

# Fire Hose Trials

Chandler Probert

Dr. Bryan Ormond

Ellie Griffin & Parris Tysinger

NC State University

## Goal

Test the effectiveness of a new firefighter hose cleaner developed by \_\_\_\_\_

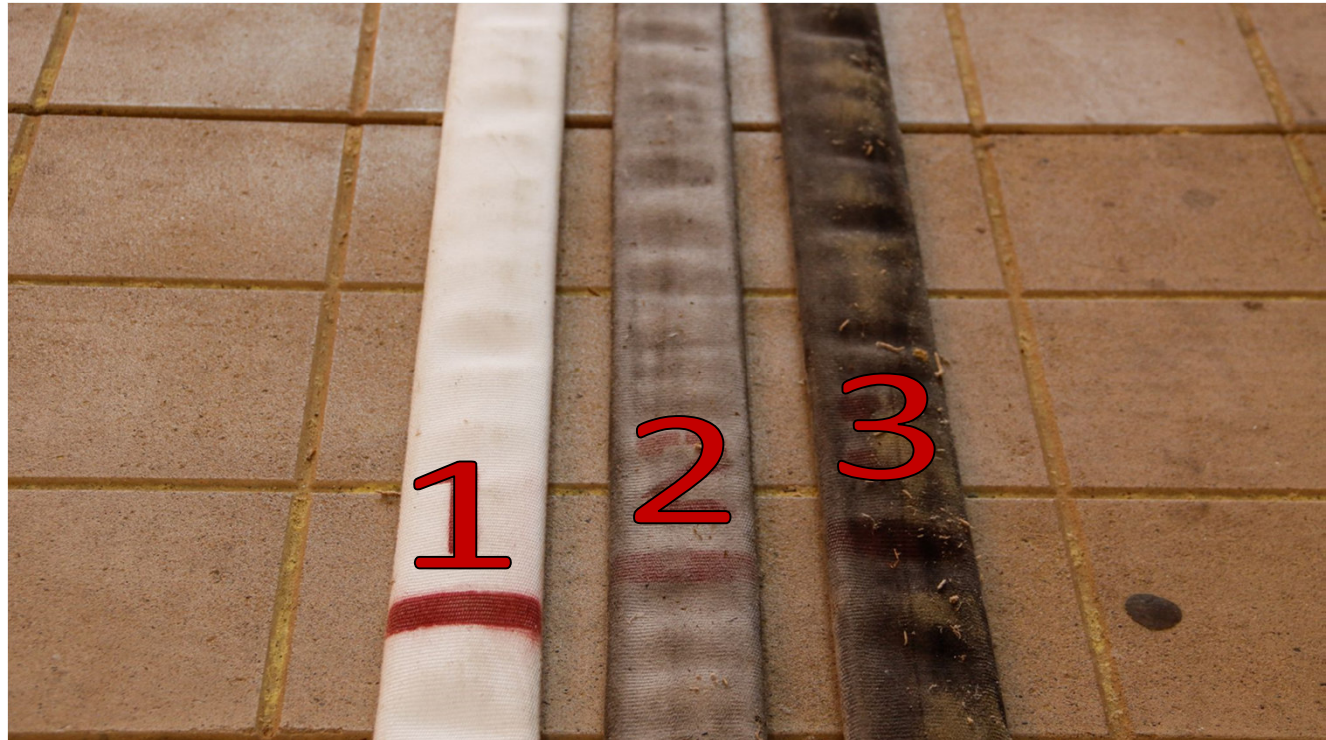
## Experiment

Three brand new all white firefighter hoses were purchased and used by \_\_\_\_\_ to collect fire scene contaminants.

- Fire hose 1 was kept as a control and never used.
- Fire hose 2 was cleaned at the end of each day.
- Fire hose 3 was never cleaned at all.

Insert data on the number of exposures (sheet of paper that came with the hoses).

## Fire hoses after exposures



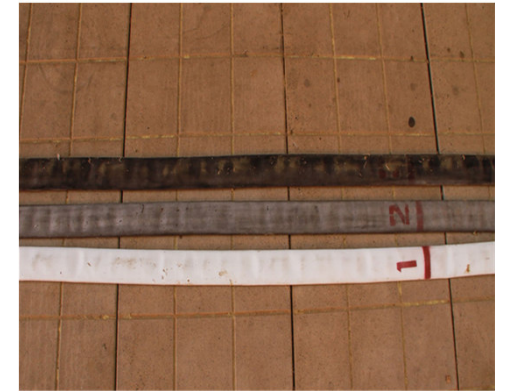




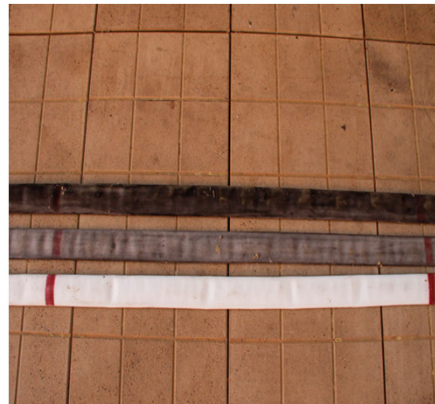
**Start 0 - 5 ft  
15 - 20 ft**



**5 - 10 ft  
20 - 25 ft**



**10 - 15 ft  
25 - 30 ft**





**30 - 35 ft**  
**40 - 45 ft**



**35 - 40 ft**  
**45 - 50 ft**



Beginning (0-5 ft)



Middle (20-25 ft)



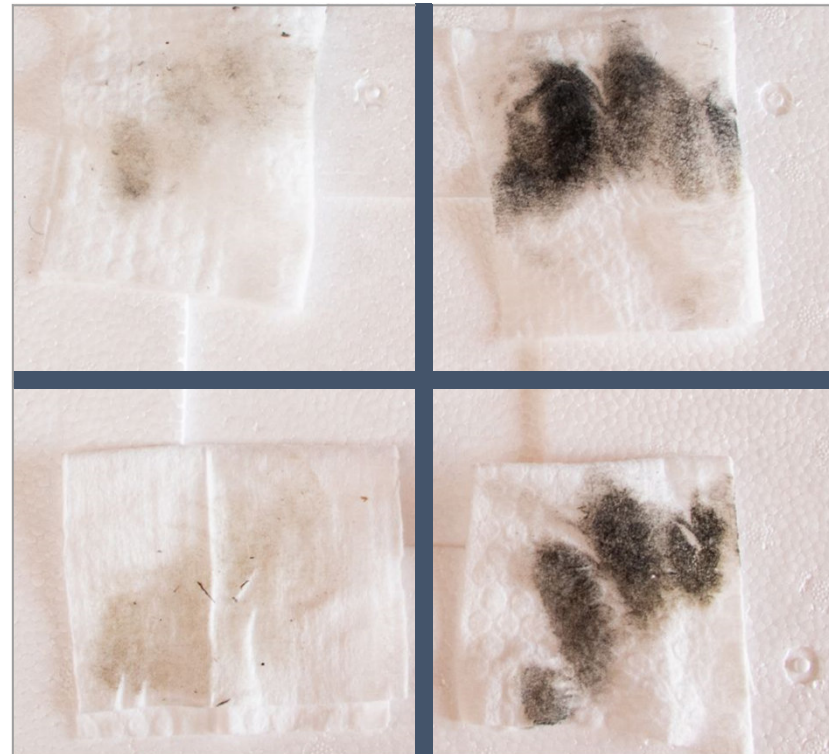
End (45-50 ft)





## Wipe Samples

<b>Hose 2 4 Swipes</b>	<b>Hose 3 4 Swipes</b>
<b>Hose 2 1 Swipe</b>	<b>Hose 3 1 Swipe</b>



## Qualitative Results

- Based on visual assessments, cleaning fire hoses at the end of the day or shift will reduce amount of contaminants and particulate matter on the fire hose significantly.
- The middle section of the fire hose is likely to be the dirtiest part of the hose. Front is carried and end does not make it into the scene.
- Heavy amounts of particulate deposition occurs during fire training exercises and PPE, gear, and individuals should be cleaned when fire suppression activities end.

- Fire Hose 2 was noticeably cleaner than Fire Hose 3.
- The first 10 feet of hose was visibly cleaner than the rest of the hose, this is likely due to the firefighters in the front carrying the hose and it being off the ground.
- The wipe samples confirmed the visual assessment of cleanliness between fire hoses 2 and 3.
- Fire hose three had loose particulates on the surface, which were easily collected by baby wipes. Indicating that handling the fire hose without protection is a source of dermal exposure to contaminants and particulate matter.

# Samples

Samples were taken in triplicate from five foot sections along the fire hoses. These samples were analyzed using a hand-held spectrophotometer to take light measurements and then extracted using pressurized liquid extraction technique and analyzed using high performance liquid chromatography.

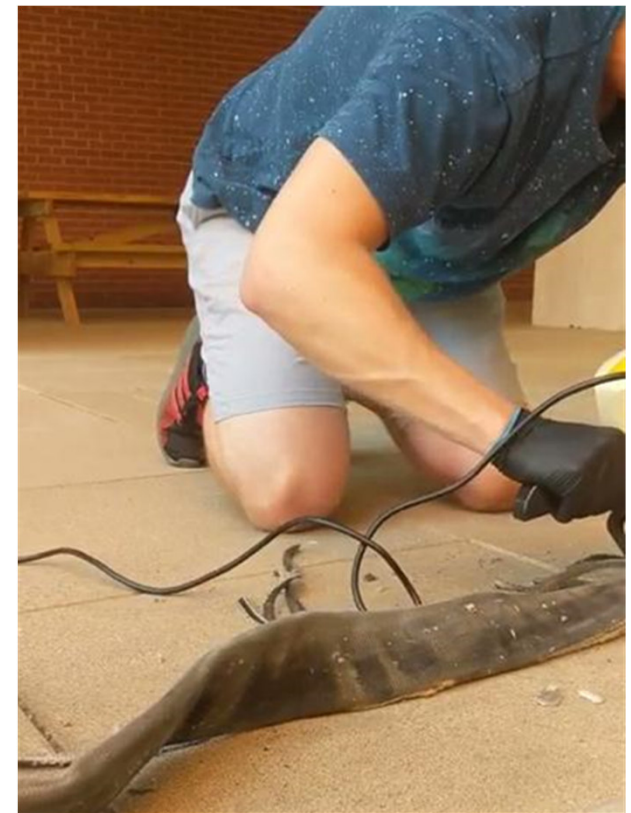
Samples were roughly the size of a post-it note

Wipe samples were taken after receiving the hoses from \_\_\_\_\_ and after any additional hose cleanings. Wipe samples were extracted using pressurized solvent extraction technique and analyzed using high performance liquid chromatography to assess surface contamination of each hose.

$2 \pm 1$  inches x  $2 \pm 1$  inches







## Cleaning

After collecting the fire hoses back from \_\_\_\_ the NC State research group took the hoses to Fire Station 2 to experiment with the fire hose cleaner further.

Fire Hose 2 was run through the cleaner once with Citro Squeeze.

Fire Hose 3 (Never Cleaned) was run through the cleaner twice with water only and an additional time with Citro Squeeze.



## **After Washing**

Hose 2 was cleaned once with Citro Squeeze.

Hose 3 was cleaned twice with water and once with Citro Squeeze.

Hoses were bagged and transported back to NC State to dry and take samples.

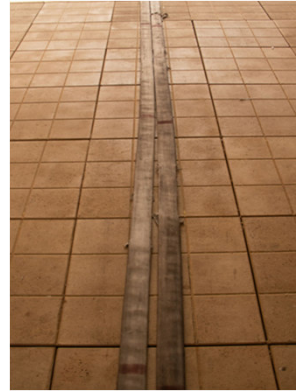




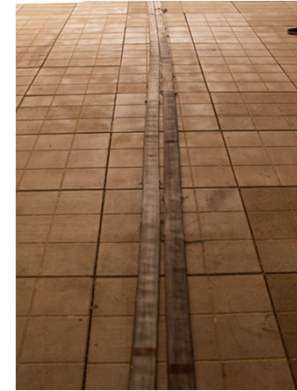
0 - 5 ft



5 - 10 ft



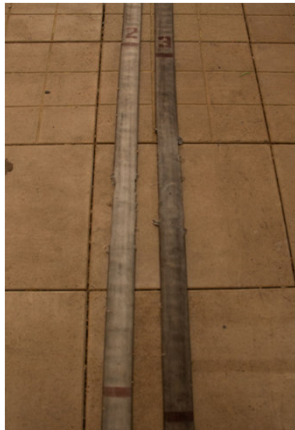
10 - 15 ft



15 - 20 ft



20 - 25 ft



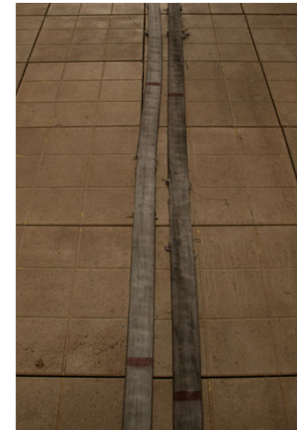
25 - 30 ft



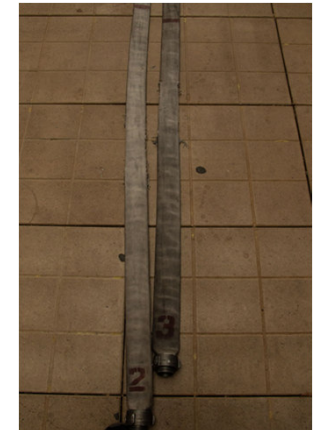
30 - 35 ft



35 - 40 ft

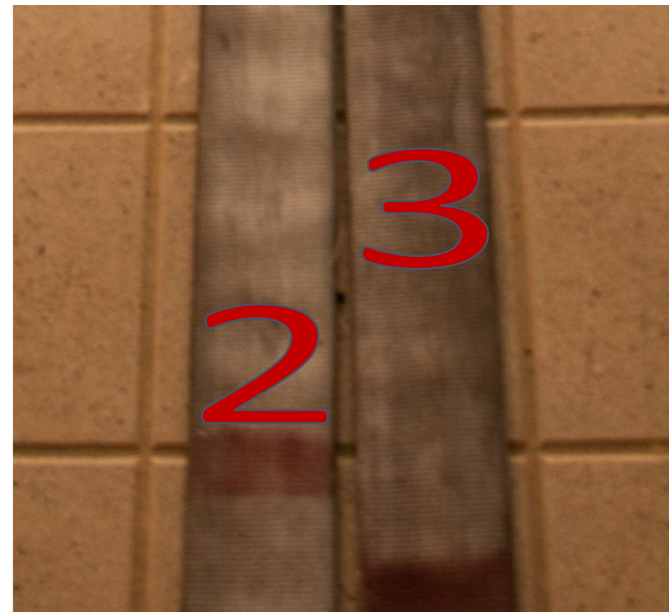


40 - 45 ft



45 - 50 ft

## Before and After Washing



## Key Takeaways

- To minimize contamination and chemical exposures via dermal absorption the fire hose should be cleaned routinely, at least once at the end of day or shift.
- Wear gloves or some form of protection while handling fire hoses after fire suppression activities as the fire hose is a source of chemical exposure.
- The fire hose cleaner can significantly reduce the amount of chemicals and contaminants on a fire hose, even after it has been used numerous times without being washed.






# Photos from Live Burn Hose Trials


November 23, 2020 – NC State University





**Soot, smoke, and ash  
accumulation on the  
walls of the training  
building walls and  
ceilings**

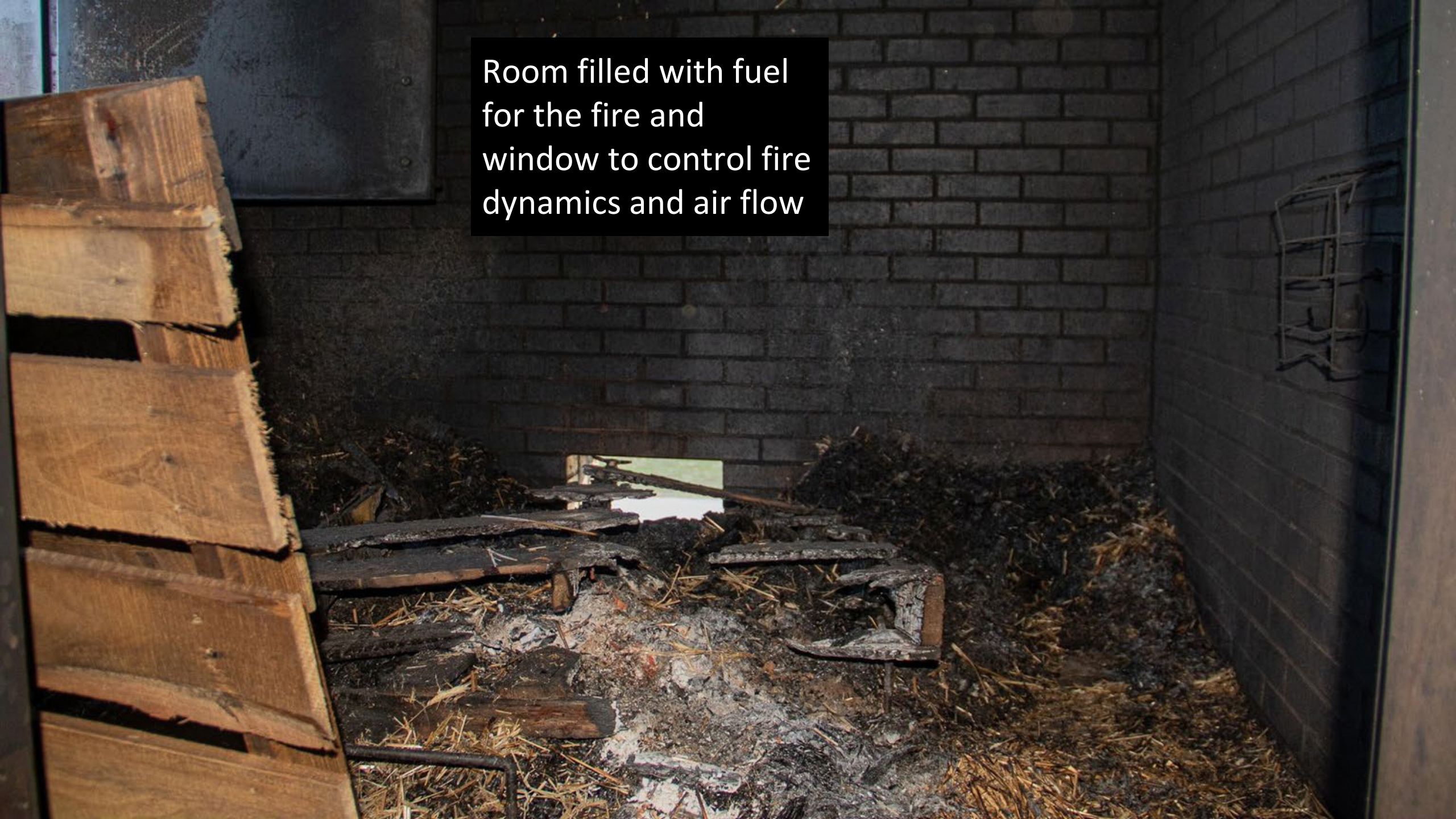


A close-up photograph showing a thick, dark brown, granular accumulation of soot, smoke, and ash on a wall. The texture is highly irregular and porous, with many small, light-colored particles visible within the darker mass. The accumulation is dense and covers the entire visible surface.

**Soot, smoke, and ash  
accumulation on the walls  
of the training building  
walls and ceilings**



Room filled with fuel  
for the fire and  
window to control fire  
dynamics and air flow





**Soot, smoke, and ash  
accumulation on the walls  
of the training building  
walls and ceilings**







Set up of the room for fire hose exposure to Class A fire smoke

- Room filled with hay bails and wood pallets
- Hose was passed through the vents through the main hallway into this room and into the adjacent room

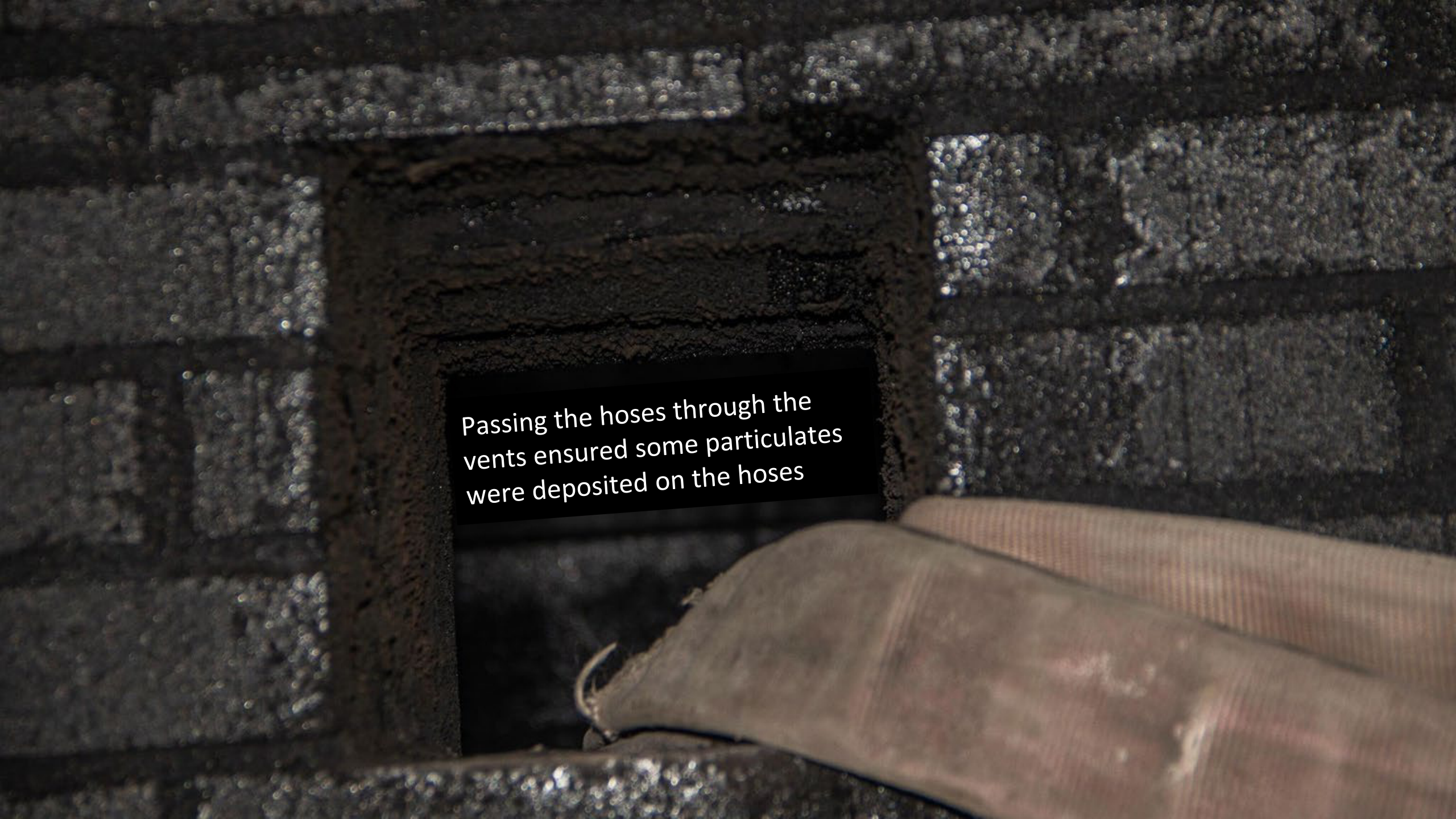


Set up of the room for  
fire hose exposure to  
Class A fire smoke

- Room filled with hay bails and wood pallets
- Hose was passed through the vents through the main hallway into this room and into the adjacent room








Passing the hoses through the  
vents ensured some particulates  
were deposited on the hoses



Three Hoses (Chicago, Orange County, and Houston) were passed through the vents to be exposed to class A fire smoke





A close-up photograph of a metal surface, possibly a hose or a pipe, showing significant staining and discoloration. The surface is dark brown and black, with a prominent, dark, wet-looking area that appears to be covered in fine particles or sediment. The texture is rough and uneven, with visible scratches and scuffs. The lighting is bright, highlighting the texture and the dark, stained areas.

**Particulate in runoff after  
hoses come into contact  
with wet ground**



A photograph showing several fire hoses laid out on a concrete surface. The hoses are arranged in a row, with the Chicago hose on the left and the Orange County hose on the right. The Chicago hose is dark red with a white label that reads '182107'. The Orange County hose is dark green. The hoses are connected to metal fittings at the bottom. A shadow is cast on the left side of the image.

**Chicago Hose**

**Orange County Hose**





**Orange County Hose**

**Chicago Hose**





Chicago Hose







The image shows three fire hoses laid out horizontally on a light-colored concrete surface. The hose on the left is heavily stained with dark, irregular patches, indicating significant dirt or residue. The middle hose is a dark, uniform color with a fine, woven texture. The hose on the right is a lighter, reddish-brown color with a similar woven texture. Each hose is labeled with a black text box at its base.

**Dirty Hoses**

**Chicago Hose**

**Orange County Hose**

**Houston Hose**



The image shows three fire hoses laid out vertically on a light-colored concrete surface. The hoses are arranged side-by-side for comparison. The leftmost hose is a reddish-brown color. The middle hose is a dark, almost black color. The rightmost hose is a brown color with a distinct woven texture. A black text box is positioned in the upper left area, containing white text. Another black text box is at the bottom left, and two more are at the bottom, each centered under one of the hoses.

**Washed Hoses  
(Water Only)  
(Most likely the 2x rinse)**

**Chicago Hose**

**Orange County Hose**


**Houston Hose**



Spraying hoses with either  
Dawn or CitroSqueeze  
before running them  
through the cleaner







The image shows three fire hoses laid out horizontally on a concrete surface. The hoses are arranged side-by-side, with the leftmost hose being red and white, the middle hose being dark grey/black, and the rightmost hose being red and black. The hoses appear to be covered in a thick, white, foamy residue from the cleaning detergent, which is most prominent on the red hoses. The concrete surface is stained and discolored, with some areas appearing darker and more saturated with the detergent residue. The text 'Hoses after spraying with cleaning detergents (No wash)' is overlaid on the left side of the image.

Hoses after spraying  
with cleaning  
detergents  
(No wash)







Hoses after running them  
through the cleaning  
machine – Samples with  
soap presoak





# Houston Hose

Before  
Cleaning

After  
Cleaning  
(4 passes with soap  
presoak)



# Orange County Hose

Before  
Cleaning


After  
Cleaning  
(4 passes with soap  
presoak)



A close-up photograph of a section of a fire hose, showing a dark, heavily soiled and discolored surface. The hose is laid out on a light-colored, textured ground. A black rectangular box with white text is positioned at the bottom left of the image.

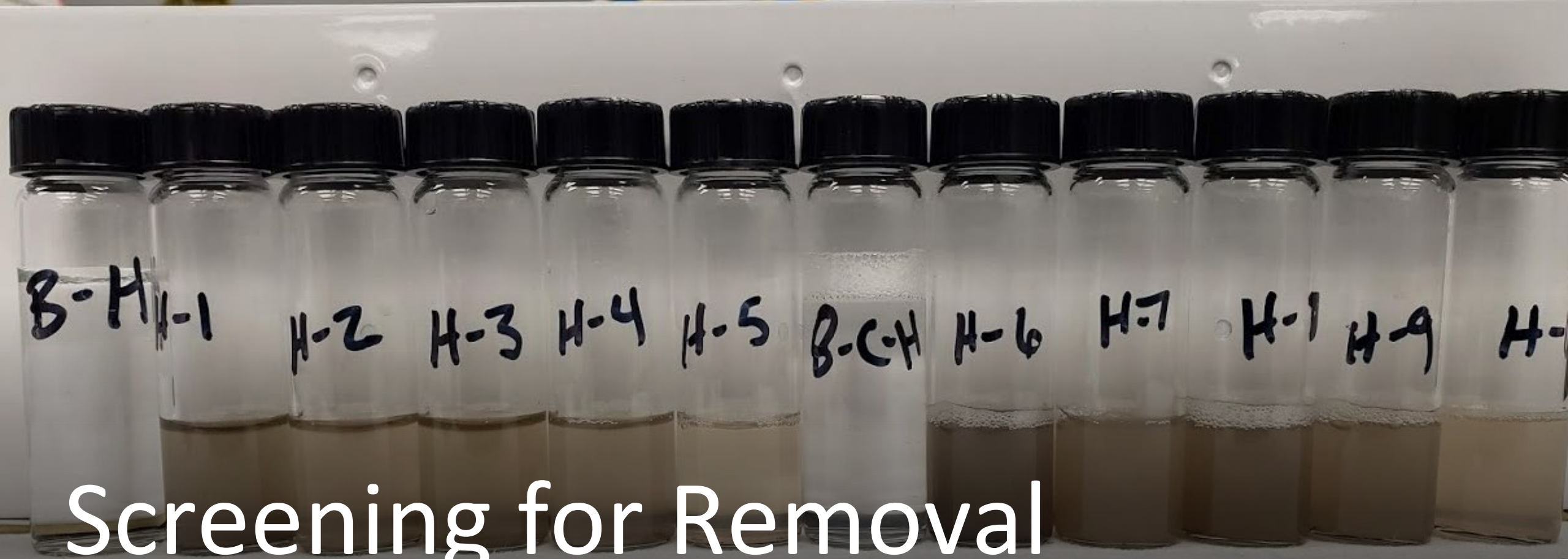
## Chicago Hose

Before  
Cleaning

A close-up photograph of the same section of the fire hose after cleaning. The surface is now bright red and appears much cleaner, though some texture and slight discoloration remain. A black rectangular box with white text is positioned at the bottom right of the image.

After  
Cleaning  
(4 passes with soap  
presoak)

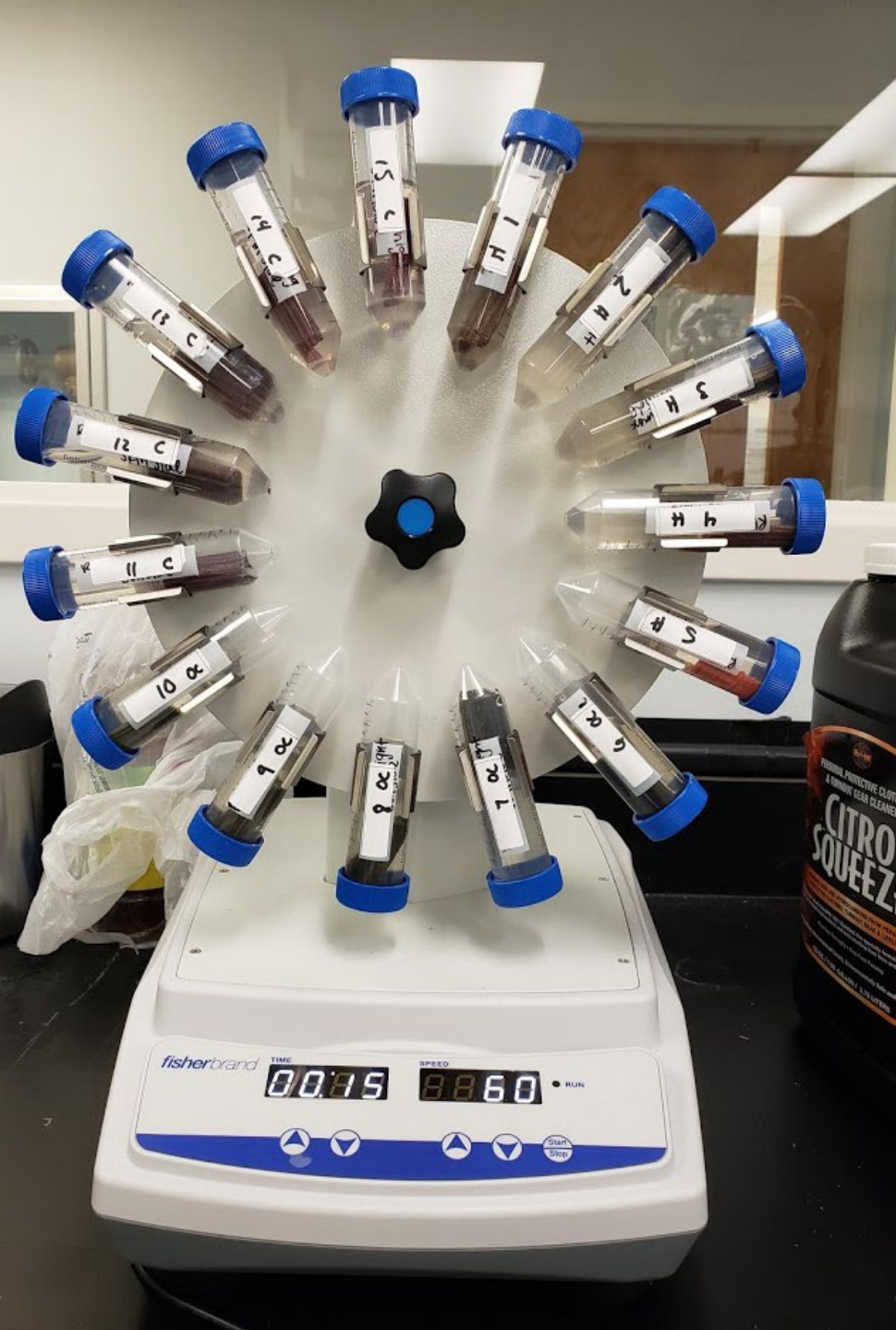




# Screening for Removal of Particulates

Experimental Process

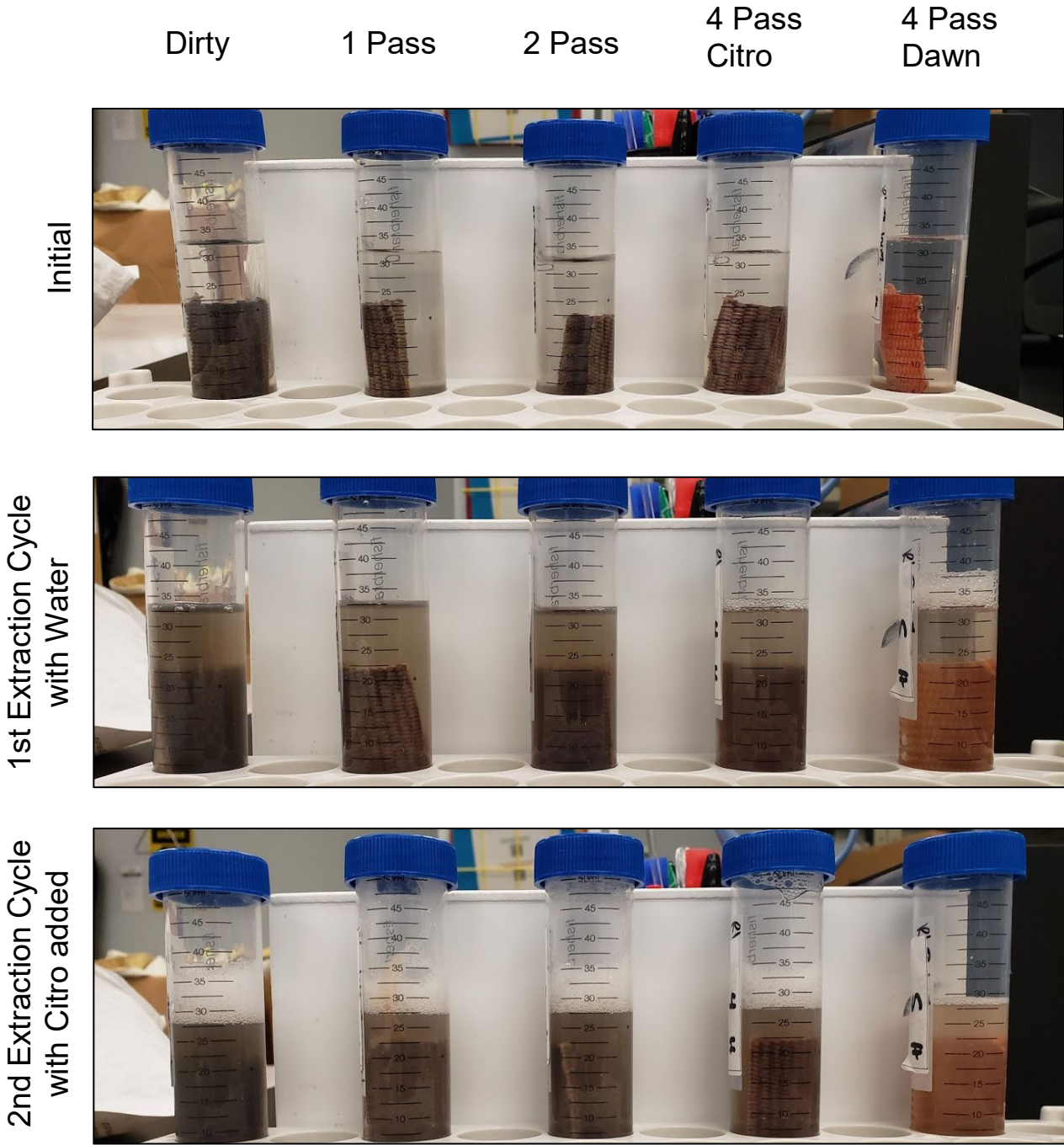
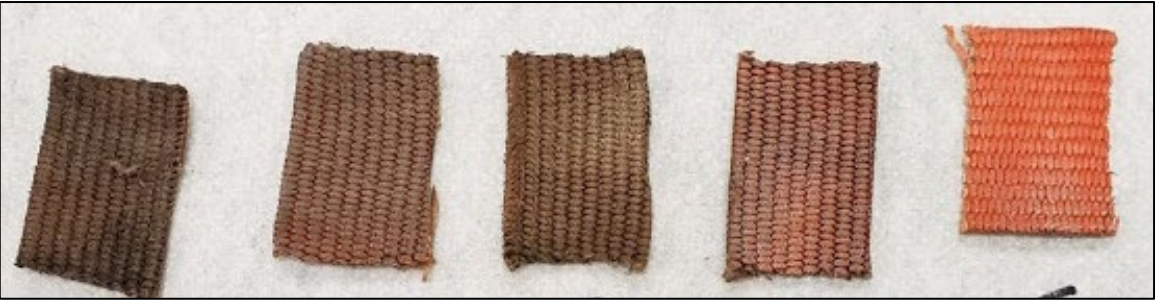
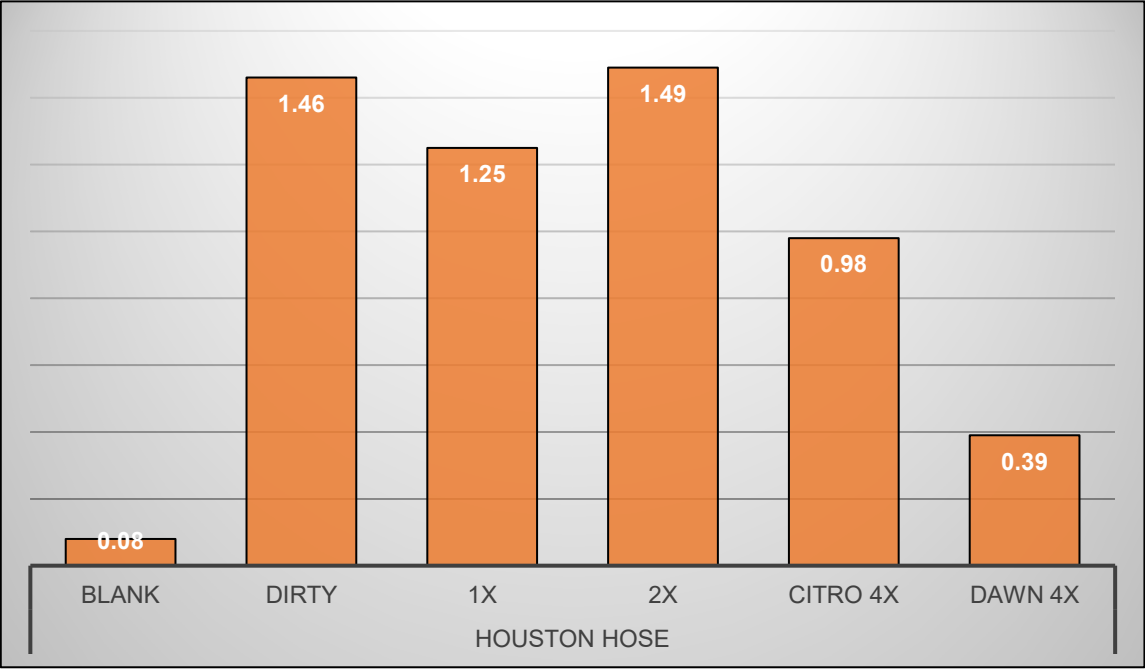




# Particulate Removal Screening

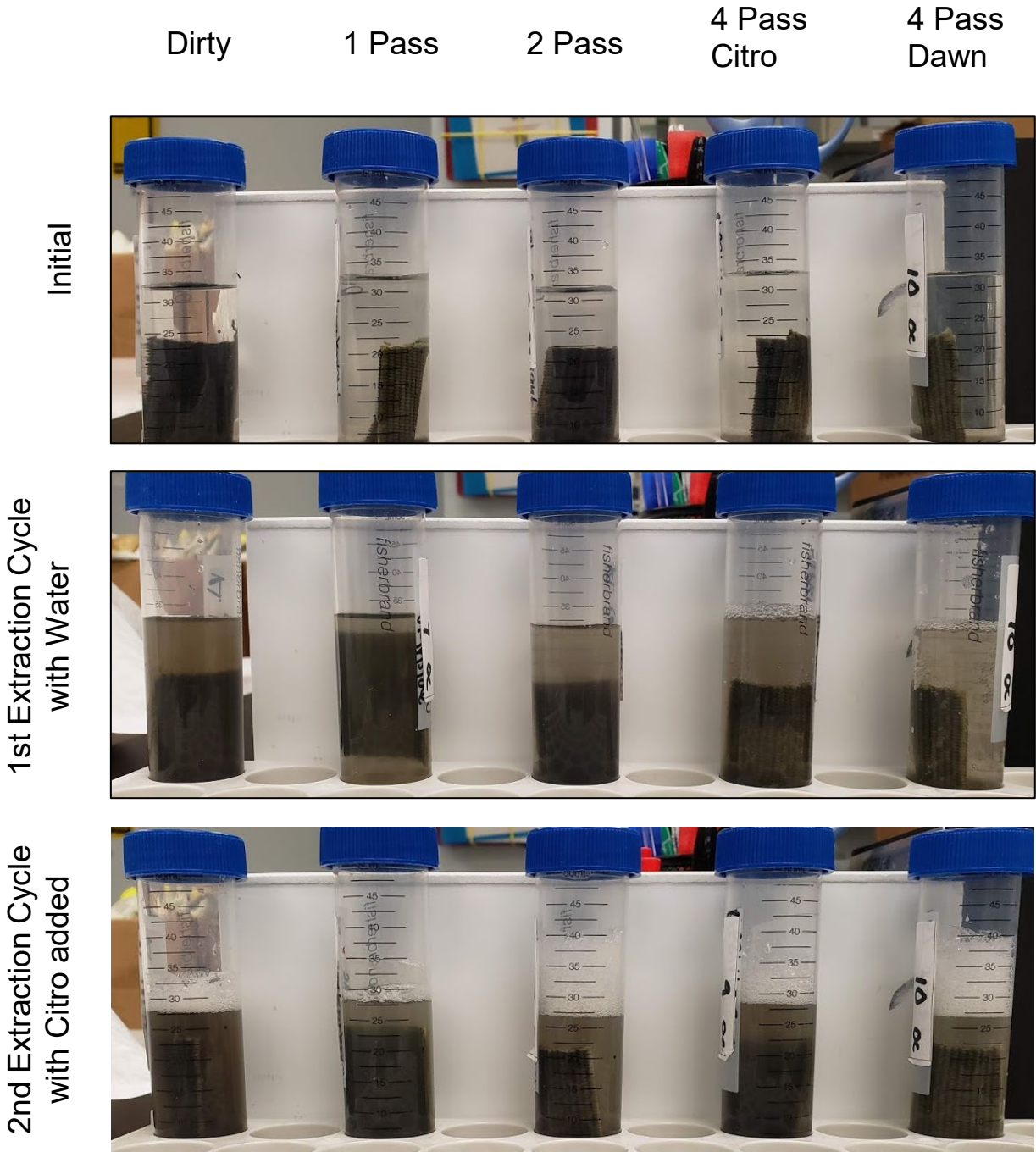
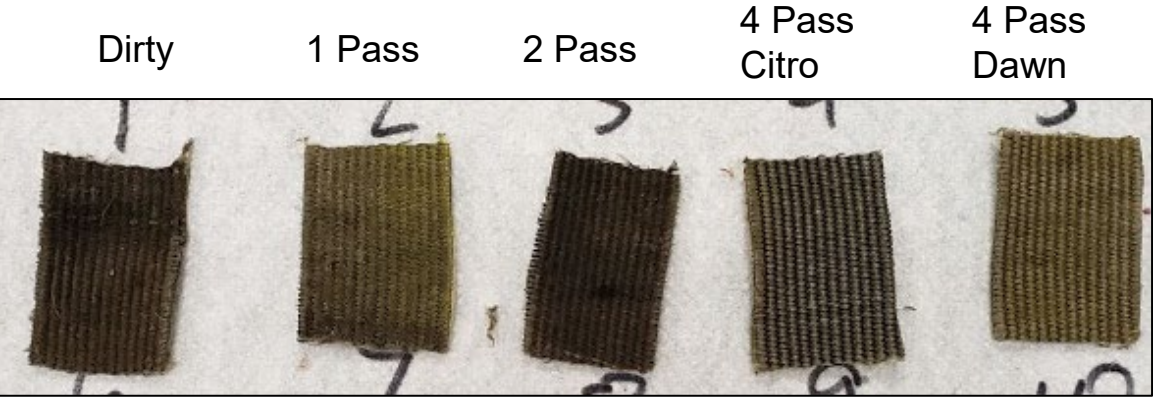
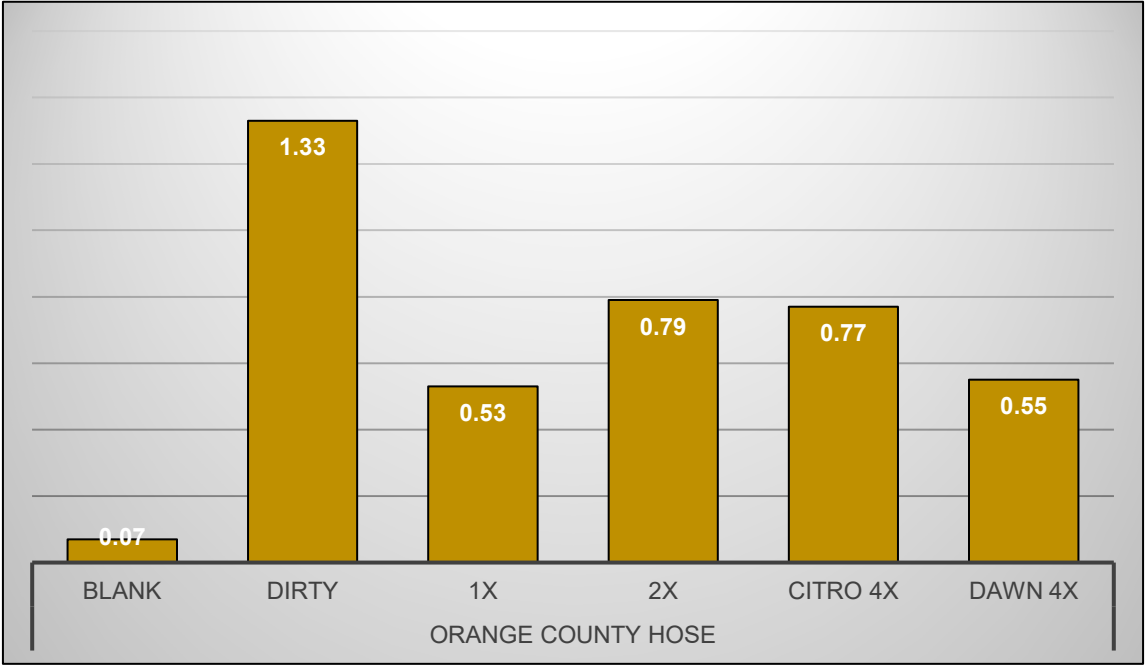
- Goal: Gauge how much particulate was still on samples following field decontamination
- Basic Process:
  - Fabric specimens placed in vials with water and extracted at 60 RPM for 15 minutes as shown in the picture
  - Samples of the extract liquid were taken, and a small amount of detergent was added to the vials
  - Fabric specimens were extracted another 15 minutes at 60 RPM with the detergent
  - Absorbance of light through the liquid samples were measured following extraction
- Data Interpretation:
  - The more light that is absorbed when passing through the liquid, the cloudier the sample, and the more particulate is in the extract
  - So, the dirty hose sample should have the highest amount of absorbed light as it should have the most particulates to rinse off

# Houston Hose



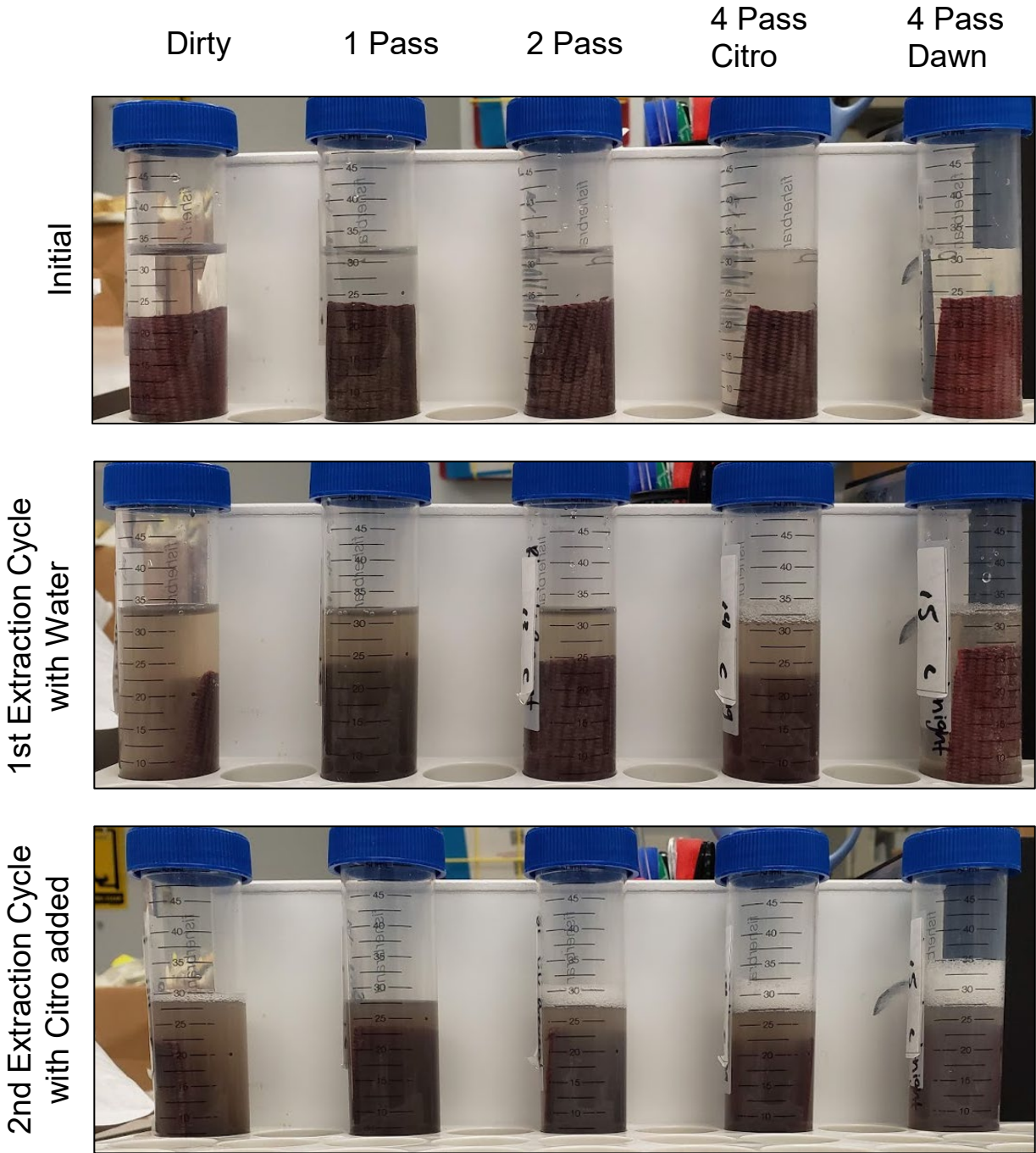
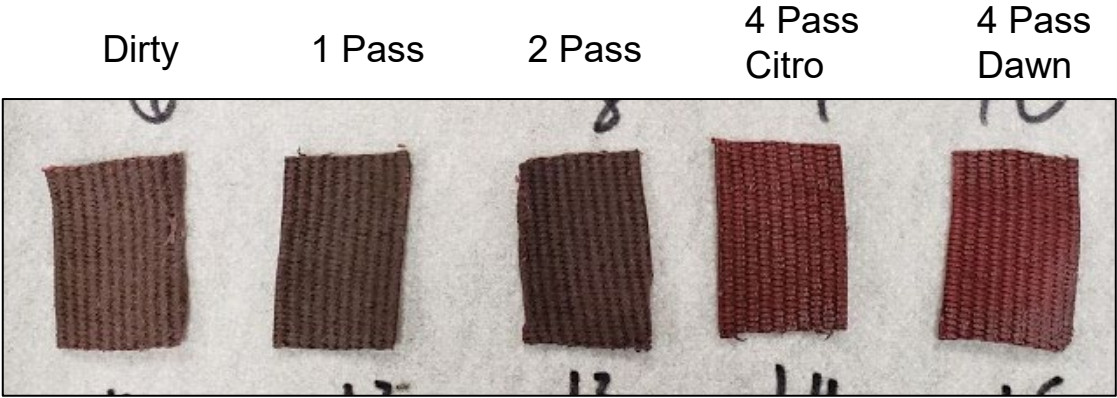
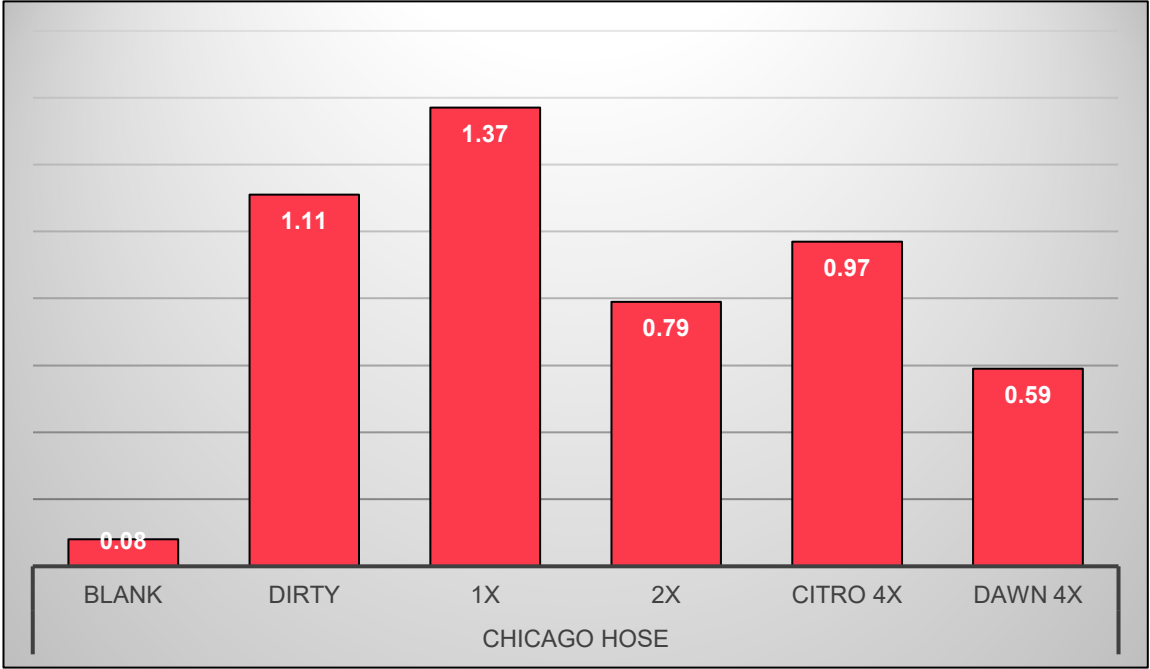


# Orange County Hose



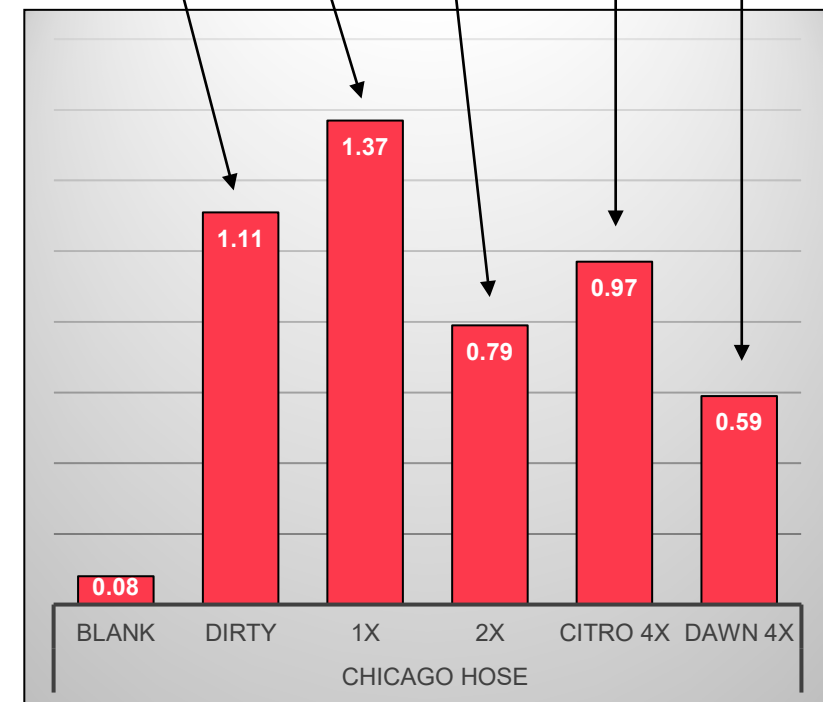
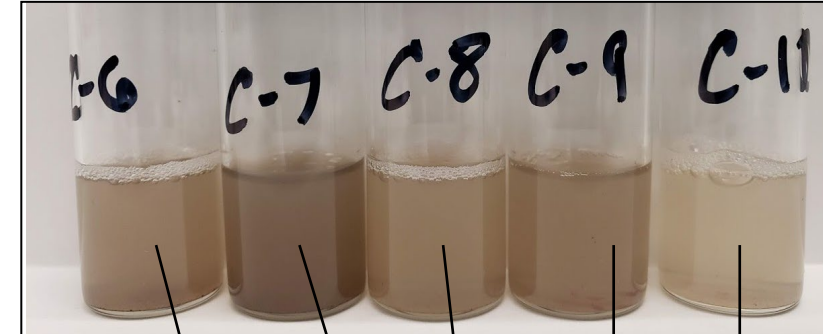
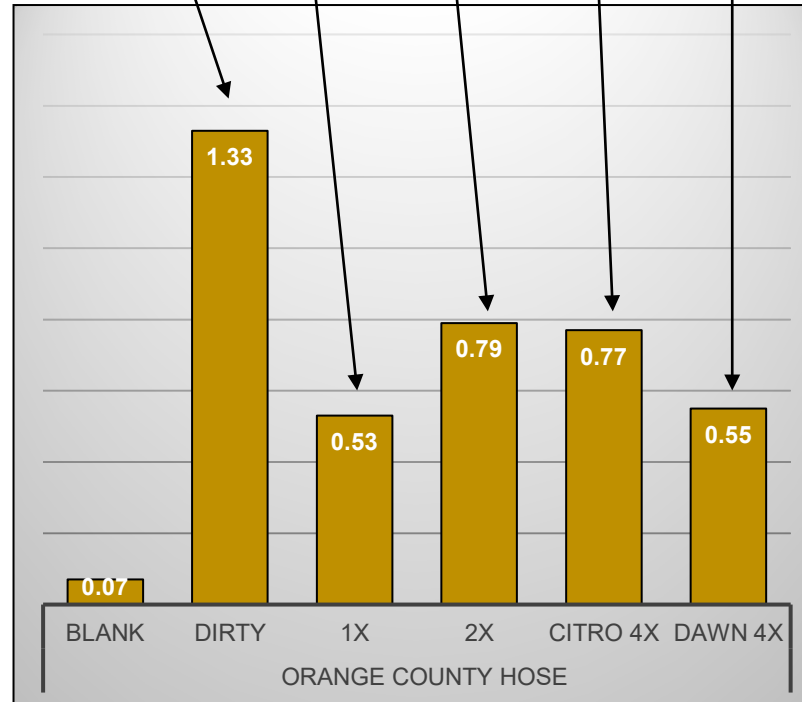
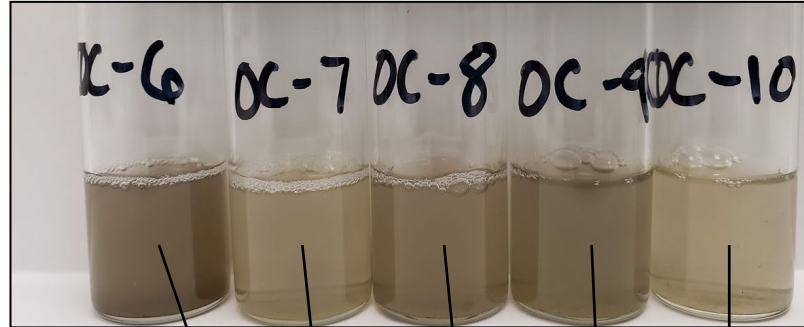
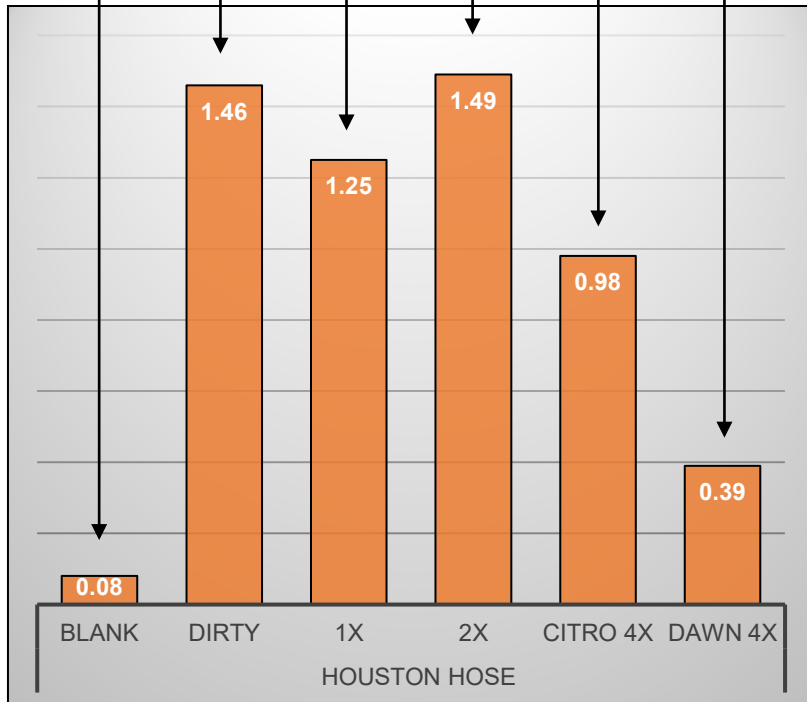
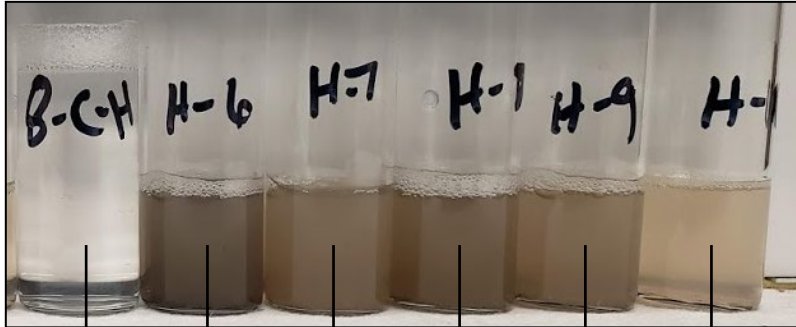


# Chicago Hose





# All Hoses





# Preliminary Conclusions

- Process was able to show that all three hoses had different levels of contamination present
- General conclusions
  - Point to there not being too much difference between the dirty hoses and the 1 or 2 passes through the cleaner
  - More of a difference when the hose is pre-soaked and passed through 4 the cleaner 4 times
- Limitations
  - Only single samples for each condition analyzed so far, need to go further to account for variability
  - Assessment can be affected by stray/loose particles or fibers



# Summary Data for Hose Cleaner Trial

Hoses Exposed May 2021 at Training Center



# Hose Descriptions

- All hoses were purchased new
  - 50 foot, 1  $\frac{3}{4}$ " attack hose
  - White in color
  - Red markings place every five feet for measurements
    - 0 ft mark is next to nozzle coupling
- Hoses
  - Hoses 1 and 4 – New, not used
  - Hose 2 - Cleaned with hose cleaner regularly (approximately 16 times)
    - After initial measurements Hose 2 was sprayed with Citrosqueeze and run through hose cleaner twice
  - Hose 3 – Never cleaned on training grounds
    - After initial measurements, Hose 3 was run through the hose cleaner once, then sprayed with Citrosqueeze and run through the hose cleaner two more times



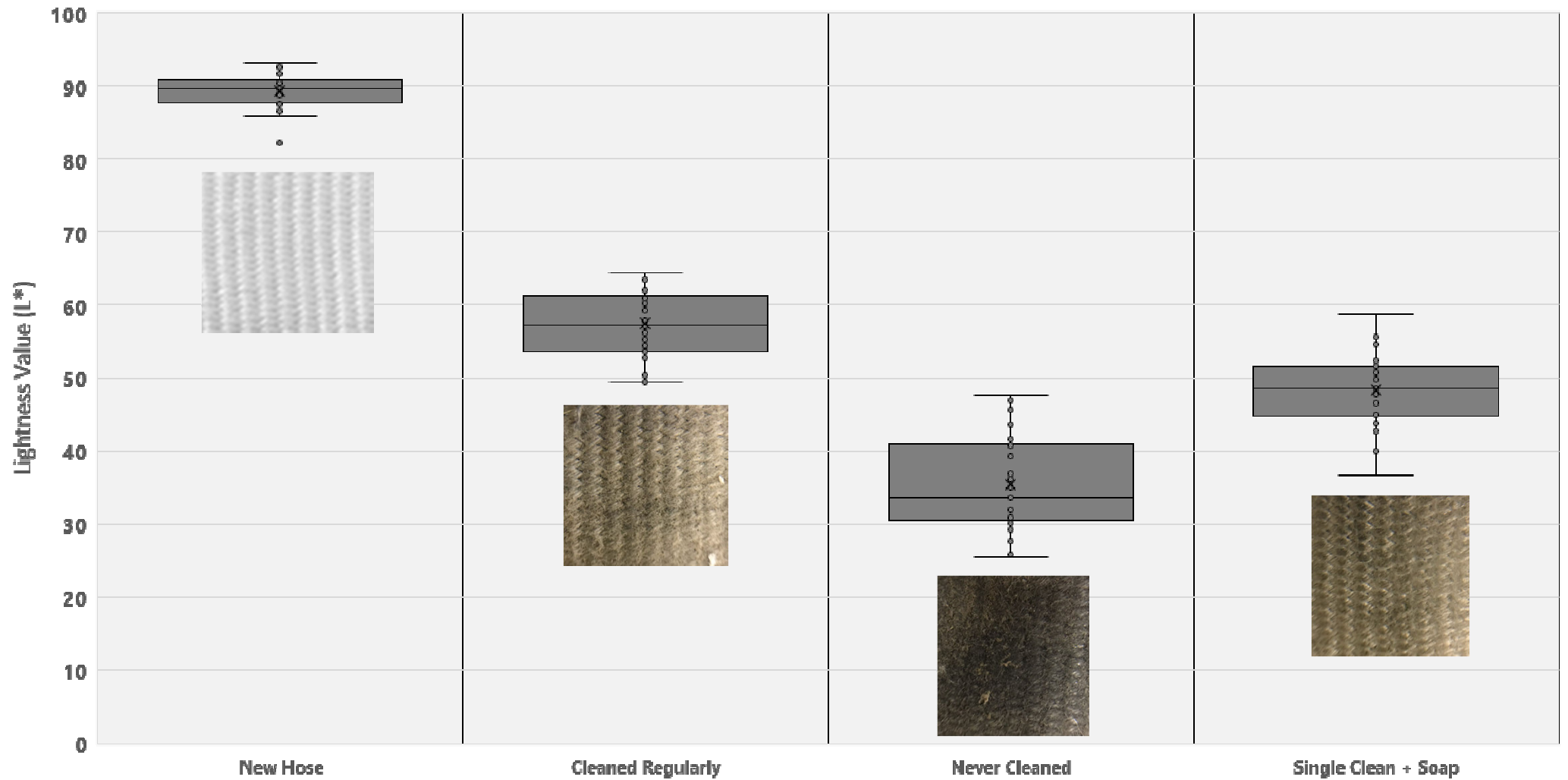
# Spectrophotometer measurements

- After each hose was dry, color measurements were taken with a handheld spectrophotometer
  - Three measurements were taken in each 5 ft segment
- Only the lightness/darkness values were taken for analysis as they showed the most change between hoses



# Spectrophotometric Measurements of Fire Hoses

Lightness Value Scale: 0 = Black and 100 = White





# Summary Spectrophotometer Data

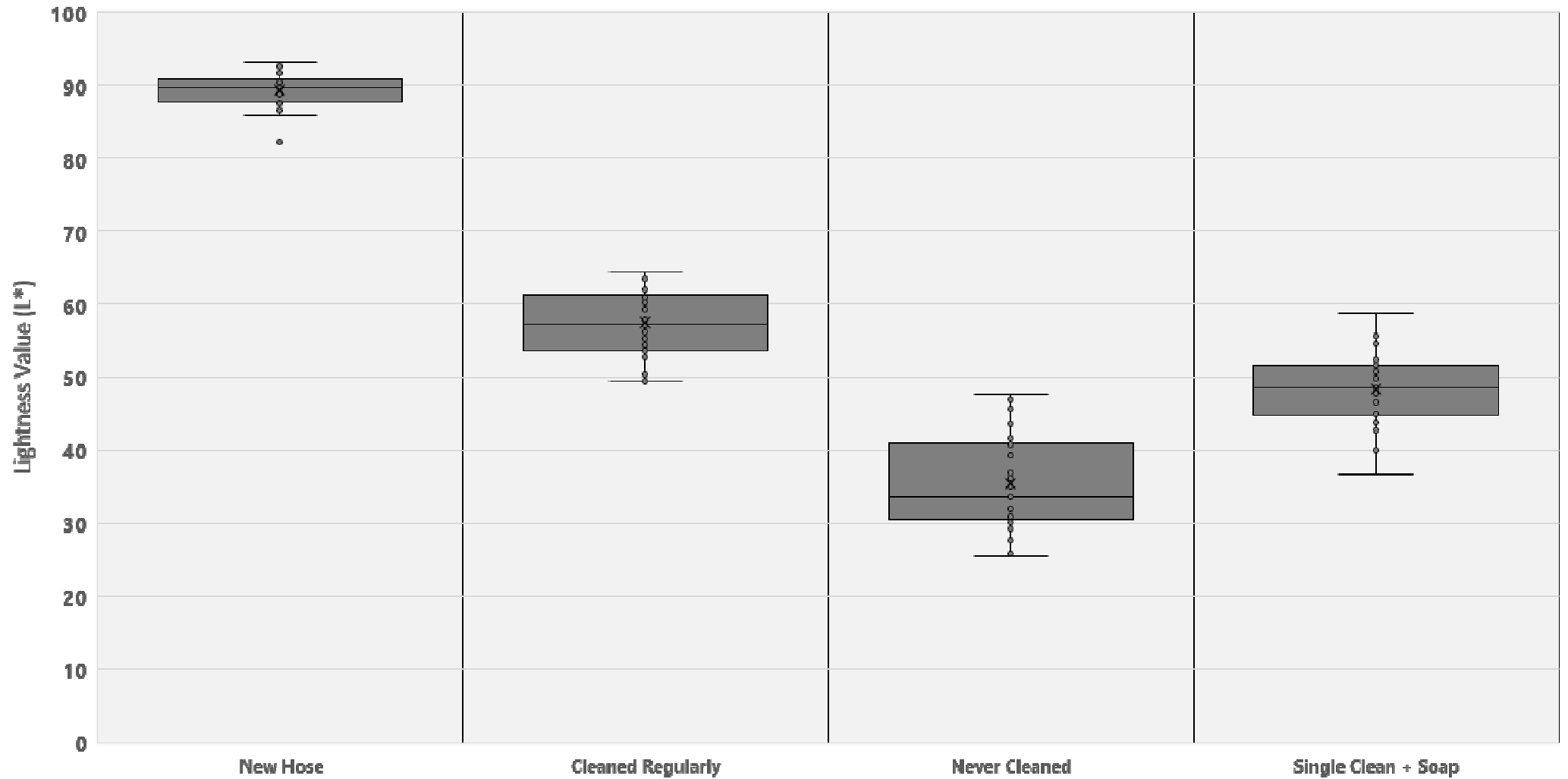
Hose	Condition	Average Lightness Value (L*)	Std. Deviation	% of New Hose (Avg. 90.56)
Hose 1	New	90.56	2.18	100%
Hose 2	Cleaned Regularly	57.47	4.36	63.46%
Hose 3	Never Cleaned	58.55	6.30	39.12%
Hose 3 – AW	Single Clean with Soap	48.32	5.08	53.35%

- Notes
  - All values are averaged from the 30 measurements taken along the full 50 ft hose
  - The lower the number the darker/dirtier the sample
  - The highest value attainable after cleaning if complete removal of contamination should be the average of the two new hoses (90.56)
- Conclusions
  - Significant difference between regular cleaning of Hose 2 (63.46%) and never cleaning of Hose 3 (39.12%)
  - Significant improvement when Hose 3 (39.12%) was cleaned at the end of the trial (Hose 3-AW 53.35%)
  - Regular cleaning of Hose 2 (63.46%) was still significantly better than a single cleaning of Hose 3 (53.35%)



# Spectrophotometric Measurements of Fire Hoses



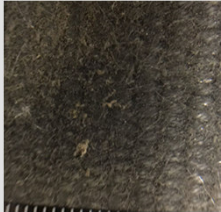
Lightness Value Scale: 0 = Black and 100 = White





# Summary Spectrophotometer Data

- Notes
  - All values are averaged from the 30 measurements taken along the full 50 ft hose
  - The lower the number the darker/dirtier the sample
  - The highest value attainable after cleaning if complete removal of contamination should be the average of the two new hoses (90.56)
- Conclusions
  - Significant difference between regular cleaning of Hose 2 (63.46%) and never cleaning of Hose 3 (39.12%)
  - Significant improvement when Hose 3 (39.12%) was cleaned at the end of the trial (Hose 3-AW 53.35%)
  - Regular cleaning of Hose 2 (63.46%) was still significantly better than a single cleaning of Hose 3 (53.35%)

Hose	Condition	% of New Hose Measurement	Image
Hose 1	New	100%	
Hose 2	Cleaned Regularly	63.5%	
Hose 3	Never Cleaned	39.1%	
Hose 3 – After Wash	Single Clean with Soap	53.4%	