VERMI-TREATMENT SOLUTIONS - FINAL UPDATE

ENHANCING AIR QUALITY AND TOXIC CHEMICAL REMOVAL THROUGH SUSTAINABLE ORCHARD WOOD UTILIZATION AND VERMI-TREATMENT FILTRATION SYSTEMS

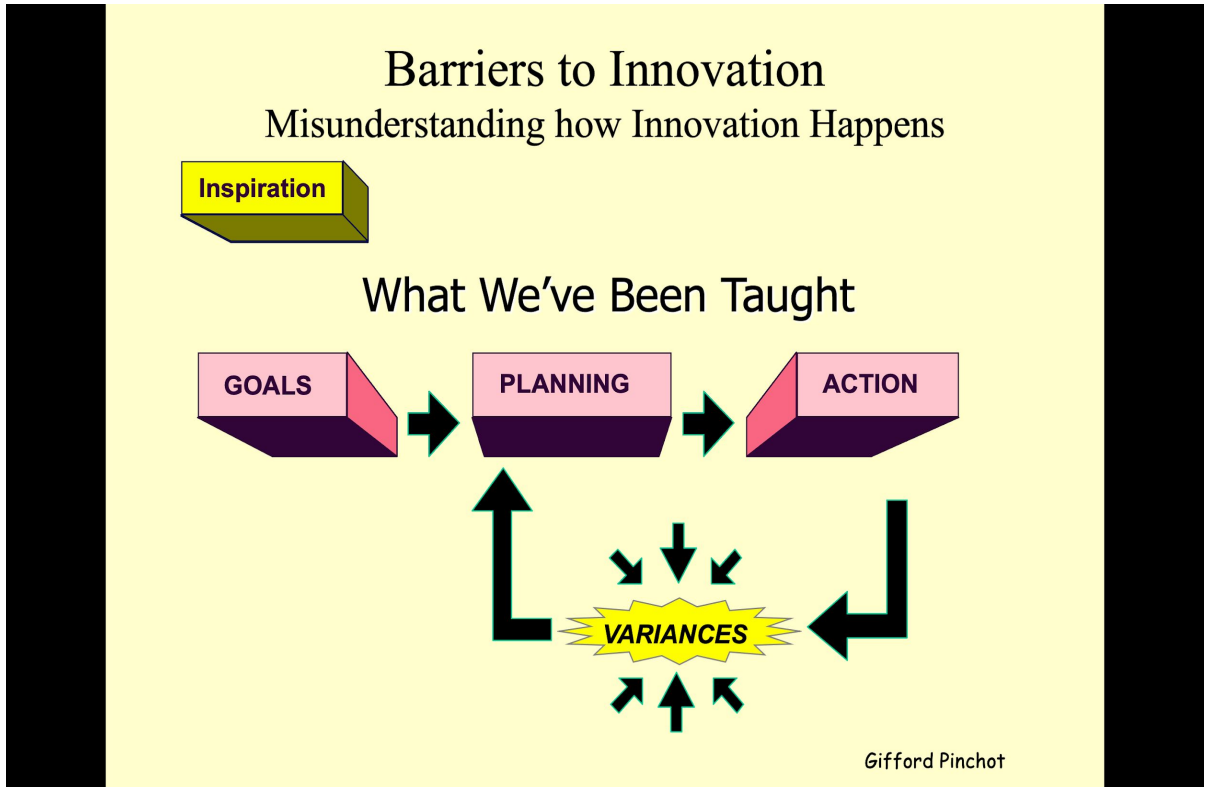
June 2025

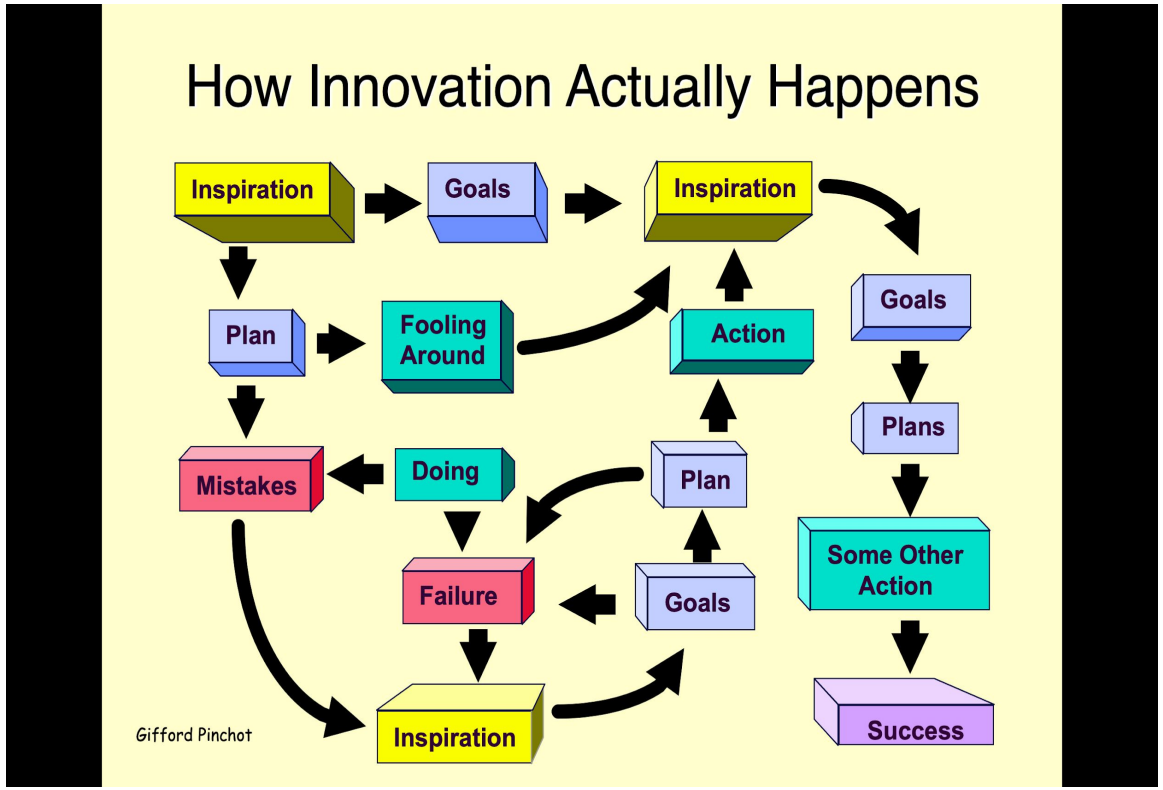
Presentation Outline

1. Purpose
2. Orchard Tear-Out Debris: Sourcing and Chipping
3. Laboratory Testing
4. Economic Feasibility
5. Air Quality Projected Impact
6. Education and Outreach

PURPOSE

An Applied Research Project as an Alternate Approach to Reduce / Eliminate Emissions from Agricultural Burning



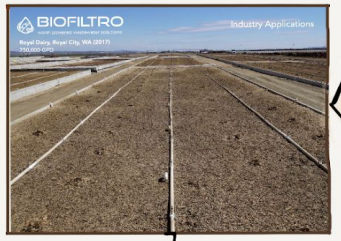


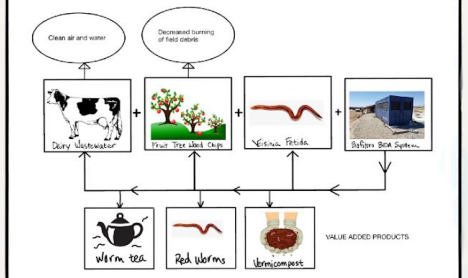
PERCA

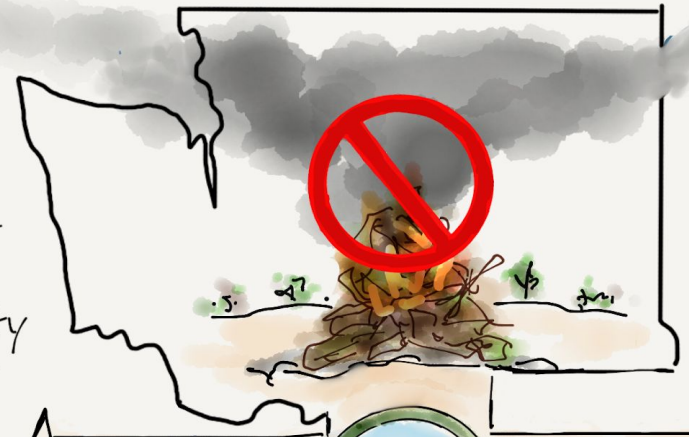
PROJECT #1

Using orchard wood in dairy waste treatment

- economic feasibility
- market development







Specific Chip Size

Unused Fines

PROJECT #2

Utilize unused fines and worms to clear toxins from waste water

- economic feasibility
- market development

PERCA

VERMITREATMENT

INDUSTRIAL SYMBIOSIS

?

Can worms + wood remove toxins from waste water?

Do the worms or substrate continue to hold the toxins?

Depending on the toxin load, in what ways might each be utilized?

Royal Dairy / Allred Orchards

WASHINGTON STATE UNIVERSITY

Juice Plant

WA DOC

Yakima Nation

Others

Orchard Tear-Out Debris

Sourcing and Chipping

Apple Wood

Chipped August 2024

Testing Substrate

Apple Wood

Control (Pine)

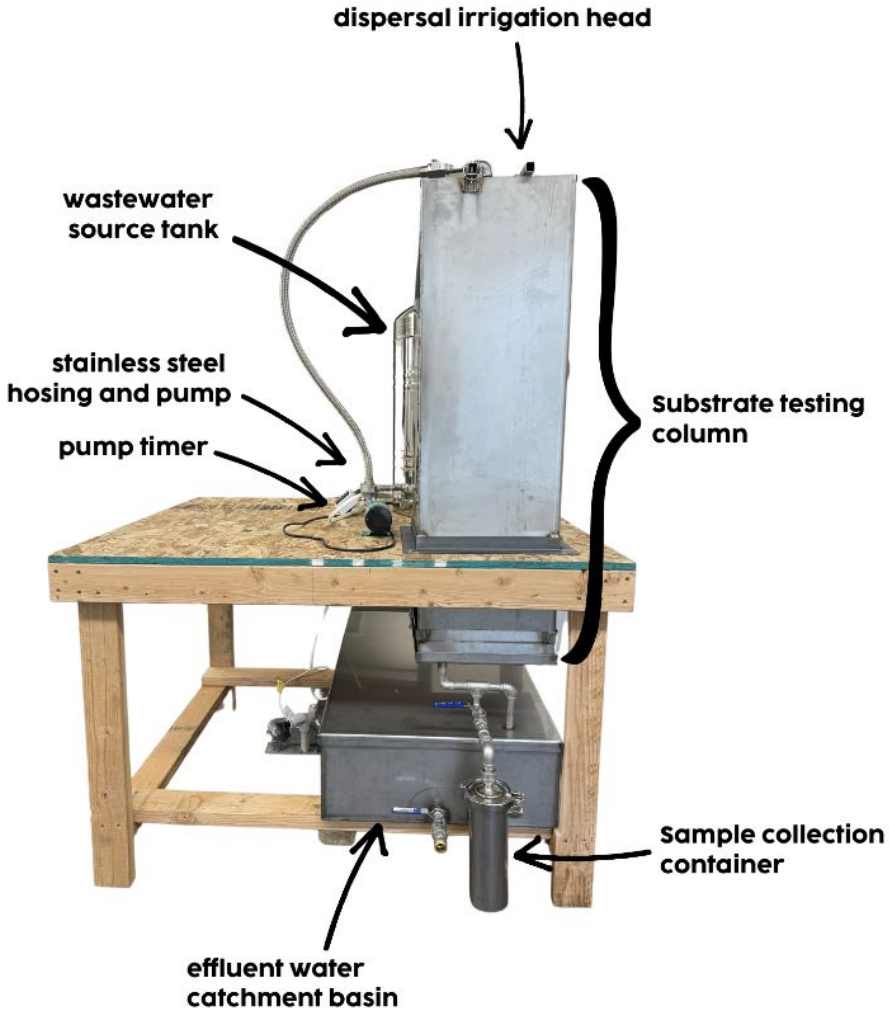
Wood Chipping Results

Process Step	Start Weight (lbs)	Usable Weight (lbs)	Usable %
Tear-out pile culling	600	450	75%
Foreign material removal and loss	450	424	94%
Chipping, screening, and loss	424	140	33%

514 lbs/yd^3 or approximately 0.26 tons/yd^3

Laboratory Testing

Bench-Scale Apple Wood Testing




Woodchips only
Apple

Total Suspended Solids Data

Apple

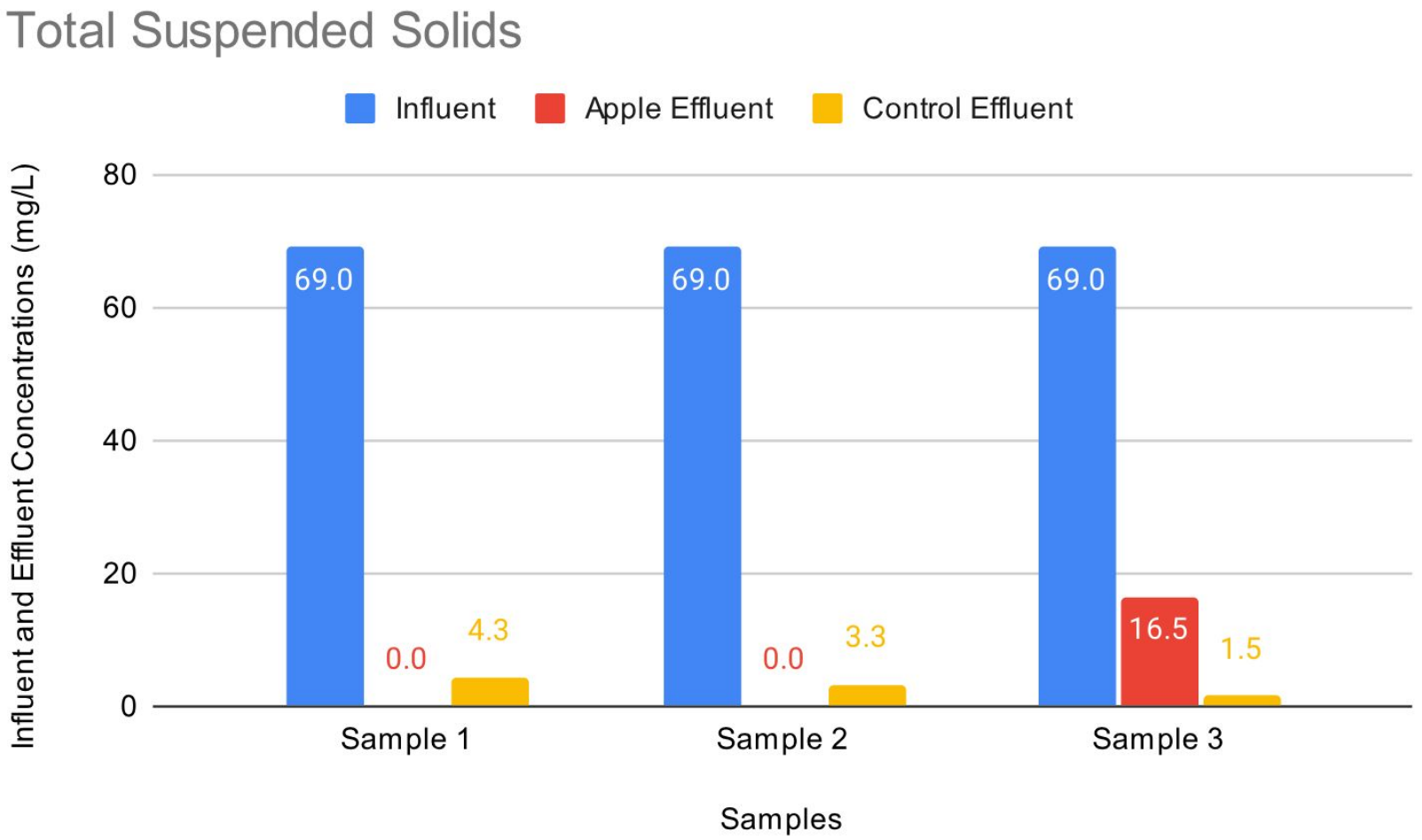
92.0% avg. removal

p = 0.0074

Control

95.6% avg. removal

p = 0.00015



Biological Oxygen Demand Data

Apple

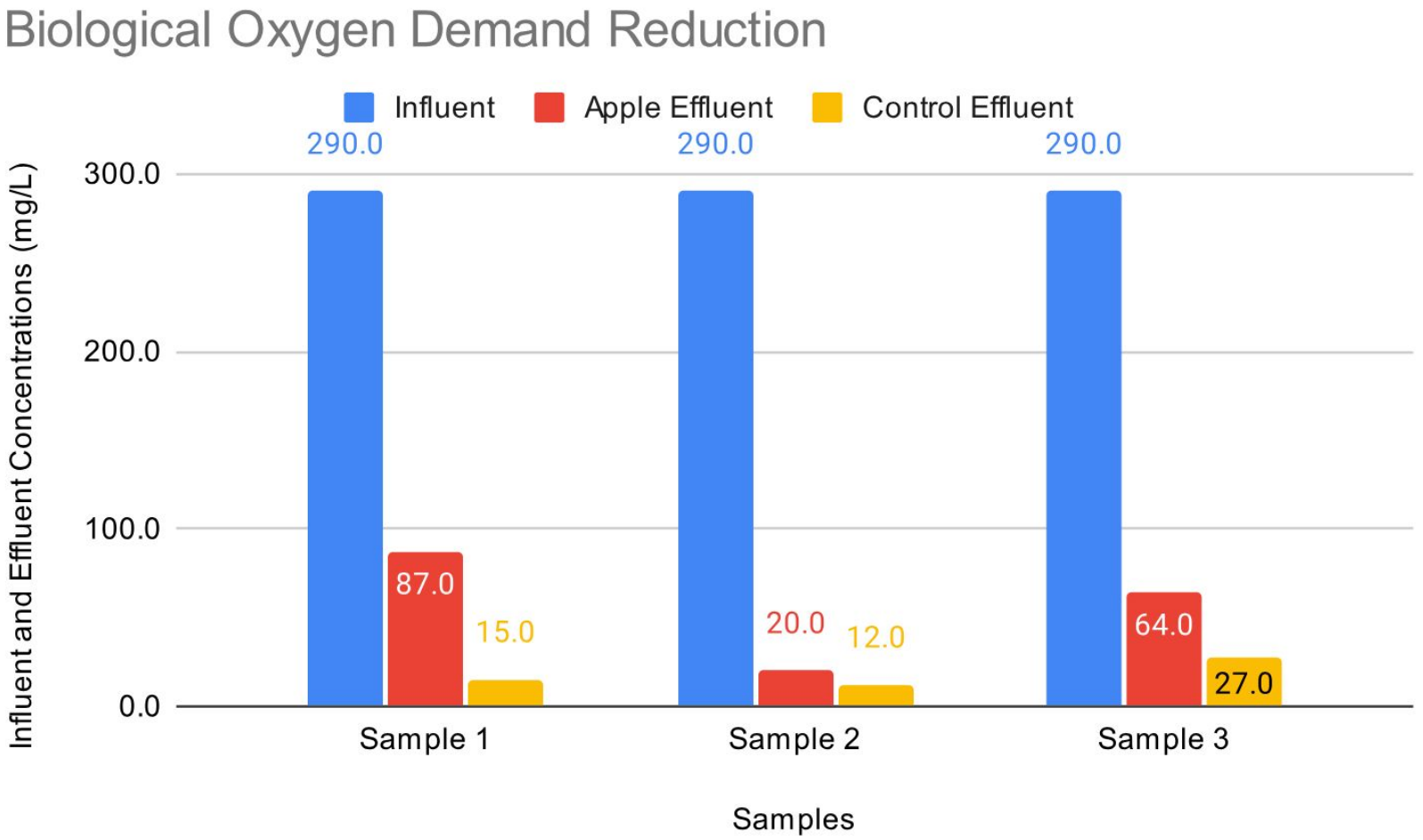
80.3% avg. removal

p = 0.0070

Control

93.8% avg. removal

p = 0.00028



Polychlorinated Biphenyls Data

Apple

85.5% avg. removal

p = 0.011

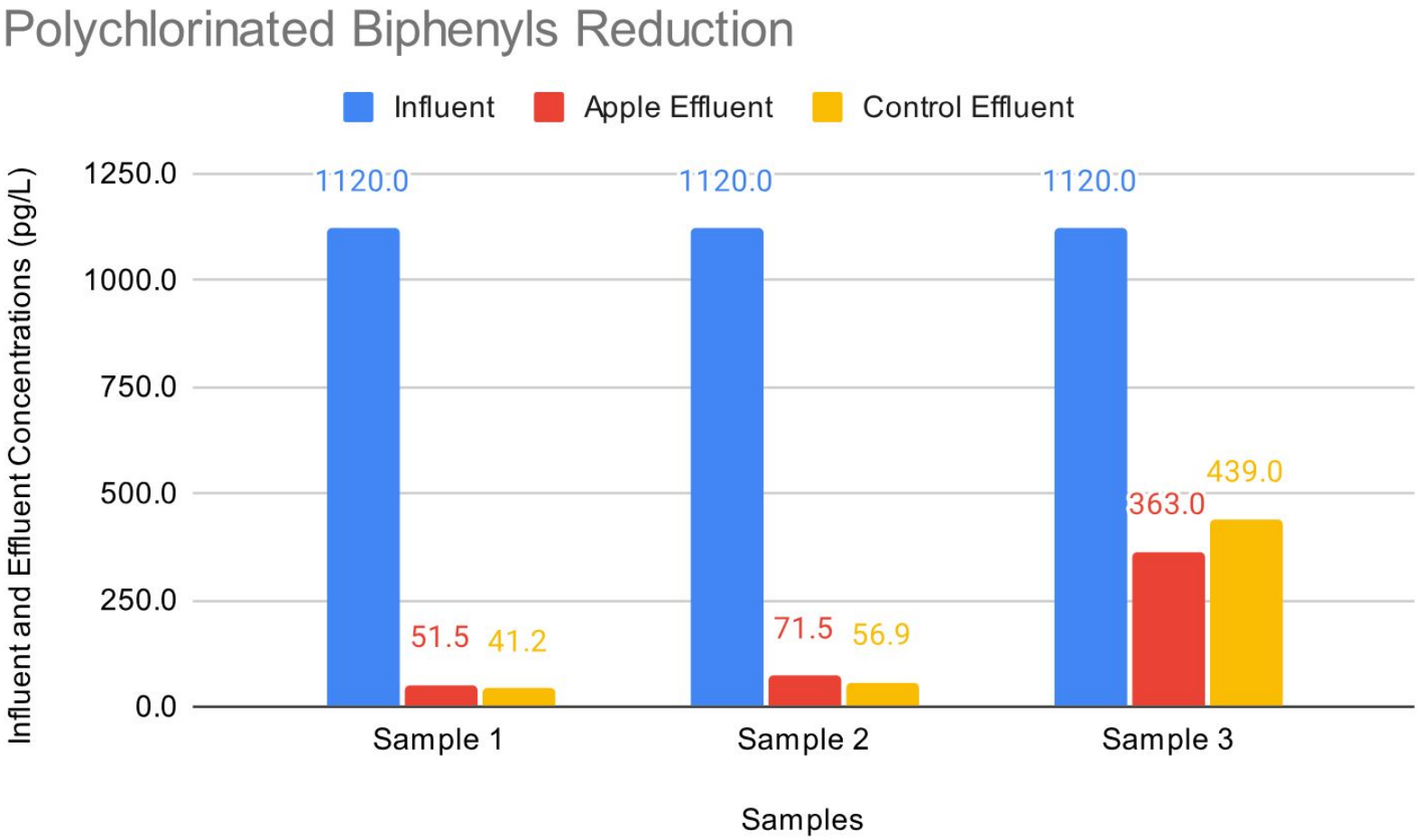
Substrate: 112 ng/kg

Control

84.0% avg. removal

p = 0.0186

Substrate: 116 ng/kg



Chipped Orchard Debris as Drop-In Replacement

TSS

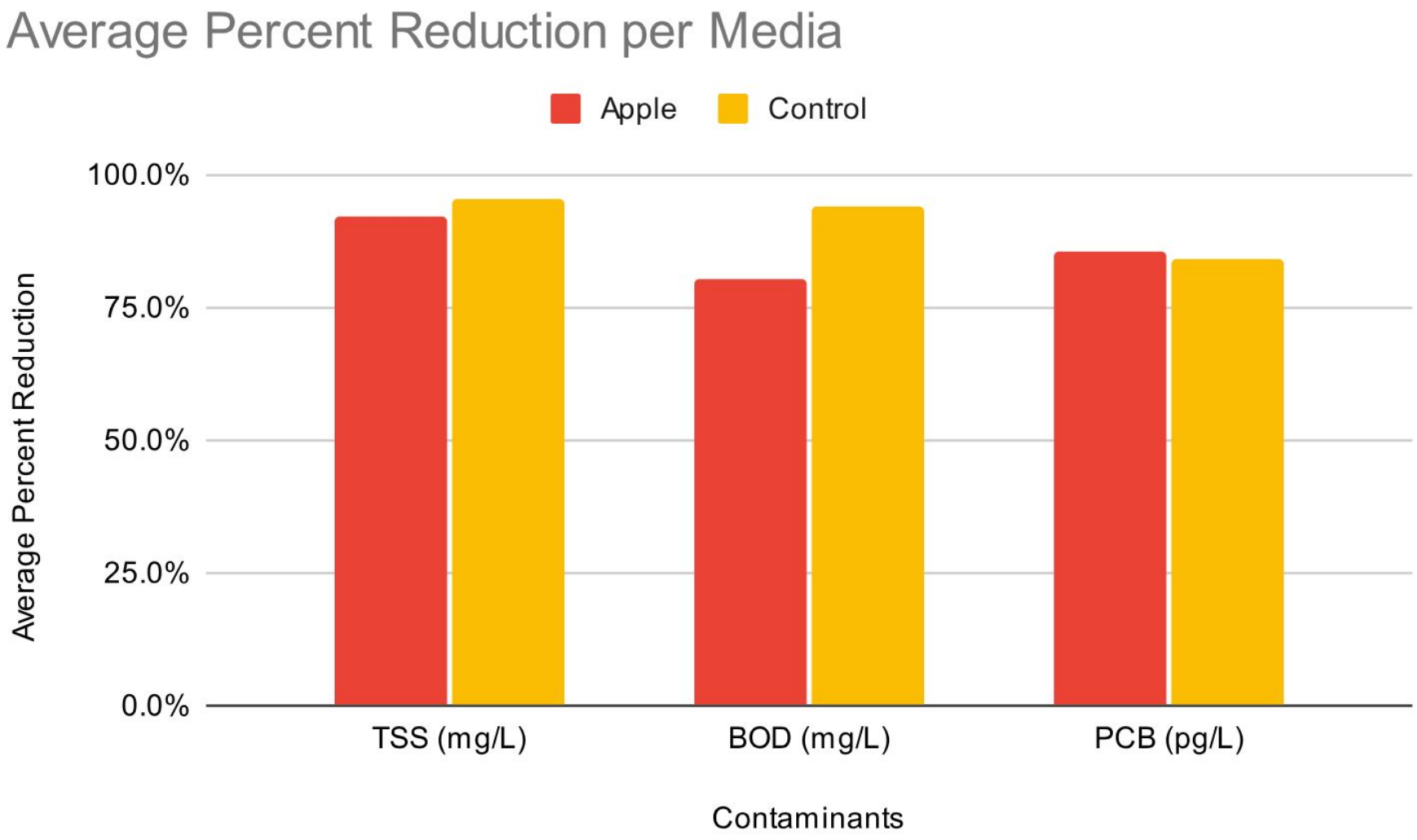
p = 0.73

BOD

p = 0.17

PCBs

p = 0.62



Economic Feasibility

Major Economic Limitations

1. Orchardist Buy-In
2. Cost Prohibitive
    a. Chipping
    b. Screening
    c. Labor
3. Limited Markets

Cost of chipping apple orchard tear-out debris

	Trellised Orchards	Non-trellised Orchards
Cost to separate trellis wire and pile orchard foreign material $ per acre	$12,500.00	$2,500.00
Tons of wood per acre	8.5	21
Yield of 3 inch or larger	50%	75%
Usable tons of wood per acre	4.25	15.75
Cost of wood per ton	$2,941.18	$158.73
Trucking cost $/ton	$2.25	$2.25
Chipping cost $/ton	$65.00	$65.00
Wood chips cost per ton	$3,008.43	$225.98
Cost per cubic yard	$1,719.10	$129.13

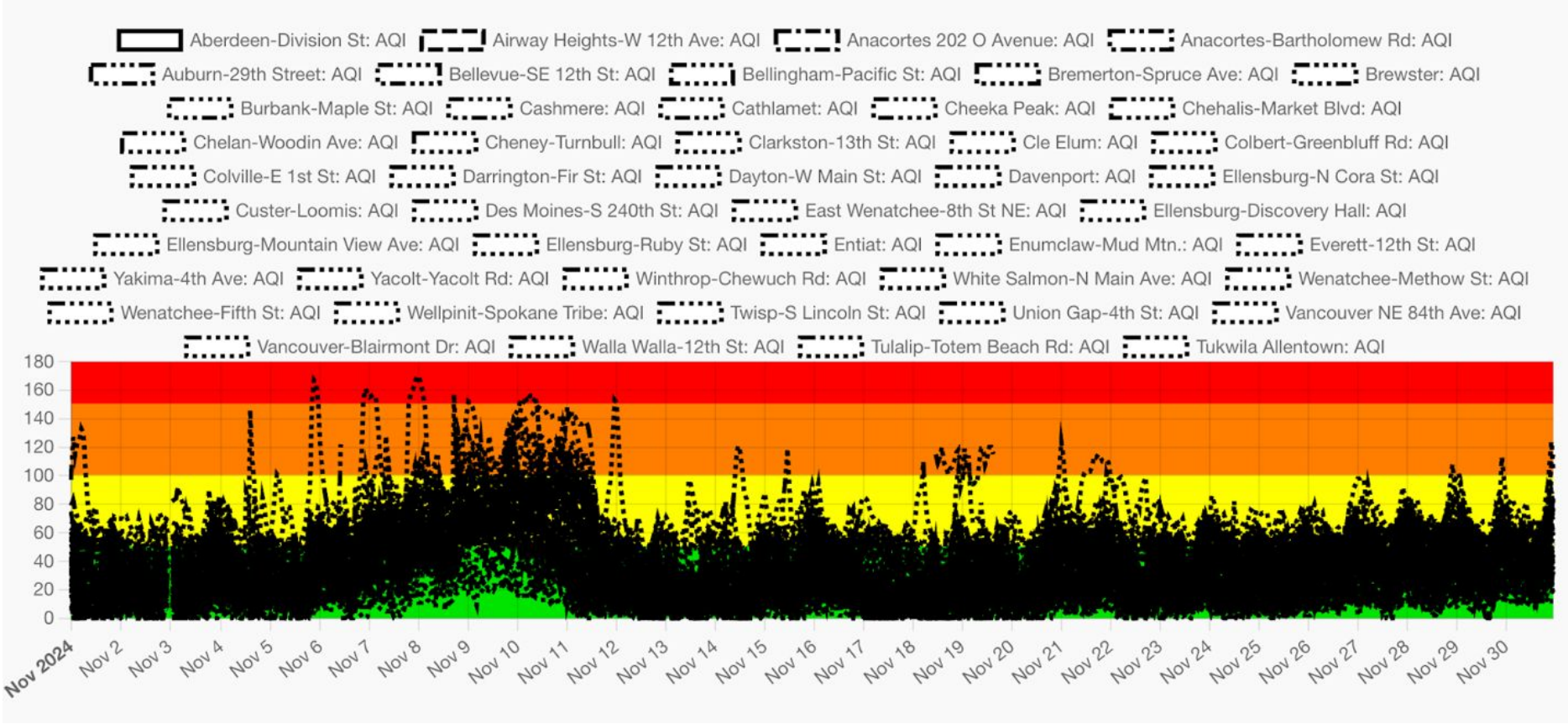
Market Projections

	Cubic yards of wood	Tons of wood
2025	56.89	14.62
2026	3,693.25	949.38
2027	7,814.46	2,008.77
2028	16,117.49	4,143.14
2029	32,723.56	8,411.86
Total	**60,405.66**	**15,527.78**

Metric	Value	Source
Total WA apple orchard acreage	173,000 acres	USDA NASS
Avg. tear-out rate per year	3.10%	Orchard interviews + literature
Acres removed per year	5,354 acres	Calculated
Tons of debris per acre	8.5 tons	Orchard interviews
Total tear-out mass per year	45,512 tons	Calculated
Usable yield from chipping	33.02%	Field data
Usable fine wood per year	15,028 tons	Calculated
Tons per cubic yard	0.26 tons/yd³	Field data
Usable volume per year	**3,862.95 yd³**	Final output

Air Quality Projected Impact

Purpose of this Grant: Air Quality



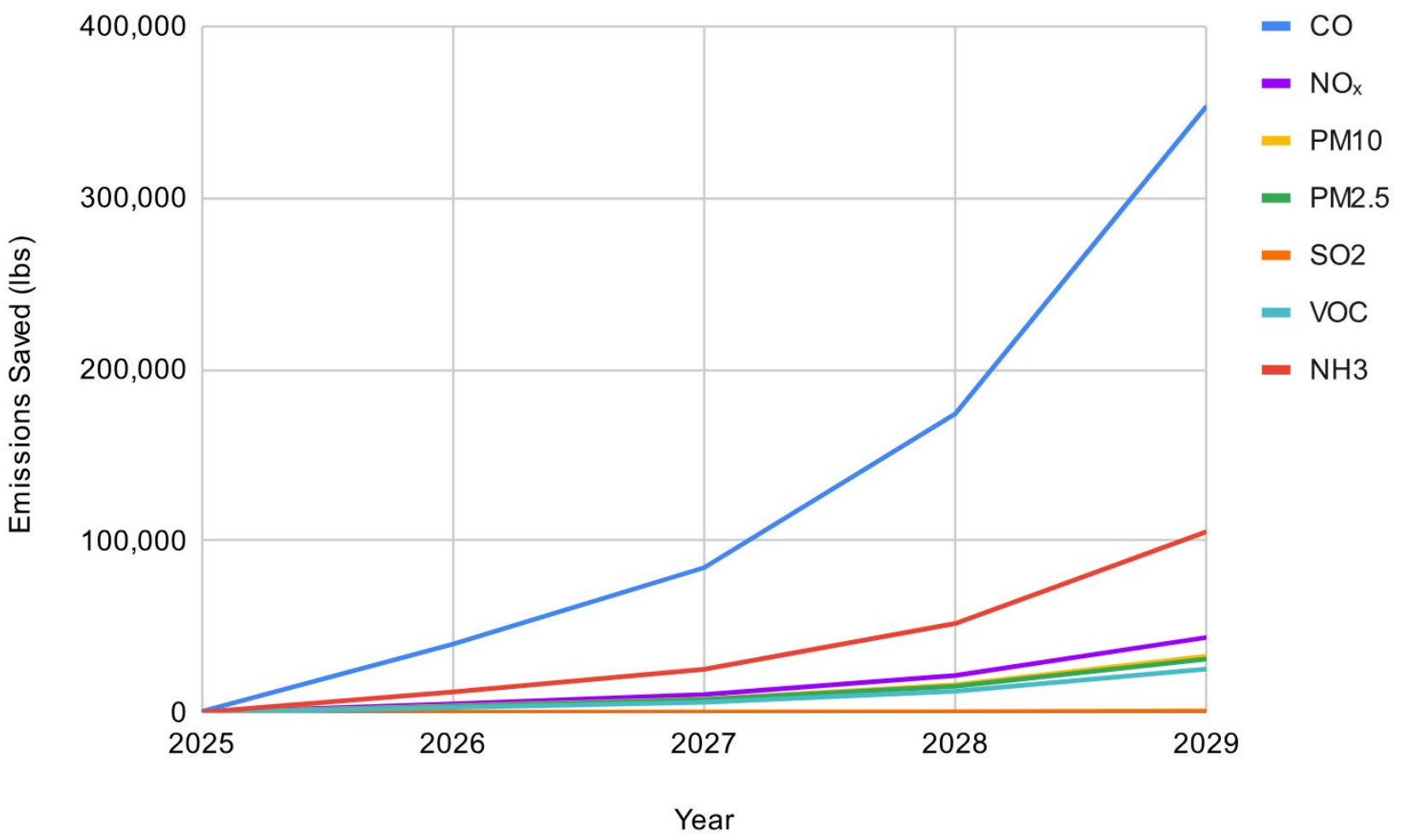
Source: https://enviwa.ecology.wa.gov/

Emission Factors (pounds per ton of material consumed)

CO	42
NO_x	5.2
PM10	3.9
PM2.5	3.7
SO_2	0.1
VOC	3
NH_3	12.52

Source: 2020 Washington Comprehensive Emissions Inventory (2024, Publication #20-02-012)

Air Quality Benefits of Scaling Perca VFS with Apple Wood in the PNW



Total Projected Emissions Saved Over 5 Years

CO (carbon monoxide)	652,166.64
NO_x (nitrogen oxides)	80,744.44
PM10 (particulate matter ≤10µm)	60,558.33
PM2.5 (particulate matter ≤2.5µm)	57,452.78
SO_2 (sulfur dioxide)	1552.777703
VOC (volatile organic compounds)	46,583.33
NH3 (ammonia)	194,407.77

Education and Outreach

Waste to Worth Conference

April 7-11, 2025

Boise, ID

Platform Presentation

Air Quality and GHG Emissions Track

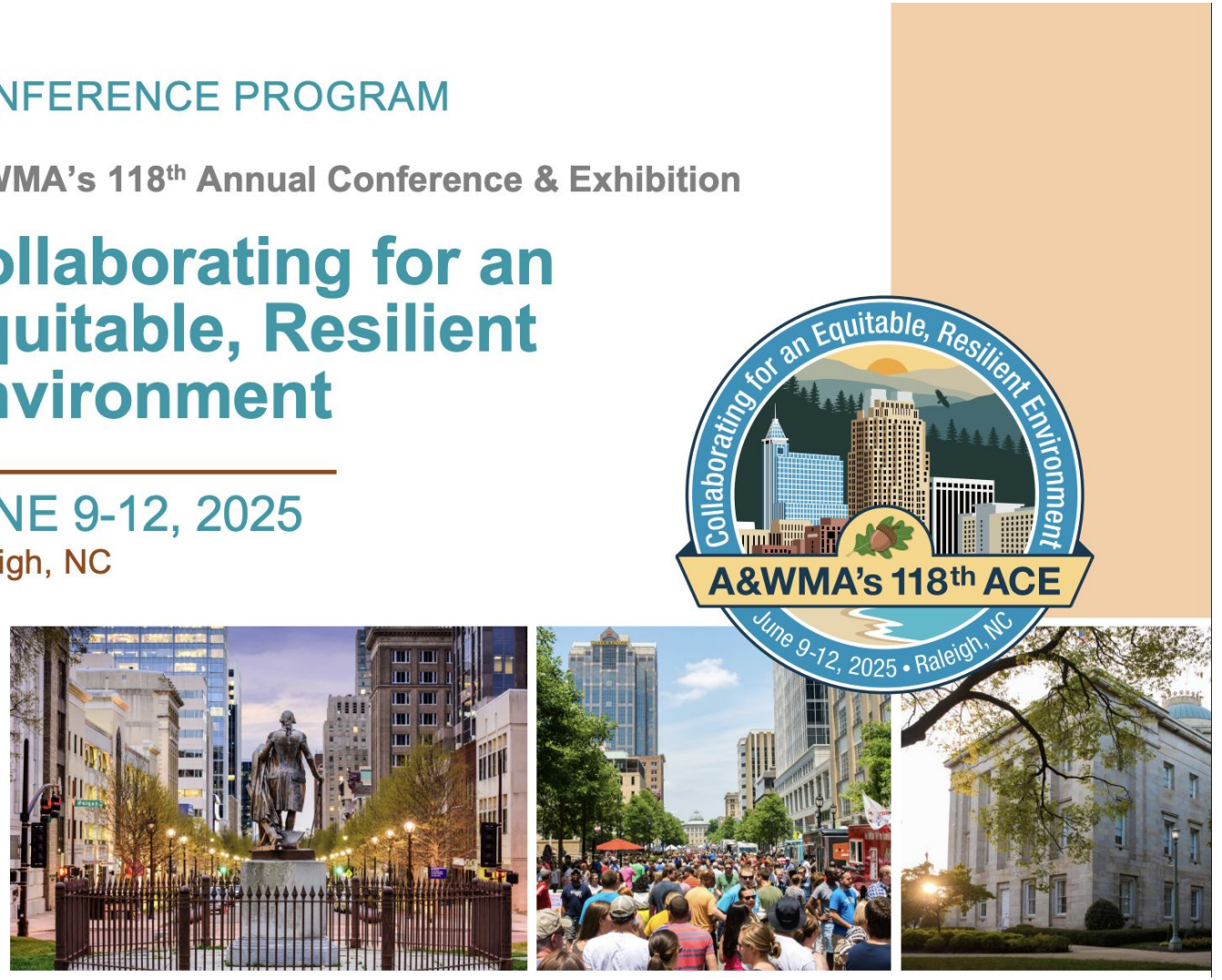
Air and Waste Management Conference

June 9-12, 2025

Raleigh, NC

Platform Presentation

Agricultural Waste Reuse and Sustainable Products for Food Systems Track



Additional Outreach and Contact

- Perca Investors
- Municipals
- Engineers
- Universities
- Orchardists
- Agriculturalists
- Columbia Basin Fruit Growers Club
- North Central Washington Fruit Growers and Fieldmen
- Yakima Valley Pomology Club

Final Outlook

Can we use orchard tear-out debris as OM in VFS?

Thank you

Questions and Feedback

PERCA