Fire Hose Trials

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NC State University

Goal

Test the effectiveness of a new firefighter hose cleaner developed by _____

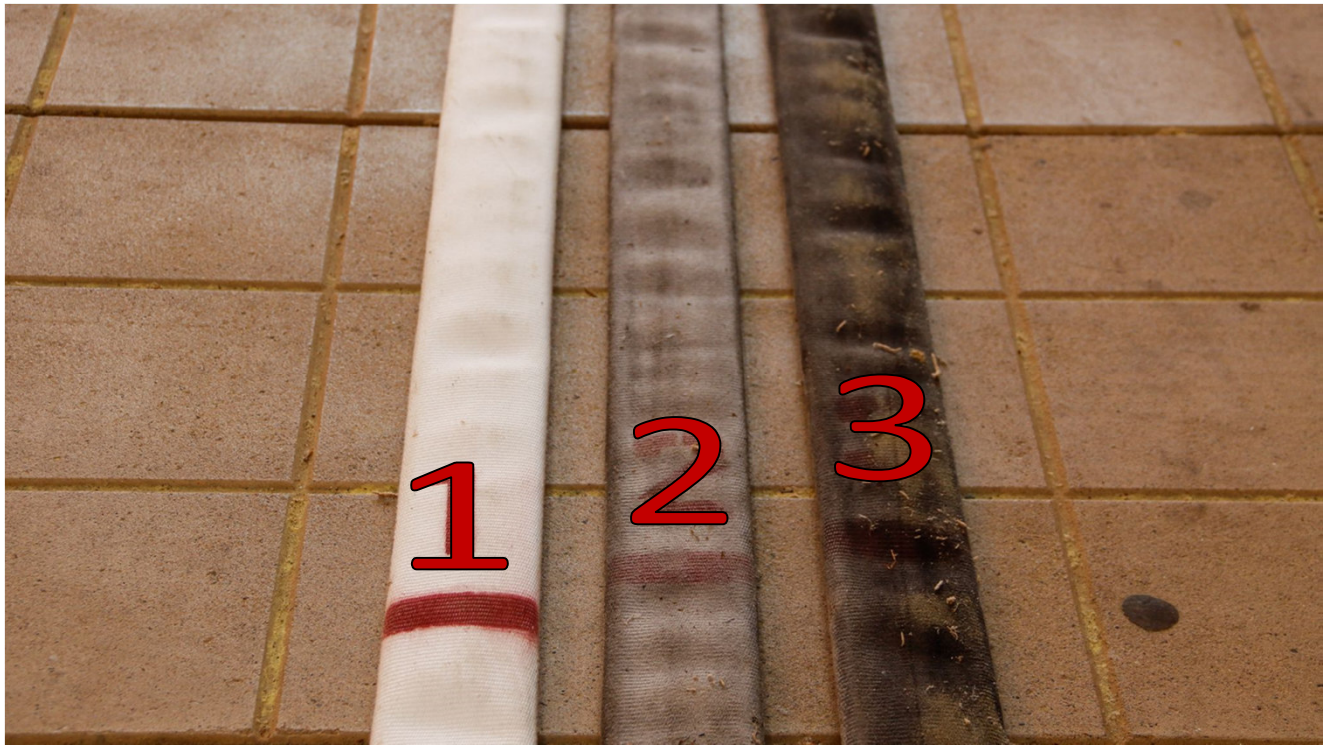
Experiment

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

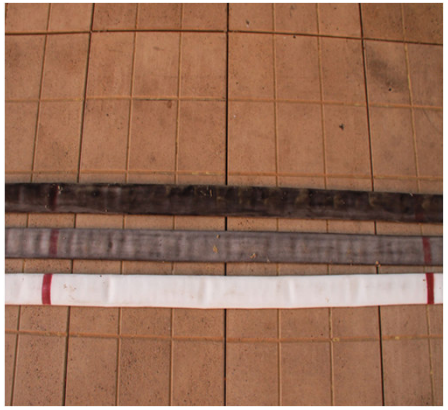
- Fire hose 1 was kept as a control and never used.
- Fire hose 2 was cleaned at the end of each day.
- Fire hose 3 was never cleaned at all.

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

Fire hoses after exposures

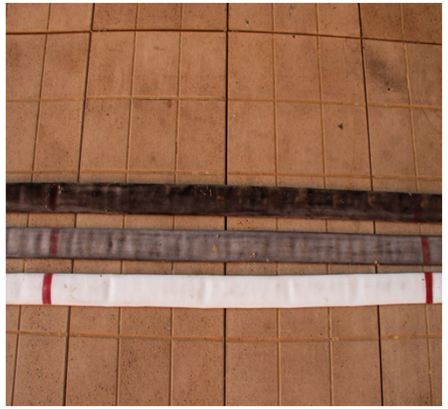


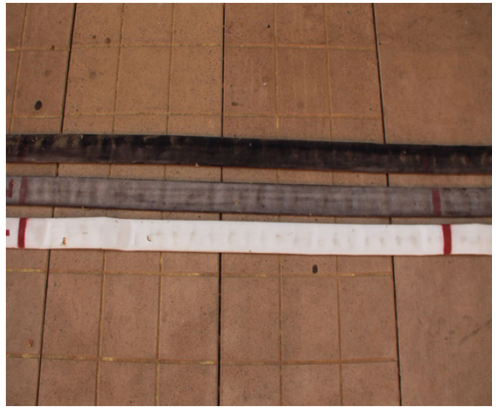
Start 0 - 5 ft
15 - 20 ft



5 - 10 ft
20 - 25 ft

10 - 15 ft
25 - 30 ft



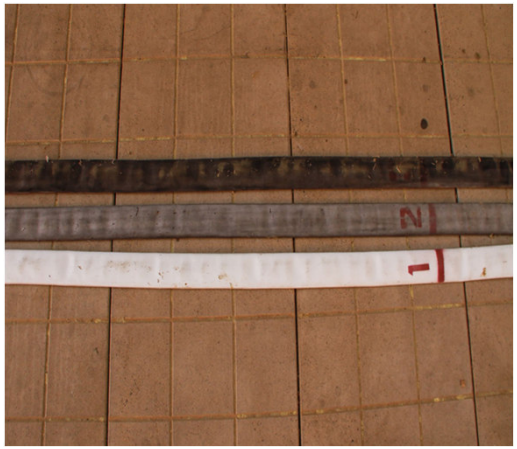


30 - 35 ft
40 - 45 ft

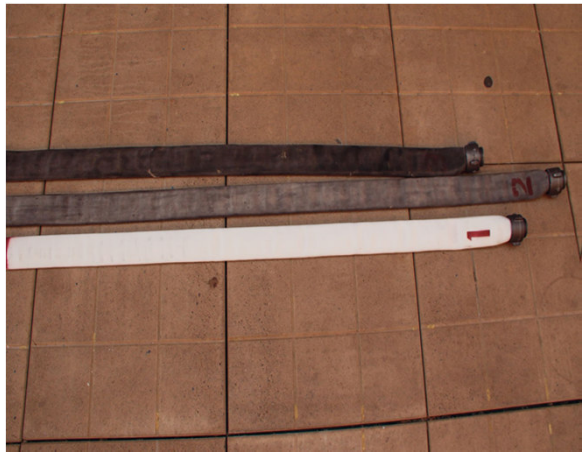
35 - 40 ft
45 - 50 ft

Beginning (0-5 ft)

Middle (20-25 ft)

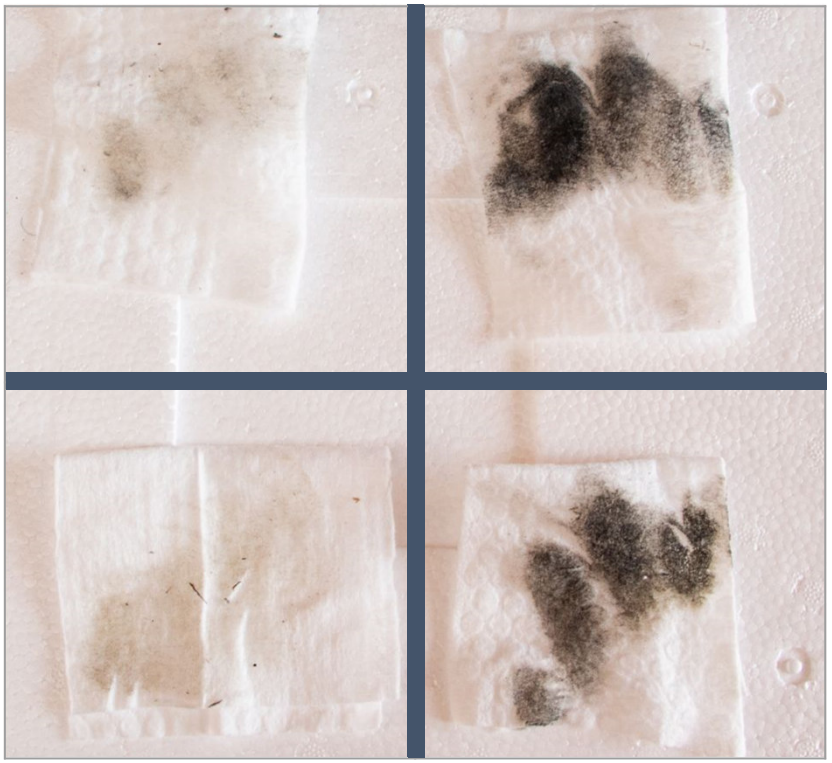


End (45-50 ft)



Wipe Samples

Hose 2 4 Swipes	**Hose 3 4 Swipes**
Hose 2 1 Swipe	**Hose 3 1 Swipe**



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.

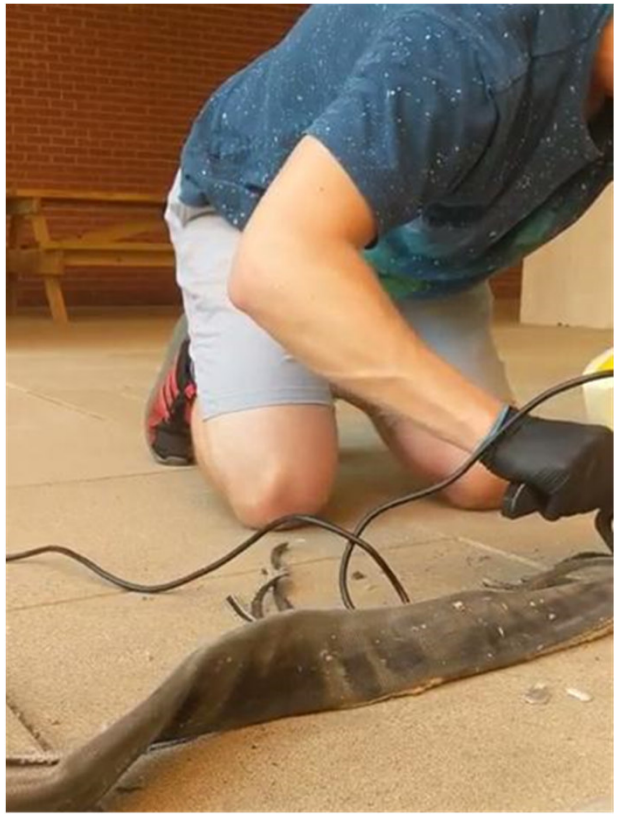
Samples

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 ± 1 inches x 2 ± 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

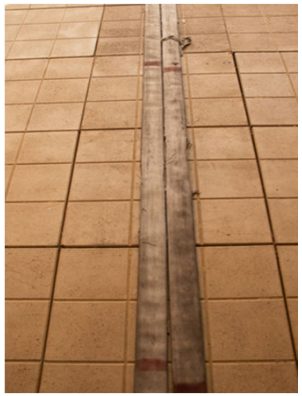
Hose 2 was cleaned once with Citro Squeeze.

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.

NC State Wilson College of Textiles Textile Protection and Comfort Center

0 - 5 ft



5 - 10 ft

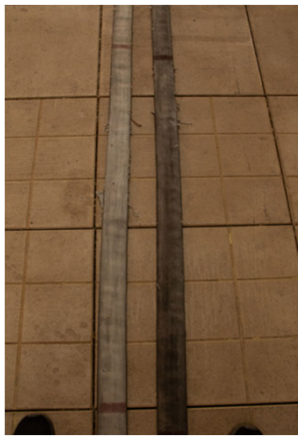
10 - 15 ft

15 - 20 ft

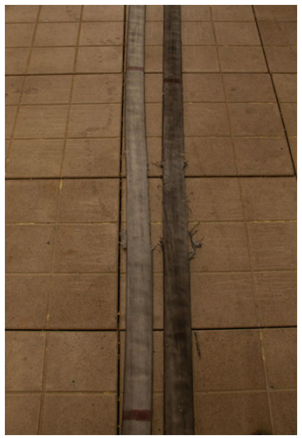
20 - 25 ft

25 - 30 ft

30 - 35 ft

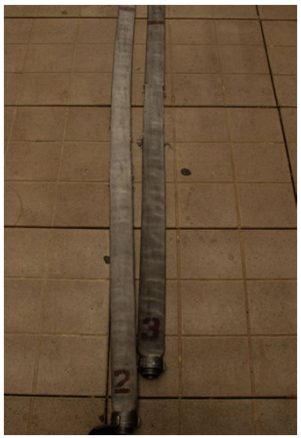


35 - 40 ft

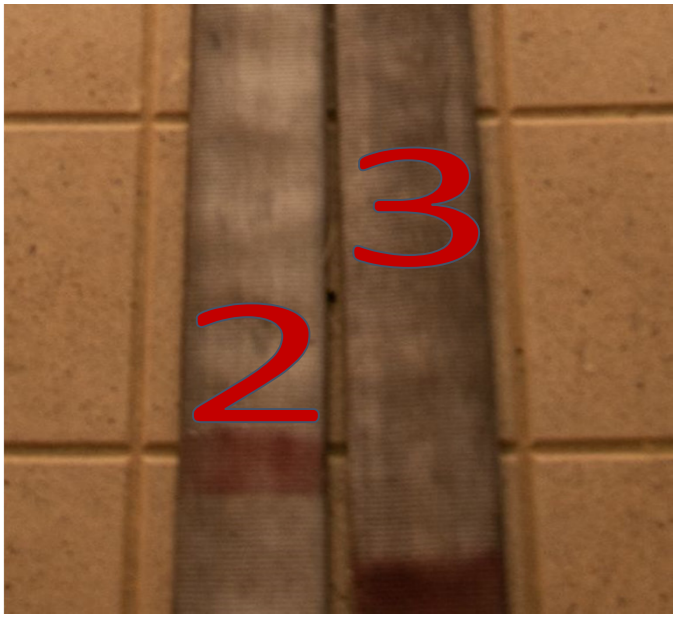


40 - 45 ft

45 - 50 ft



Before and After Washing



Key Takeaways

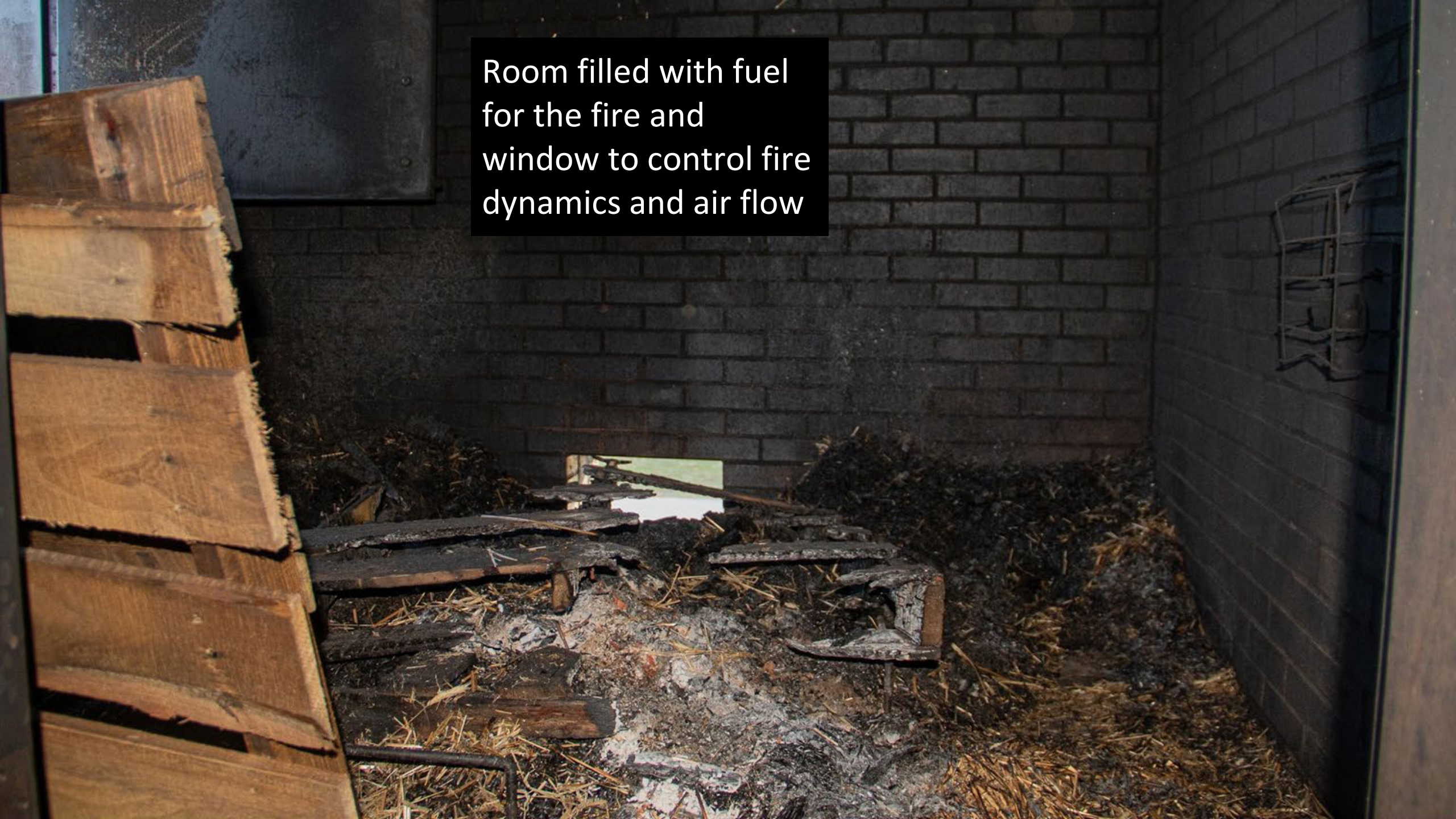
- To minimize contamination and chemical exposures via dermal absorption the fire hose should be cleaned routinely, at least once at the end of day or shift.
- Wear gloves or some form of protection while handling fire hoses after fire suppression activities as the fire hose is a source of chemical exposure.
- 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

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

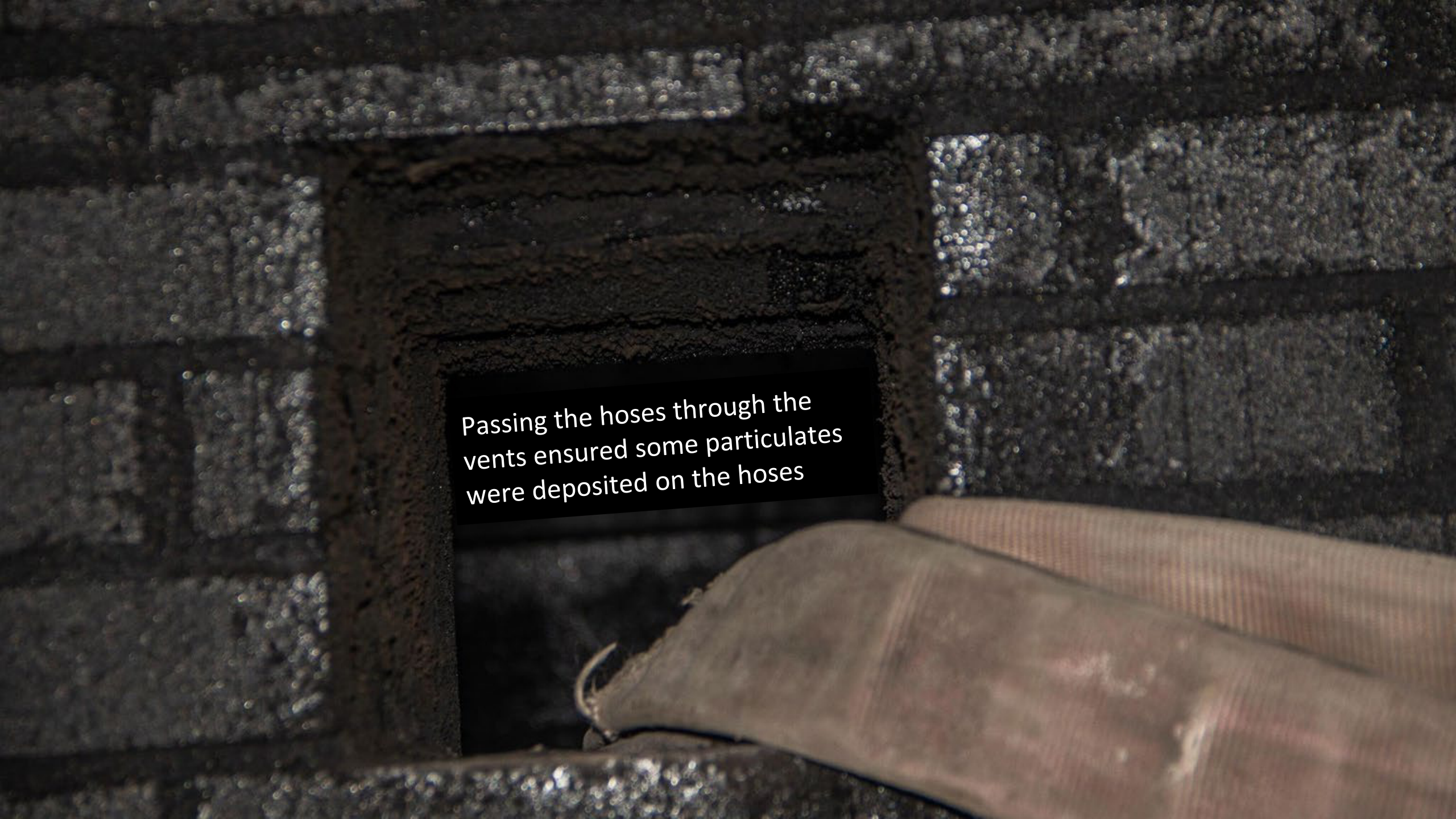

Soot, smoke, and ash accumulation on the walls of the training building walls and ceilings

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

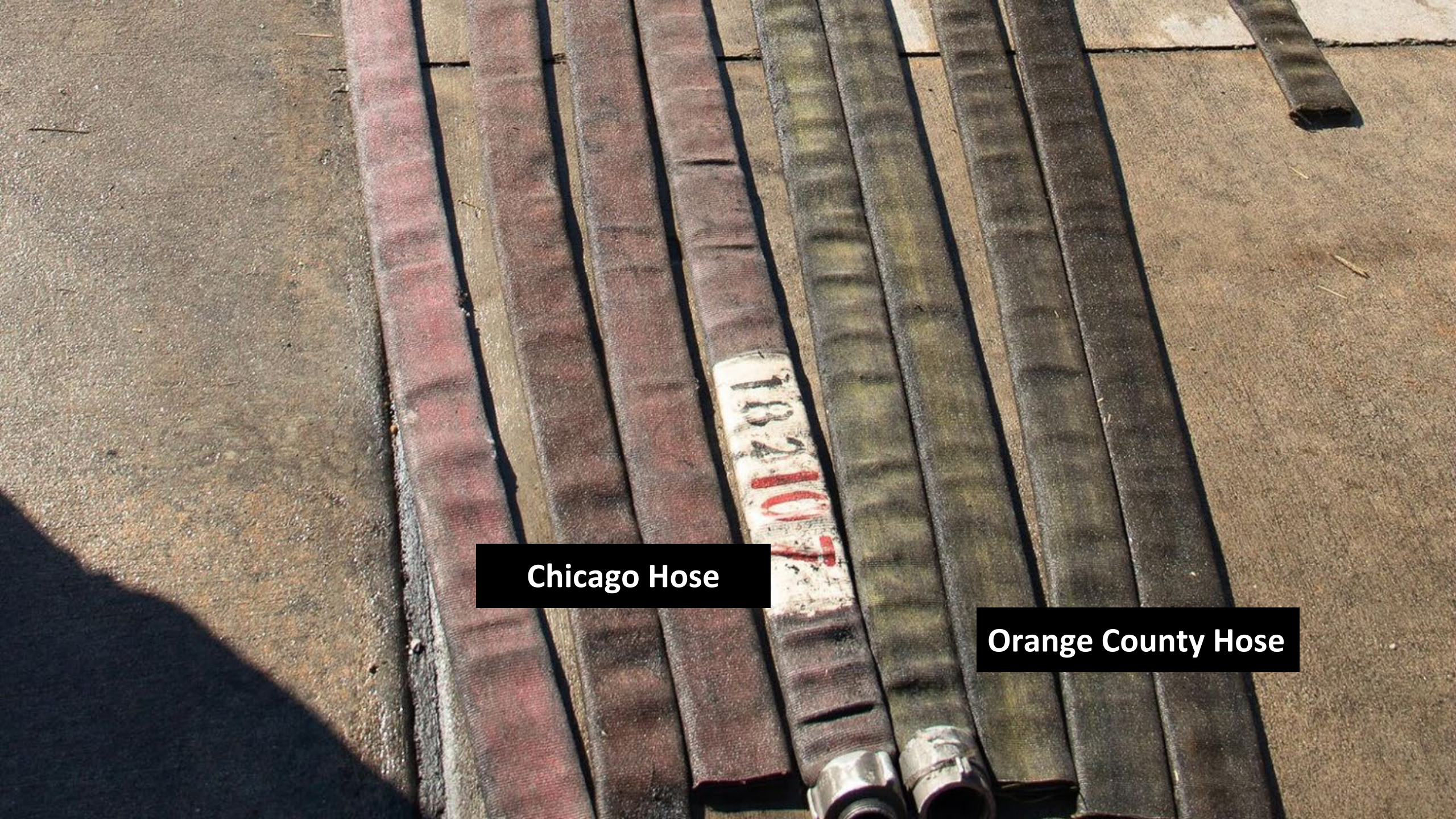
Set up of the room for fire hose exposure to Class A fire smoke

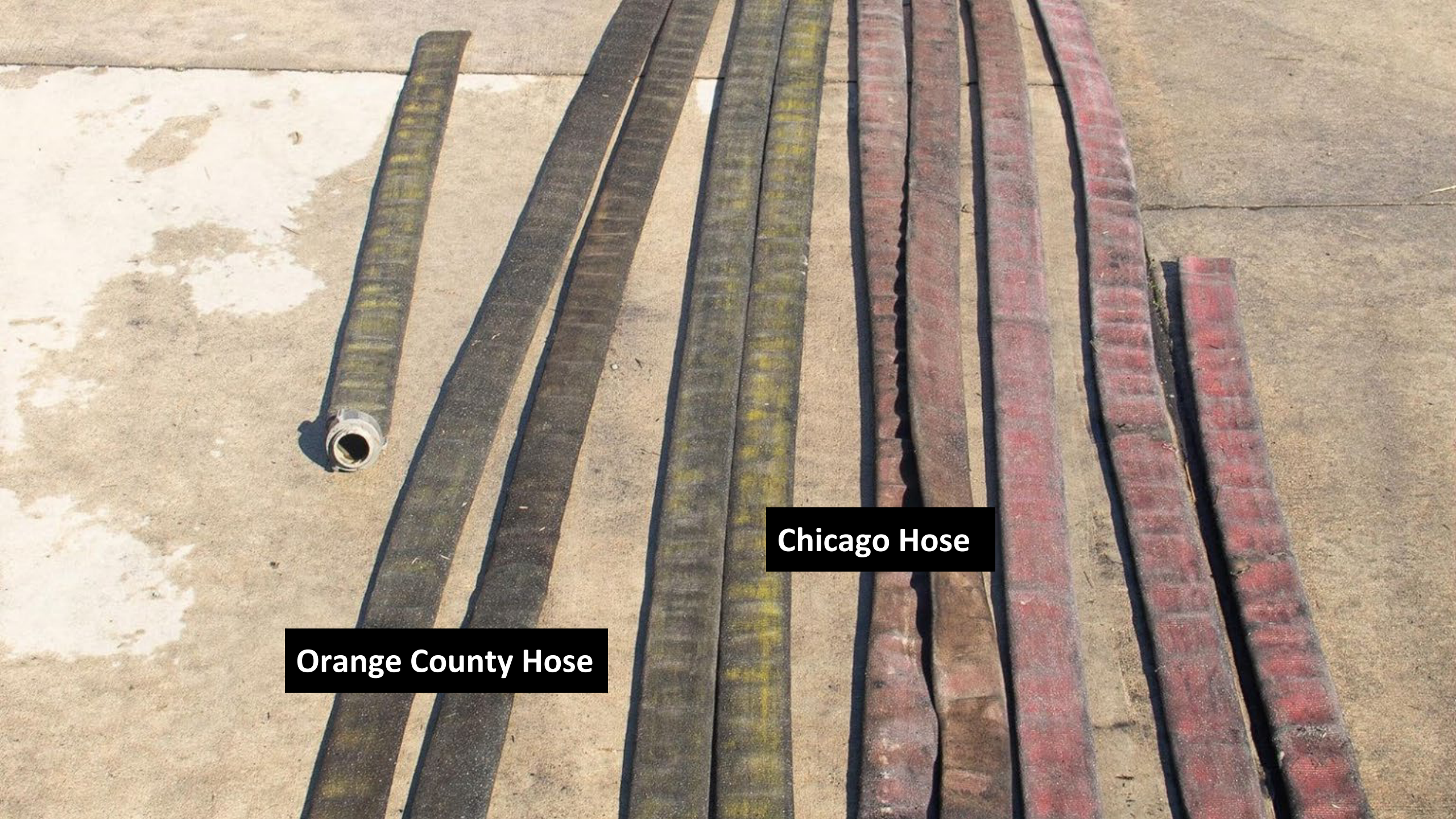
- Room filled with hay bails and wood pallets
- Hose was passed through the vents through the main hallway into this room and into the adjacent room


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

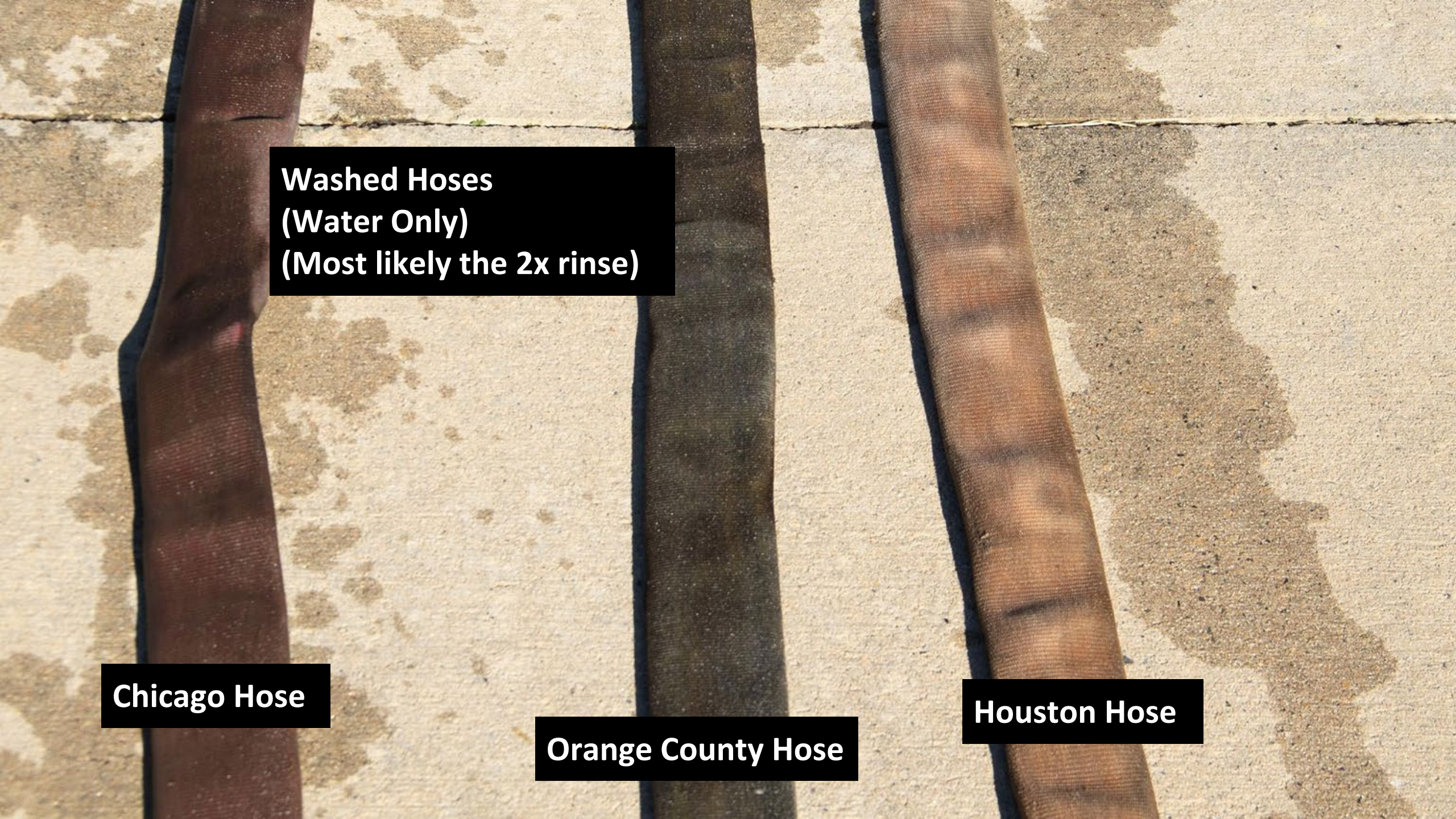

Particulate in runoff after hoses come into contact with wet ground


Chicago Hose
Orange County Hose


Chicago Hose
Orange County Hose


Chicago Hose

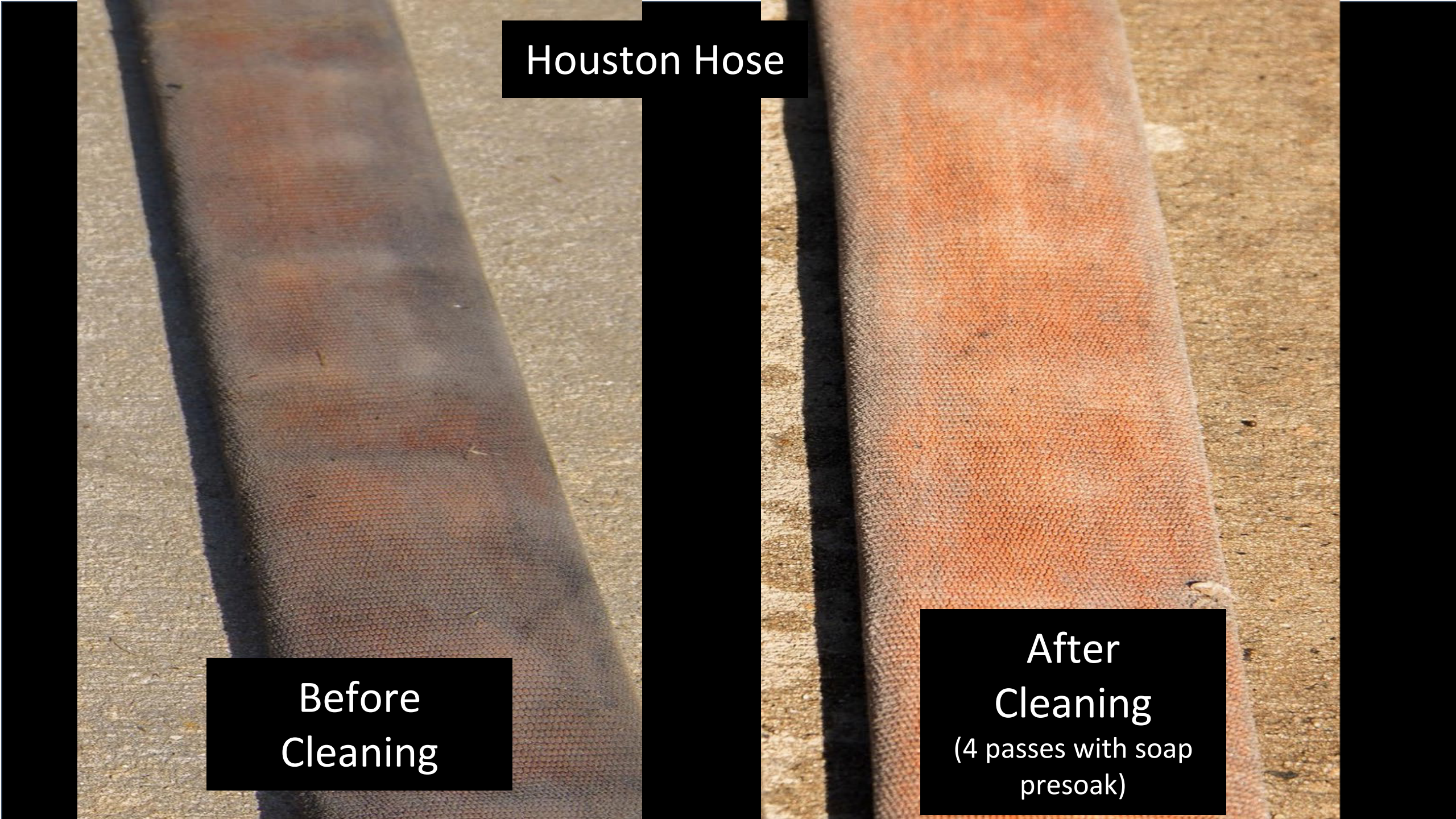

Dirty Hoses
Chicago Hose
Orange County Hose
Houston Hose


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


Hoses after spraying with cleaning detergents (No wash)

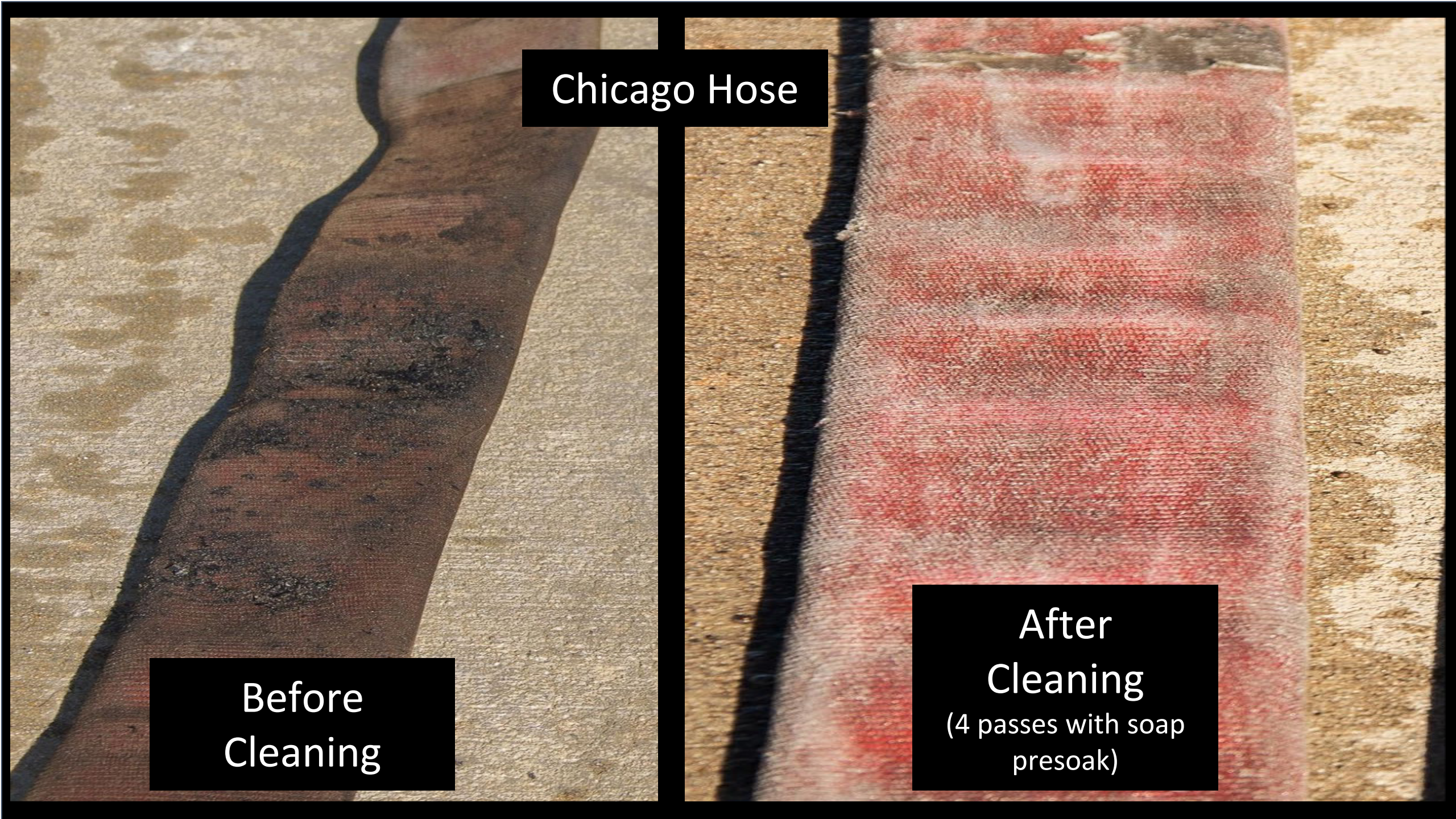

Hoses after running them through the cleaning machine – Samples with soap presoak

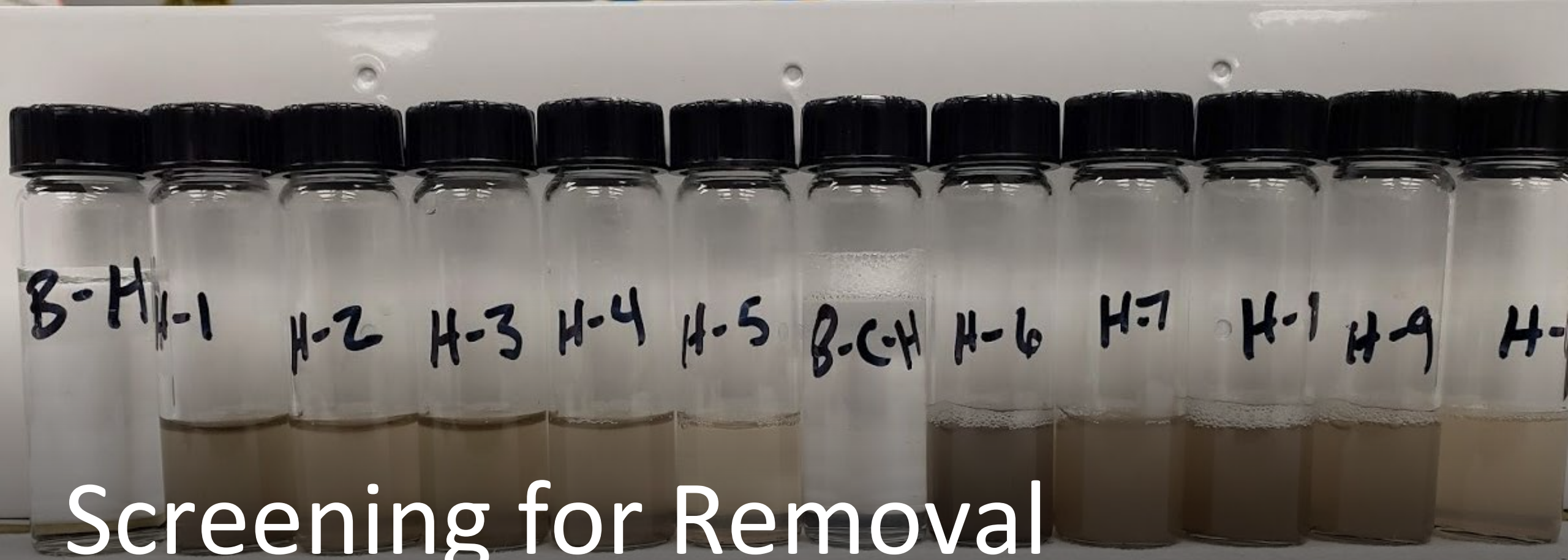

Houston Hose
Before Cleaning
After Cleaning
(4 passes with soap presoak)

Orange County Hose

Before Cleaning

After Cleaning
(4 passes with soap presoak)


Chicago Hose
Before Cleaning
After Cleaning
(4 passes with soap presoak)



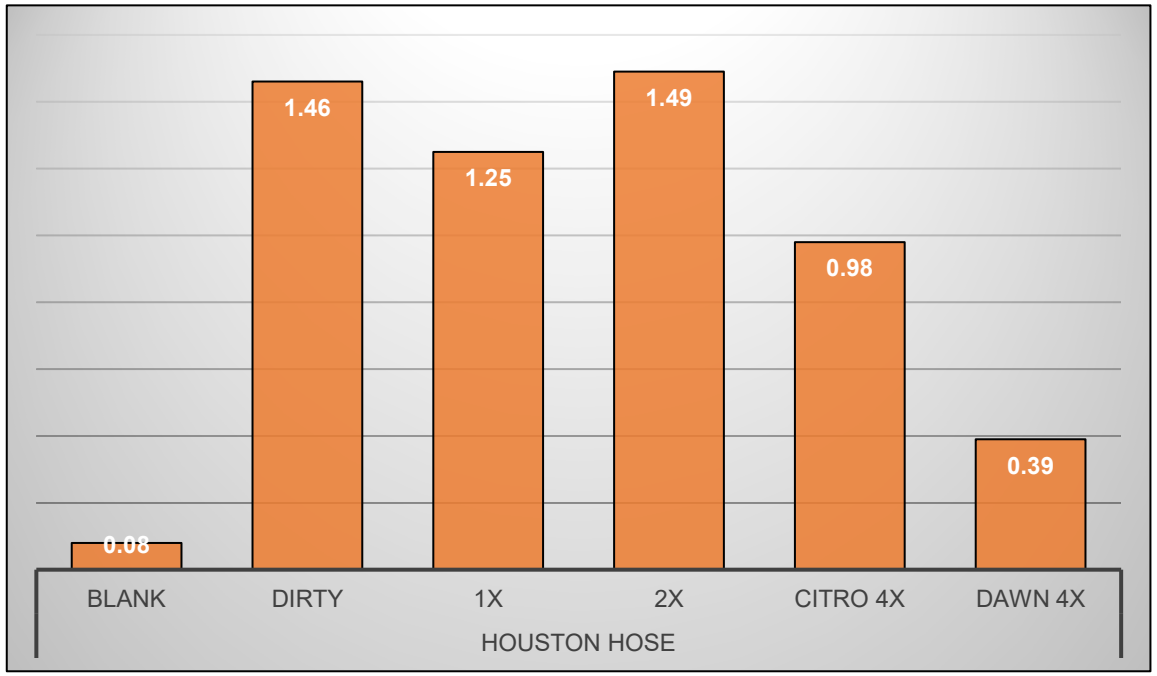
Screening for Removal of Particulates

Experimental Process

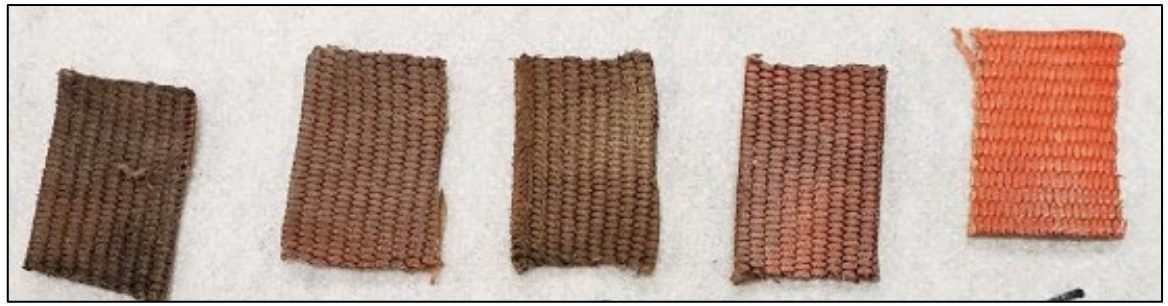
Particulate Removal Screening

- 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

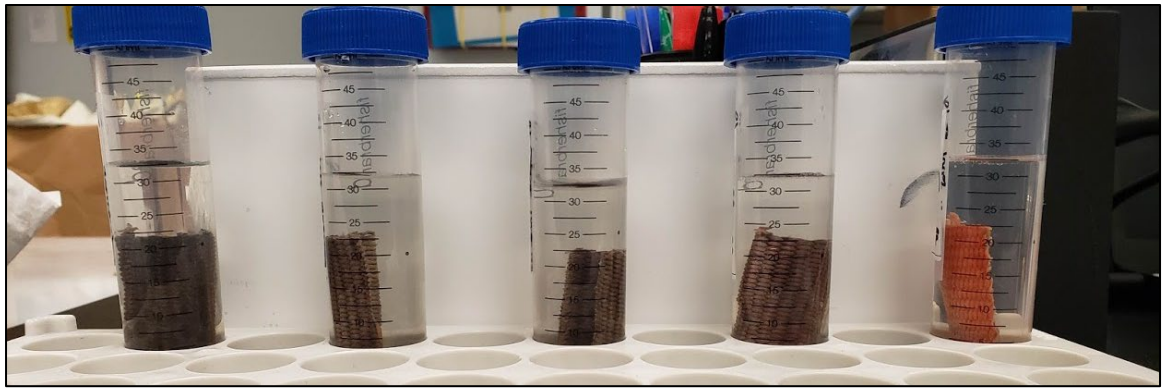


Dirty | 1 Pass | 2 Pass | 4 Pass Citro | 4 Pass Dawn

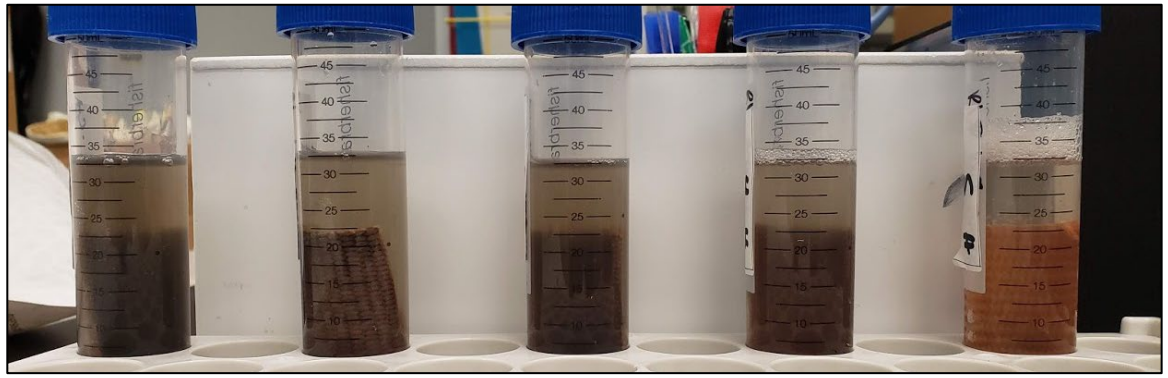


Dirty | 1 Pass | 2 Pass | 4 Pass Citro | 4 Pass Dawn

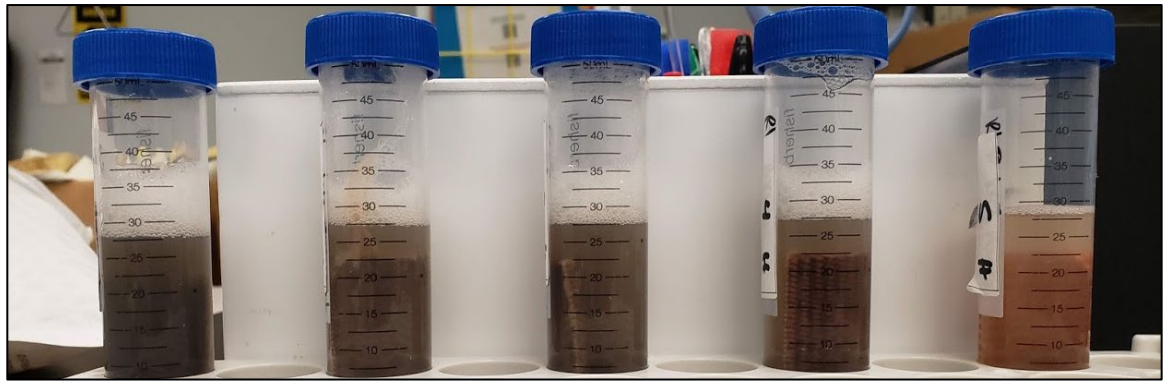
Initial



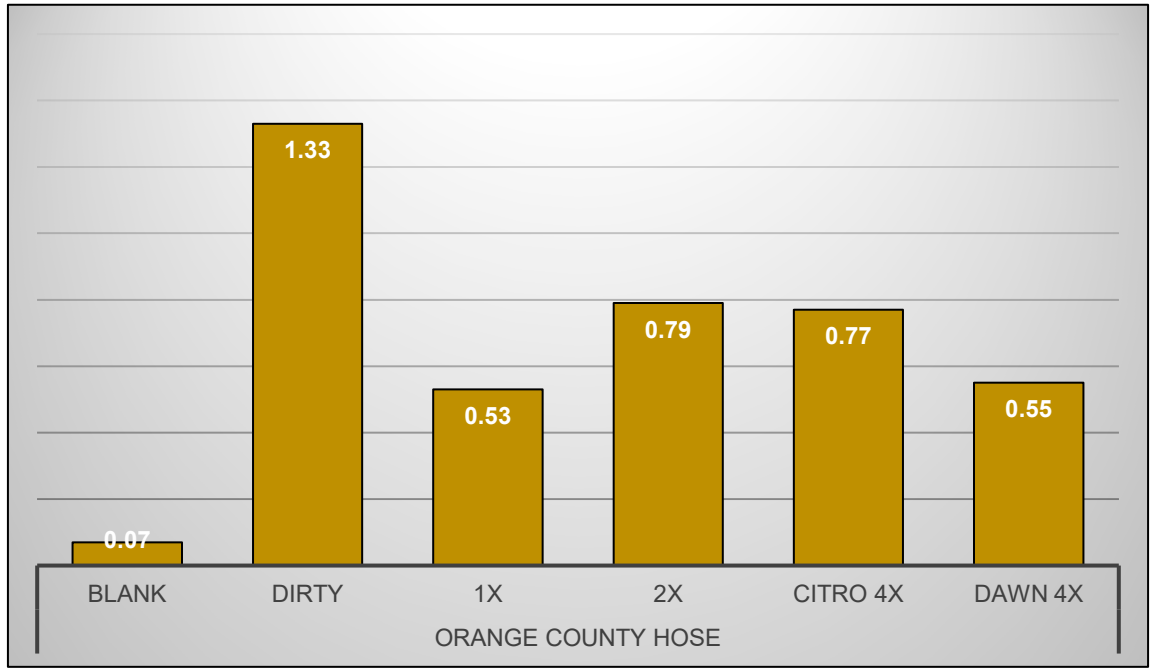
1st Extraction Cycle with Water



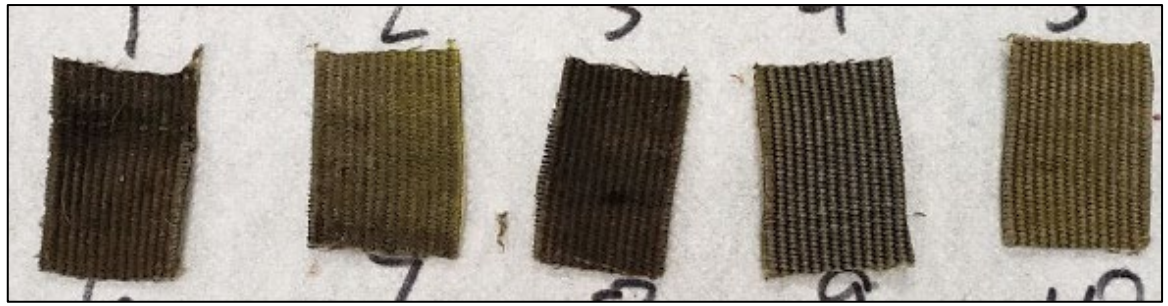
2nd Extraction Cycle with Citro added



Orange County Hose



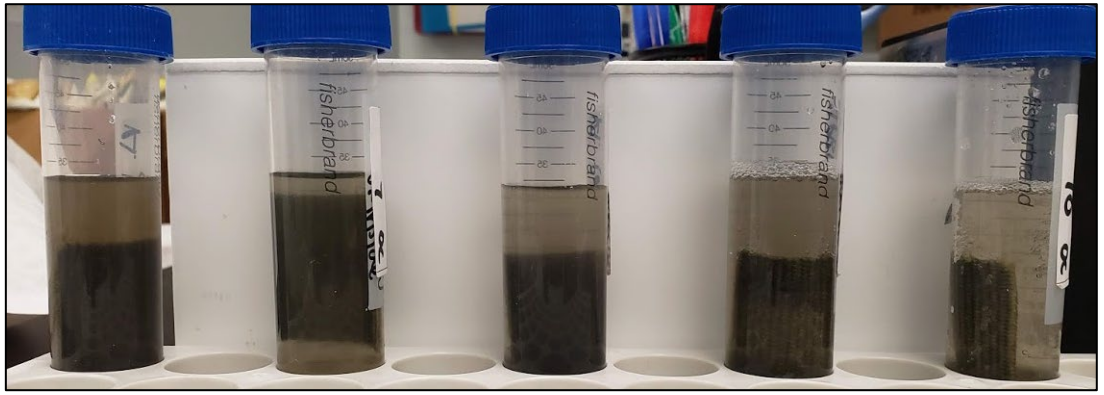
Dirty | 1 Pass | 2 Pass | 4 Pass Citro | 4 Pass Dawn



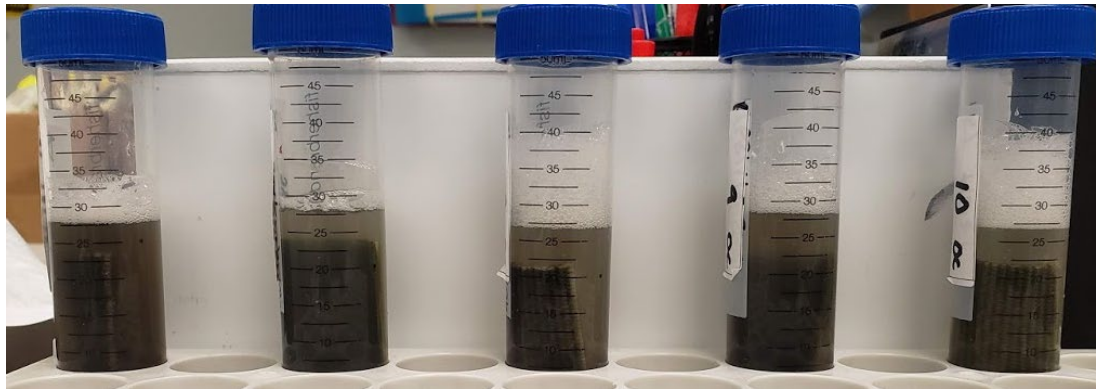
Dirty | 1 Pass | 2 Pass | 4 Pass Citro | 4 Pass Dawn

Initial

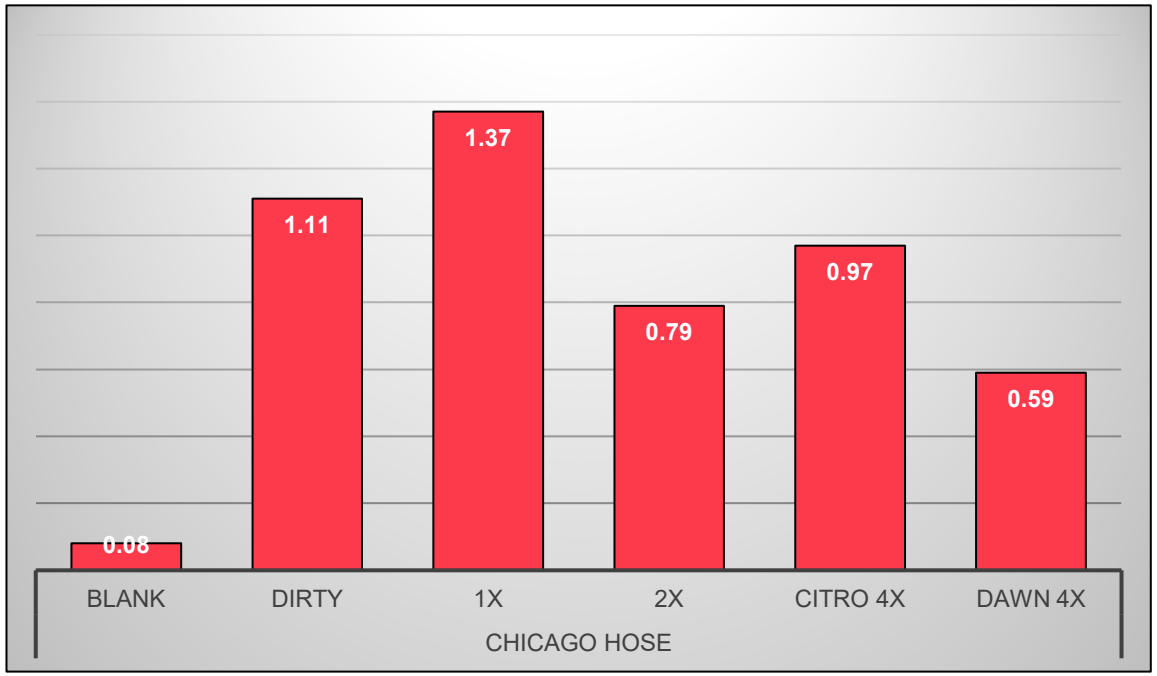
1st Extraction Cycle with Water

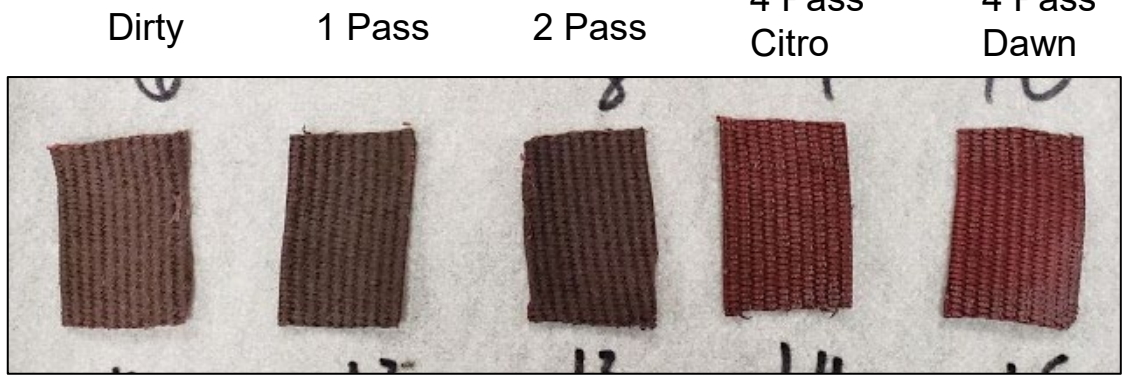


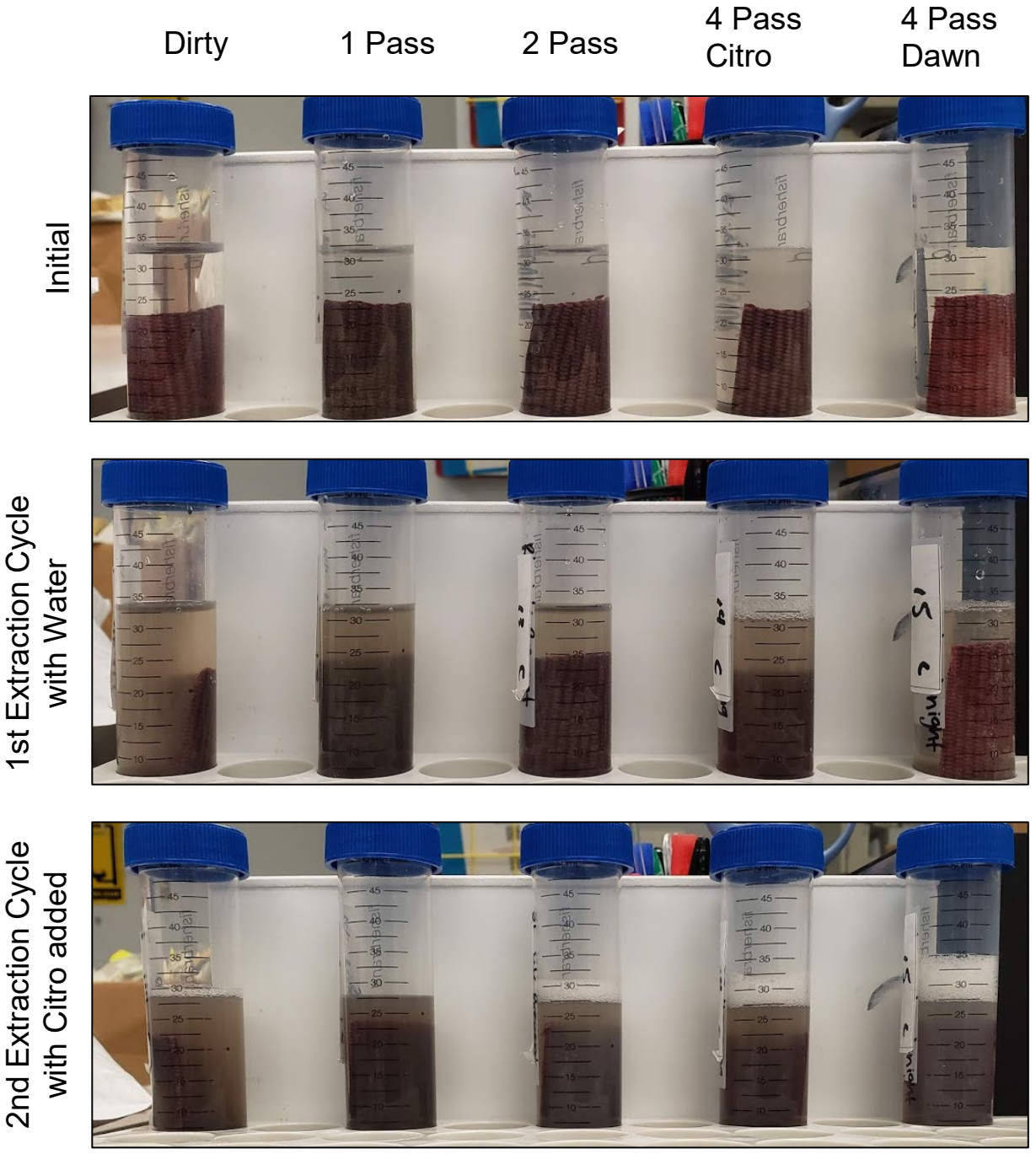
2nd Extraction Cycle with Citro added



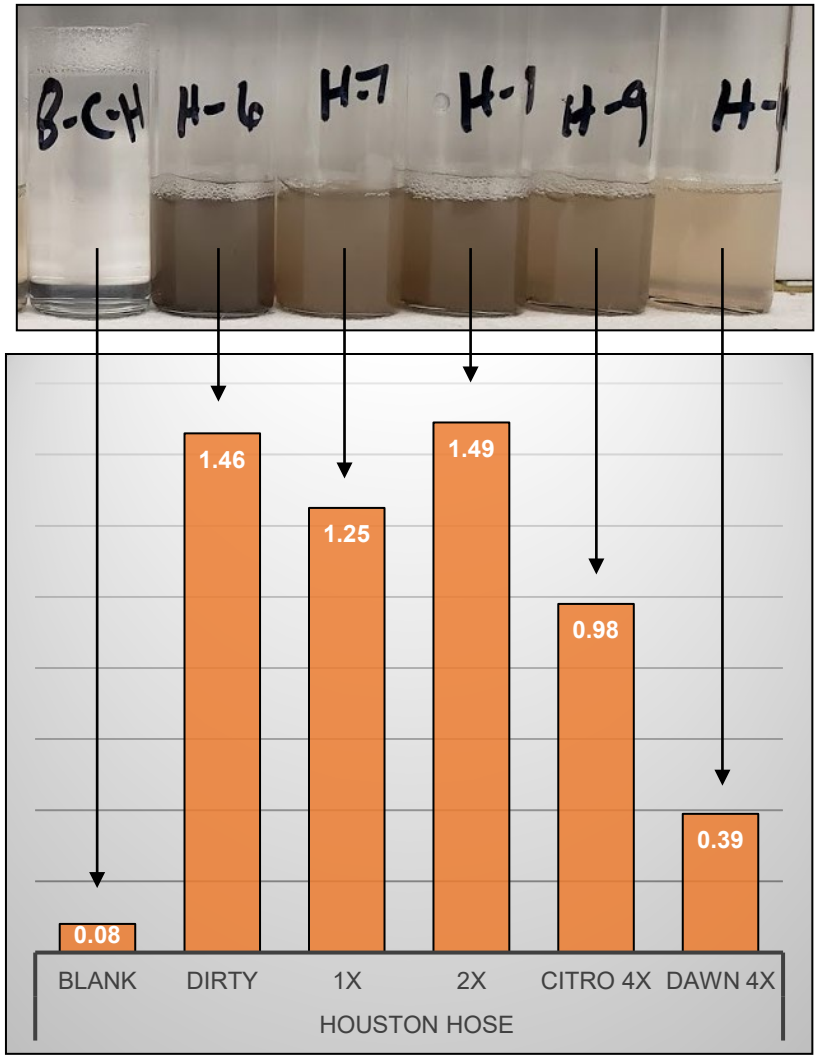
Chicago Hose

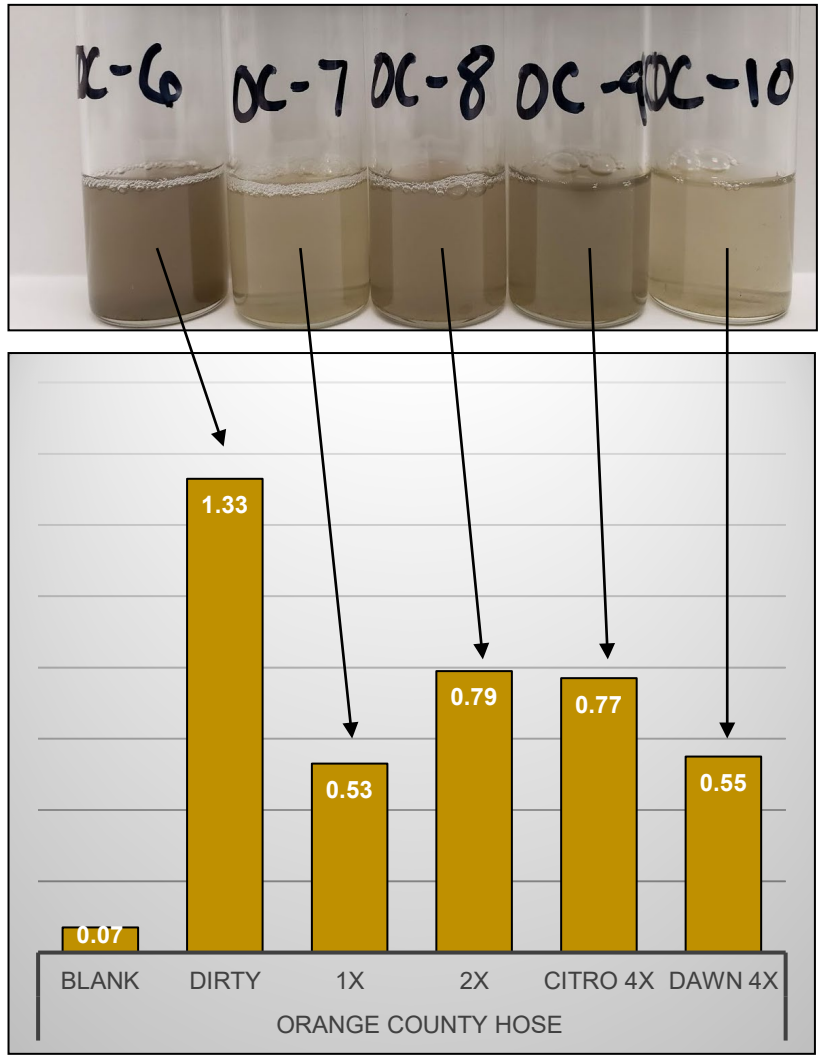


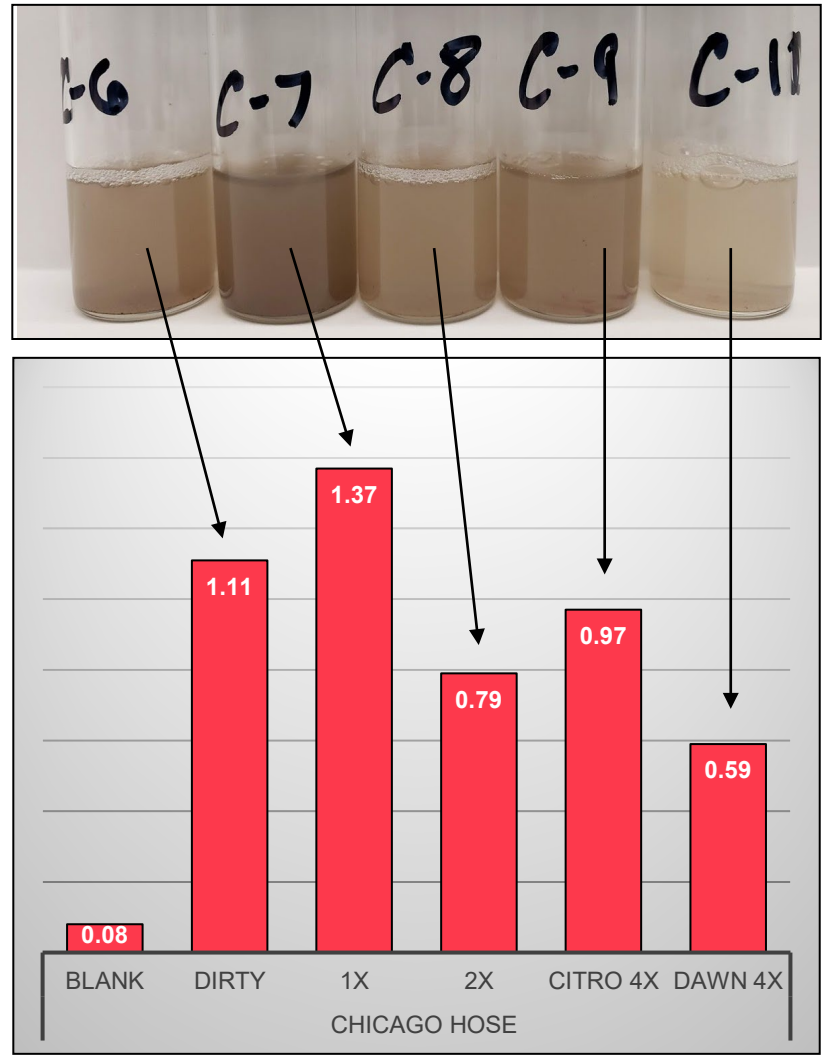




All Hoses


0.08
1.46
1.25
1.49
0.98
0.39
BLANK
DIRTY
1X
2X
CITRO 4X
DAWN 4X
HOUSTON HOSE


0.07
1.33
0.53
0.79
0.77
0.55
BLANK
DIRTY
1X
2X
CITRO 4X
DAWN 4X
ORANGE COUNTY HOSE


0.08
1.11
1.37
0.79
0.97
0.59
BLANK
DIRTY
1X
2X
CITRO 4X
DAWN 4X
CHICAGO HOSE

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 variablity
  - Assessment can be affected by stray/loose particles or fibers

Summary Data for Hose Cleaner Trial

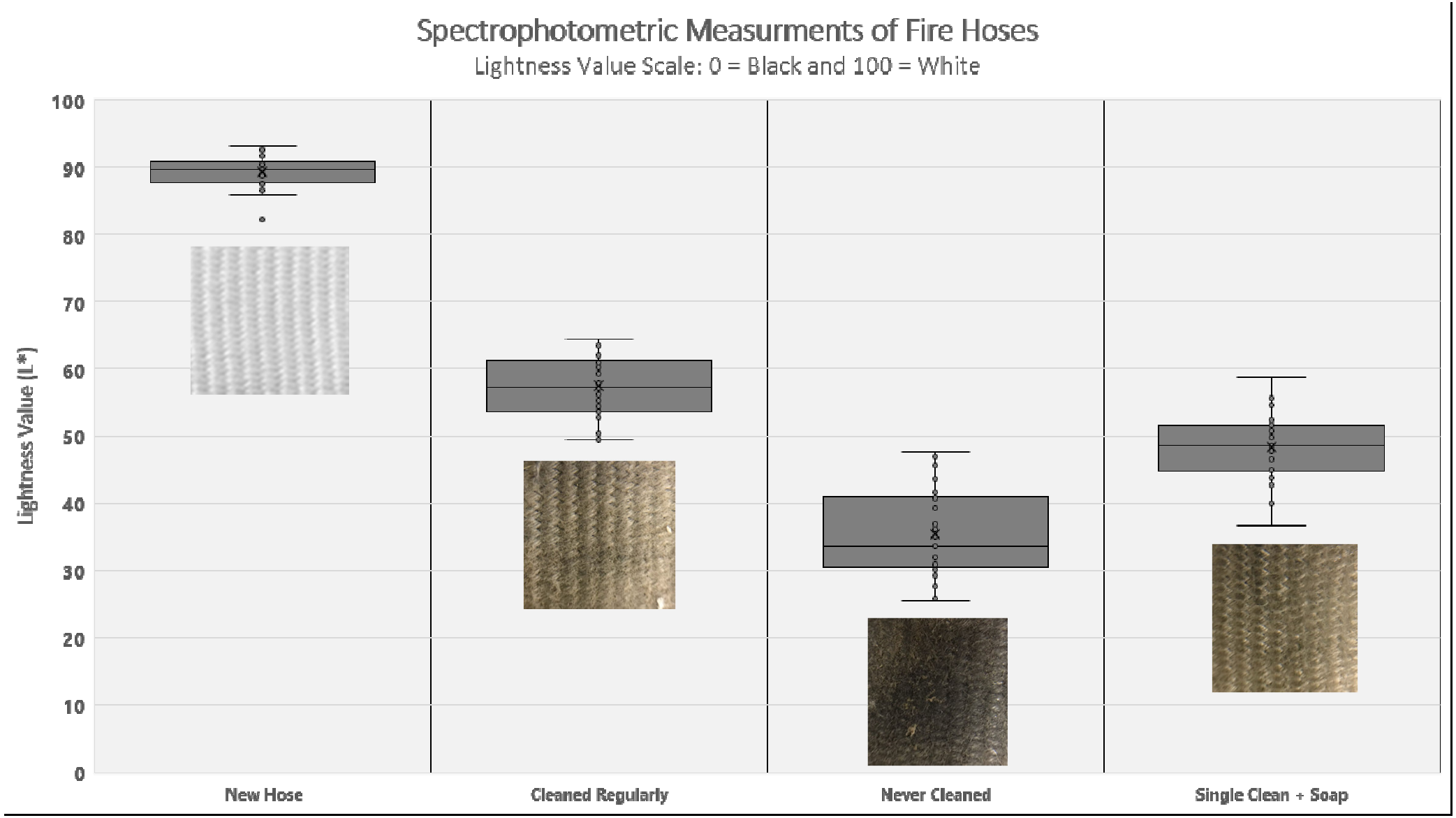
Hoses Exposed May 2021 at Training Center

Hose Descriptions

- All hoses were purchased new
  - 50 foot, 1 ¾” attack hose
  - White in color
  - Red markings place very 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

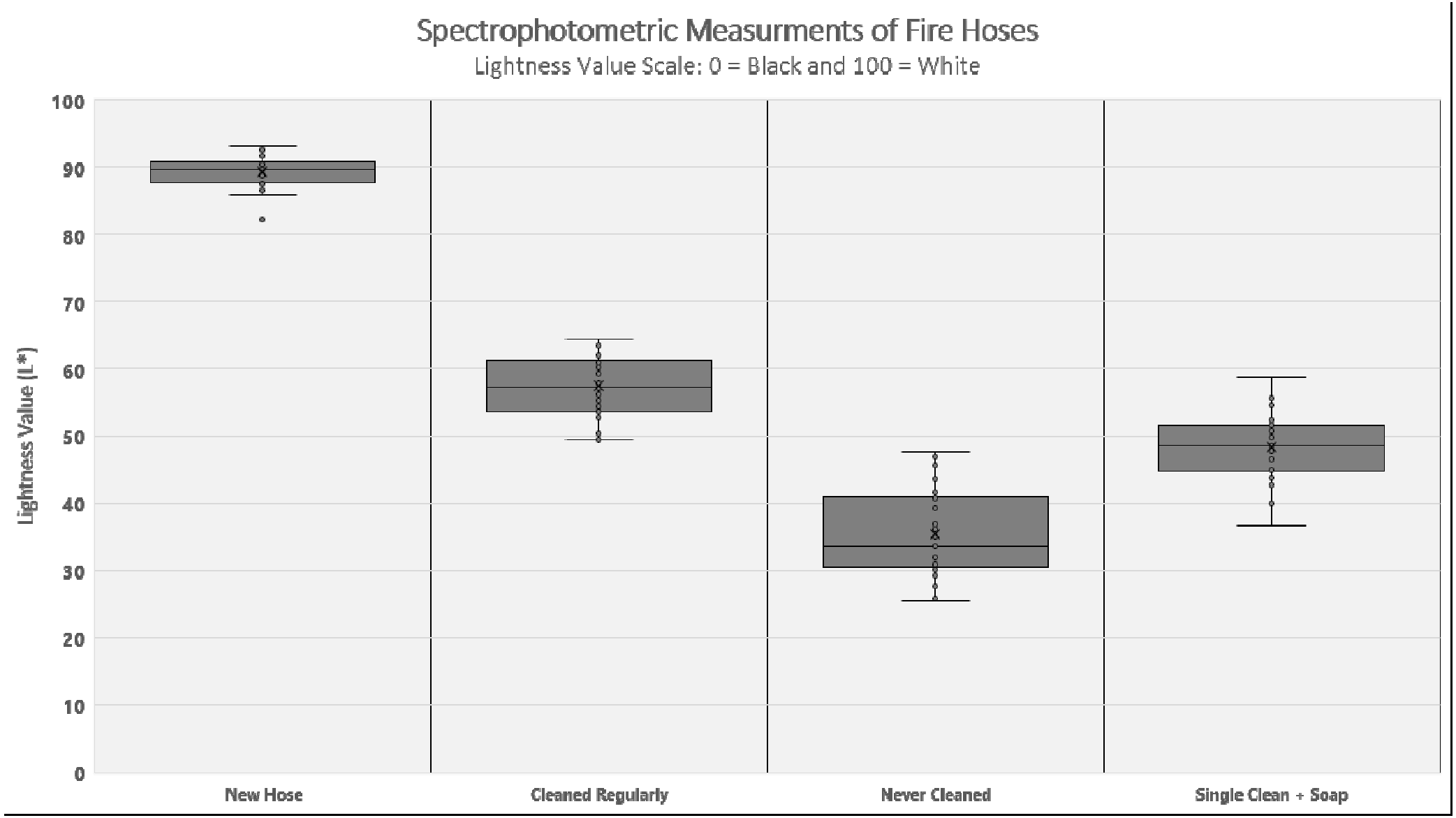

Spectrophotometric Measurments of Fire Hoses
Lightness Value Scale: 0 = Black and 100 = White
Lightness Value (L*)
100
90
80
70
60
50
40
30
20
10
0
New Hose
Cleaned Regularly
Never Cleaned
Single Clean + Soap

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 Measurments of Fire Hoses
Lightness Value Scale: 0 = Black and 100 = White
Lightness Value (L*)
100
90
80
70
60
50
40
30
20
10
0
New Hose
Cleaned Regularly
Never Cleaned
Single Clean + Soap

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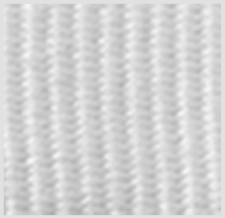
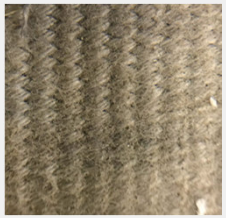
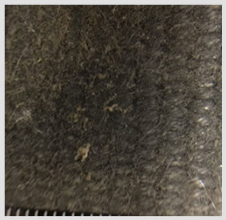
Hose	Condition	% of New Hose Measurement	Image
Hose 1	New	100%	
Hose 2	Cleaned Regularly	63.5%	
Hose 3	Never Cleaned	39.1%	
Hose 3 – After Wash	Single Clean with Soap	53.4%