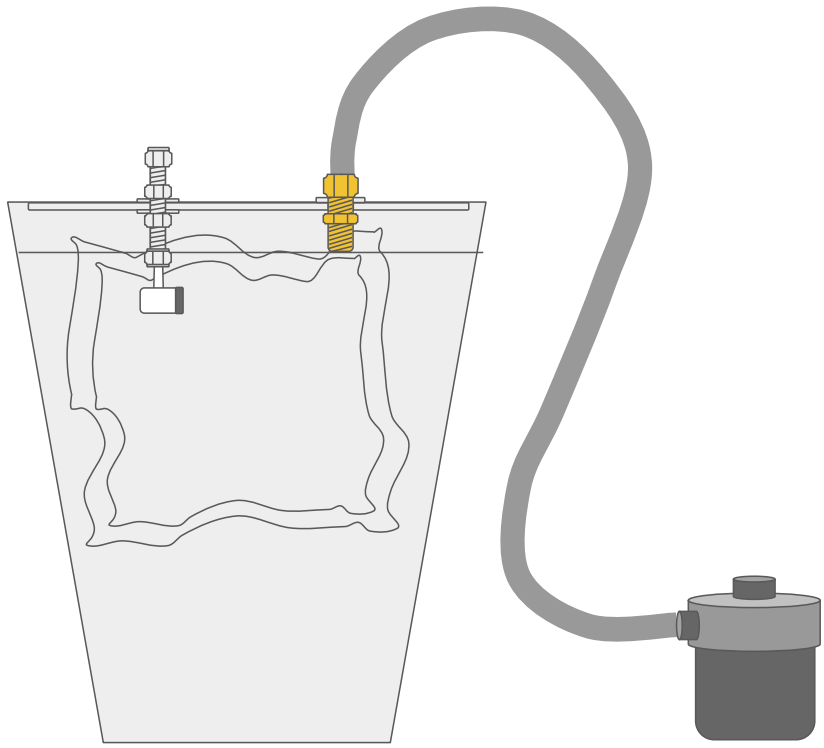


Step 14: Let the bucket lid dry. Don't skip this step! Set the lid out overnight and prop it with supports to avoid putting pressure on the joints.



Step 15: Attach the bag and pump

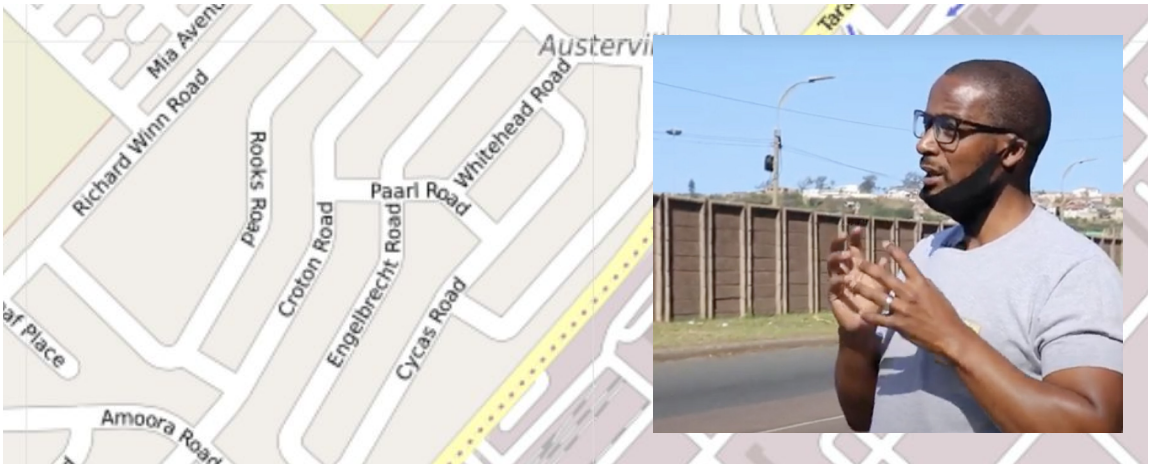
Put the cap on the intake port when not in use.



Congratulations! You're ready to take a sample!

How to Take a Sample

Step 1: Choose a location. In order to find the right sampling location you might have to sniff around. Literally. Try to find a location with the strongest odor. This will also most likely be where the chemicals are strongest.



Bongani Mthembu, South Durban Community Environmental Alliance

Do not put yourself in harm's way!
If you start to feel dizzy, lethargic, or nauseous, stop sampling immediately and go to a safe location.

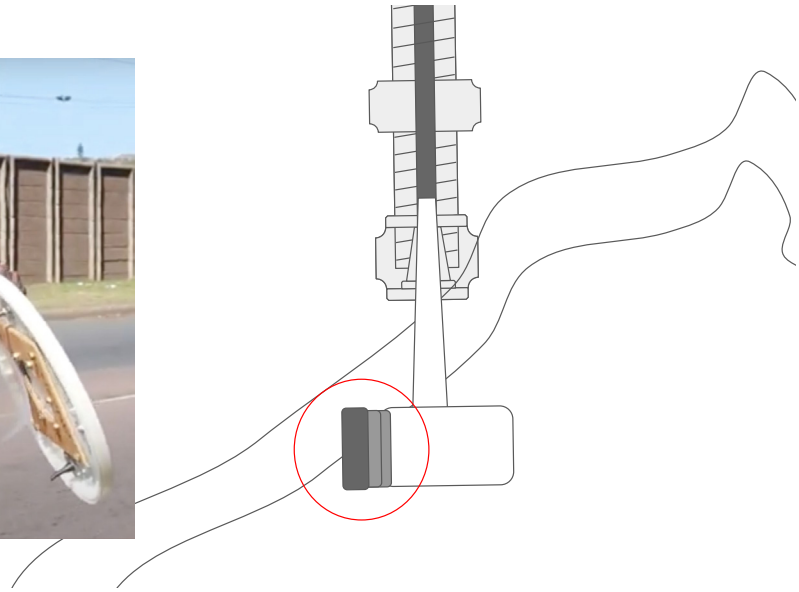
What am I looking for?

Type	Source	Cause	Effects
ROTTEN EGGS	Hydrogen Sulphide	Refineries / Crude Oil vapor	Cough, Nausea, Headaches
BURNED MATCHES	Sulphur Dioxide	Processing / Burning Crude Oil	Asthma, High Sensitivity
CADAC GAS	LPG, Butane, Propylene, Propane	Gas Storage depots / Refineries	Drowsiness, Asphyxia
CAT URINE	Ammonia	Fertiliser, Cleaning Agents	Drying out, lightheadedness
BLEACH	Chlorine	Water treatment, bleaching agent	Skin irritation, headaches
PETROL	Petrol fumes	Storage depots / Petrol users	Cancer
SWEET ALMONDS	Benzene	Industrial solvent, part of petrol	Vomiting, sleepiness
GLUE	Toluene	Paint & Resin manufacturing, part of petrol/solvent	Intoxication
CARAMEL/ SUGAR	Cane by-products	Sugar Cane Processing	
PUNGENT ACID	Polystyrene	Packaging, insulation manufacturing	Fatigue, Depression
ALCOHOL	Ethanol	Fuel refining / medical industry	Light-headedness, intoxication
ROTTEN CABBAGE	Methanol	Fuel refining / antifreeze agent	Respiratory failure, blindness
VINEGAR	Acetic Acid	Chemical product manufacturing	Digestive damage, skin irritation
HUSKY/SUFFOCATING	Chromium / Formaldehyde	Chrome manufacture	Eye irritation, Lethargy

Adapted from South Durban Community Environmental Alliance, "Smells that Kill"

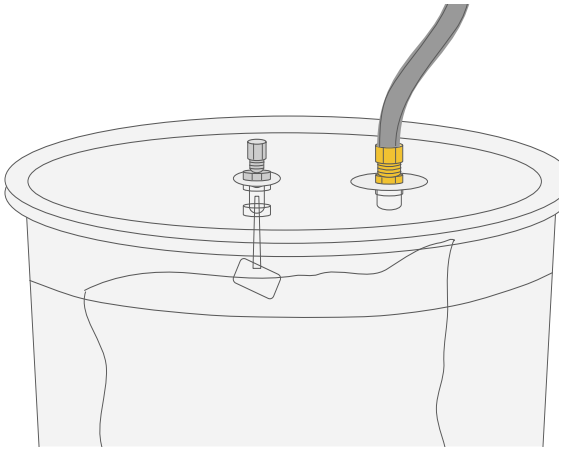
Step 2: Attach the Tedlar bag securely

Insert the nose of the Tedlar bag into the stainless steel port. If it falls out, tighten the nut and ferrule slightly with your adjustable wrenches. Loosen the valve slightly on the Tedlar bag by about three twists to allow air to flow into the bag.



Step 3: Close the bucket lid

In order for the bucket to work, a mini vacuum has to be created using the pump to draw air out of the bucket causing the bag to inflate. If the lid is open or the bag is sticking out, there will be no vacuum and the bag will not inflate.

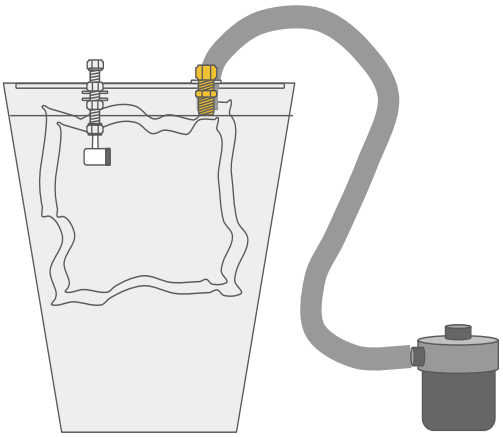


If you have followed all of the steps above and the Tedlar bag is still not inflating, it may be due to a leak somewhere else in the bucket.

Step 4: Attach the air pump and start pumping

It's important to monitor the bag as you are taking your sample. This is easy to do if you have a clear bucket. If you are using a bucket with a window, make sure you can see the bag clearly. Do not over inflate or the bag will pop. This kit comes with a camping vacuum, but any pump will work.

Taking a sample with a bike pump



Taking a sample with a camping vacuum

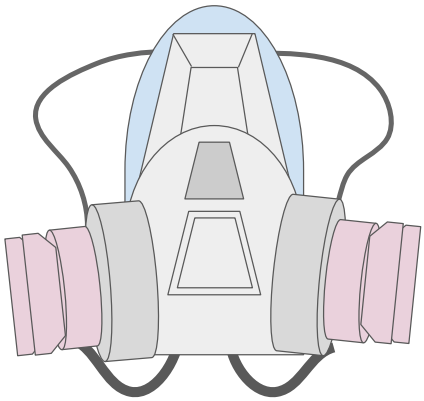
Step 5: Remove and secure your Tedlar bag

Once you have finished inflating the Tedlar bag remove the bucket lid and retighten the valve found on the nose of the Tedlar bag. If you notice the bag starting to deflate after you have taken the sample you might need to tighten the valve more. Gently remove the nose from the bucket lid port.

Step 6: Store your bucket sample

Protect the inflated bag by placing it back into the bucket and closing the lid. If you need to store your bag overnight, place it in the fridge. You will need to postmark it as quickly as possible, as it needs to get to the lab within 72 hours.

Safety Gear. If you can smell it, that means you are breathing it! You can purchase a half-facepiece reusable respirator with cartridges specifically designed to protect you from volatile gases.



3M Half Facepiece Reusable Respirator 6500 series		
Color coding for 3M chemical cartridges		
6001	Organic Vapor	Black
6002	Acid Gases	White
6003	Organic Vapor / Acid Gases	Yellow
6004	Ammonia / Methylamine	Green
6005	Formaldehyde / Organic Vapor	Olive / Black
6006	Multi-Gas/Vapor	Olive
6009	Mercury Vapor/Chlorine Gas	Orange

Do not put yourself in harm's way! If you start to feel dizzy, lethargic, or nauseous, stop sampling immediately and go to a safe location.

Chain of Custody Form

Your sample will need to be accompanied by a chain of custody form, logging the location, wind direction, date and time, and visibility. Include anything you "see, smell, or feel": odors, any physical symptoms you are experiencing (nausea, etc). This form is part of the "package" you will send to the lab.

Supporting Documentation

In addition to bucket samples, you may want to collect:

- Daily or weekly pollution logs
- Photographic evidence
- Interviews or case studies
- Recording the experience of people affected by pollution
- Developing pollution maps to identify hotspots

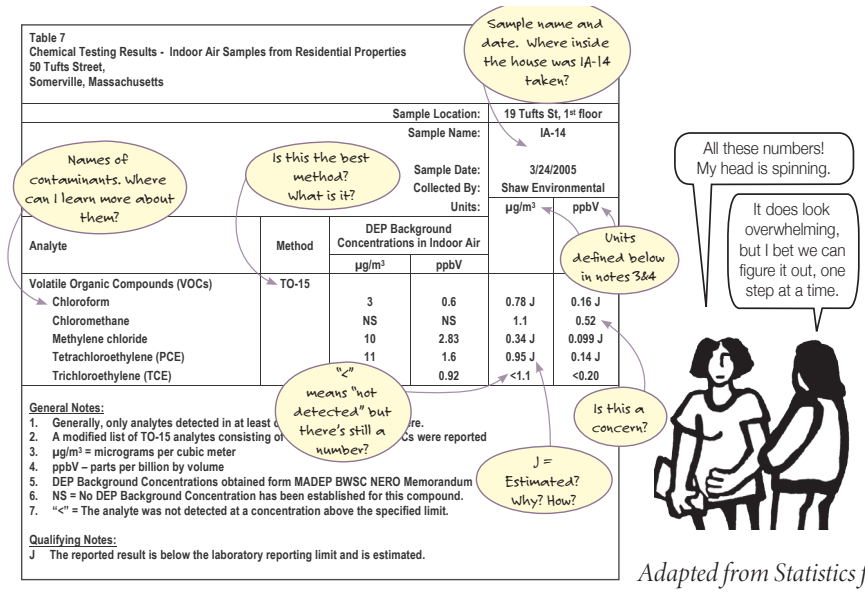
Shipping Time

In general, sulfur samples need to be analyzed within 24 hours, and VOCs within 72 hours. Have a shipping carrier and location in mind. You'll likely need to use overnight shipping to get the sample to the lab in time.

How many samples should I take? This depends on the nature of what you are sampling. You may be taking monthly samples to establish a baseline, or documenting an ongoing pollution incident. A big explosion would require 4-5 samples. A slow leak might need 1-2 samples.

Be prepared! If you are sampling regularly or live near a facility with frequent emissions, keep at least 10 extra Tedlar bags on hand at all times. If something happens, you want to make sure you have everything on hand that you need to take a sample right then.

Getting your lab results back. The lab will send you a report with the name and amount of any chemicals found. These results can be challenging to interpret, even for people with training! Go over it with a friend and don't try to understand everything at once.



Adapted from Statistics for Action Air Quality Guide

- If you have the ability and funds, it might be helpful to work with an experienced consultant or air quality engineer who can help interpret the lab results.
- A local university or college might also have faculty who are willing to help interpret lab results.
- Statistics for Action (SfA) has accessible activities on how to understand, analyze, and communicate your data.
- Toxics Action Center also has a guide to interpreting results.

Credit and Authorship

With sincere thanks to:

South Durban Community Environmental Alliance (sdcea.co.za/)

groundWork, Friends of the Earth South Africa (groundwork.org.za/)

Citizen Science Community Resources (csresources.org/) who have been using the bucket for 20 years to empower communities to take control of their air.

Thank you for sharing your wisdom and expertise.

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This guide is based on the 1999 Bucket Brigade Manual by Communities for a Better Environment (cbecal.org/), which has been working since 1978 to build community power for environmental justice, clean energy, and healthy communities. It is based on material generously shared by Global Community Monitor, which promoted the bucket brigade model for 16 years and brought it to over 40 communities around the globe.

Portions of this guide are adapted from the Statistics for Action Air Quality Manual (sfa.terc.edu/). Originally published by TERC in 2014 with support from the National Science Foundation and shared with permission. Images courtesy of Rini Templeton's estate at riniart.org.

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The Bucket Monitor Toolkit is a collaboration between Public Lab, Fair Tech Collective, South Durban Community Environmental Alliance, groundWork Friends of the Earth South Africa, and Citizen Science Community Resources.

We are indebted to the work of regional bucket brigades around the world who have spent decades building buckets, refining their design, and developing a model for integrating buckets into organizing.

For more resources, visit publiclab.org/wiki/bucket-monitor

For information about getting your samples tested in a lab, visit publiclab.org/wiki/air-lab-testing


publiclab.org