

Clean Air Hamilton
**Upwind Downwind
Conference**

High Efficiency Environmental Sweeping

Daniel McCulloch, B Acc Hons
Business Manager
The Equipment Specialist Inc.

*Sweeping Technology Innovators and Ontario
Distributor of TYMCO Street Sweepers since
2000*

May 26th 2026



Presentation Agenda

- Introduction
- Environmental Pollutants - Traffic Related Pollution and Industrial Trackout
- High Efficiency Sweeping – Traffic and Trackout Pollution Abatement
- Environmental Sweeping – Water, Air, and Health quality
- Research Studies and Articles Overview



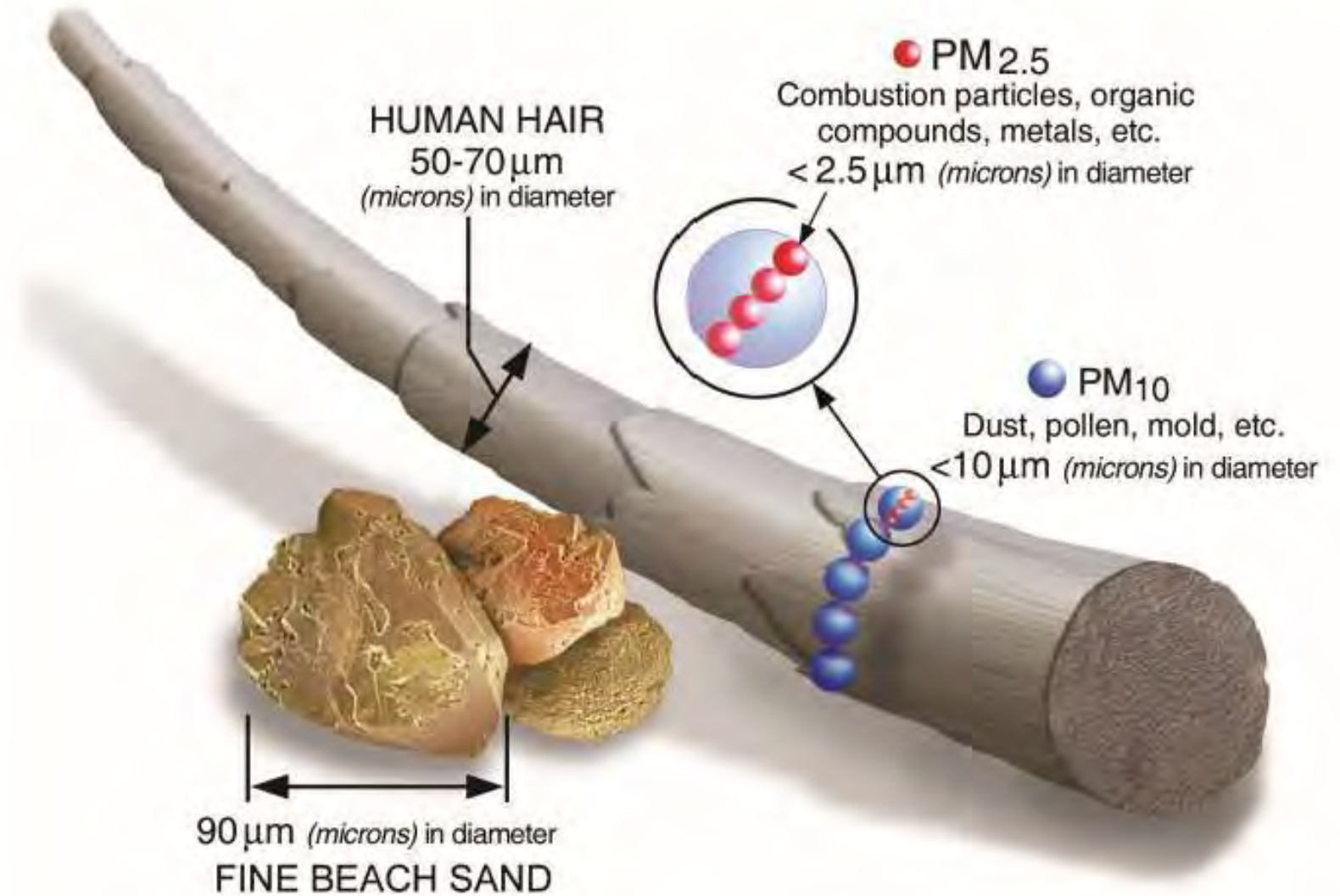
Introduction

- Daniel McCulloch, B Acc Hons
- Business Manager – **The Equipment Specialist Inc.**
– 10+ years
- **The Equipment Specialist Inc.** Incorporated in 1992.
- Ontario Distributor of TYMCO Street Sweepers since 2000.
- Pioneered TYMCO DST-6 sweeper market in Ontario.
- Participated in numerous industrial and municipal environmental sweeping tests with the TYMCO DST-6 in Ontario.
- Invented and Developing new Revolutionary Sweeping Technology

Applicable Environmental Pollutants

- Today's focus will be on-street PM_{10} and $PM_{2.5}$ including:
 - **Industrial Trackout**
 - **Traffic Related Air Pollution**
- **Industrial Trackout** and **Traffic Related Air Pollution** consists of a multitude of different sources and substances. Examples include:
 - Microplastics from Tire wear
 - Metallic dust from Brake wear
 - Diesel Particulates and Exhaust Soot from Tailpipes
 - Industrial process by-product trackout
- PM_{10} and $PM_{2.5}$ have been a known Air and Water environmental concern for many decades
- High Efficiency Street Sweeping acts as a direct pollution abatement measure of on-street pollution impacting both Air and Water quality.

Visualizing Fine Particulate



INDUSTRIAL TRACKOUT – BENZO(a)PYRENE

Air monitoring shows high levels of cancer-causing pollutant in neighbourhoods across Hamilton

Citywide pollution-tracking found unhealthy levels of common steelmaking pollutant benzo(a)pyrene at monitoring sites from Dundas to Stoney Creek.

The largest air-monitoring experiment in city history has found unhealthy levels of a cancer-linked contaminant across Hamilton — including in neighbourhoods kilometres away from polluting bayfront industries.

The results suggest coal-fired steelmaking pollutants like benzo(a)pyrene travel far beyond the lower city and pose “an even greater (health) impact than we may have expected,” said Matthew Adams, an urban air-quality expert who is co-ordinating the study alongside city staff.

Industrial Track-out Study – McMaster University Peer Reviewed

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Effective mitigation efforts to reduce road dust near industrial sites: Assessment by mobile pollution surveys

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ABSTRACT

Assessment of spatial variation of fugitive dust sources, particularly road dust track-out from industrial sites and its subsequent re-suspension is difficult with fixed air quality monitoring stations given their sparse distribution and the highly localized nature of road dust. Mobile monitoring was employed to measure levels of road dust in the industrial area of the City of Hamilton, Ontario, Canada. Results of this monitoring were used in a Fugitive Dust Control workshop held for local stakeholders, where fugitive dust control solutions were presented. After the workshop, the City of Hamilton and cooperative industrial groups executed enhanced street cleaning and individual industries and facilities performed on-site control activities. Post-workshop mobile air monitoring was performed for comparison to the initial values to determine effectiveness of these approaches. A regression model testing the difference pre- and post-workshop yielded a statistically significant difference in PM_{10} measurements demonstrating improvement. The average value of PM_{10} prior to the workshop was $114 \mu\text{g}/\text{m}^3$. Post-workshop the average value dropped to $73 \mu\text{g}/\text{m}^3$.

Table 2

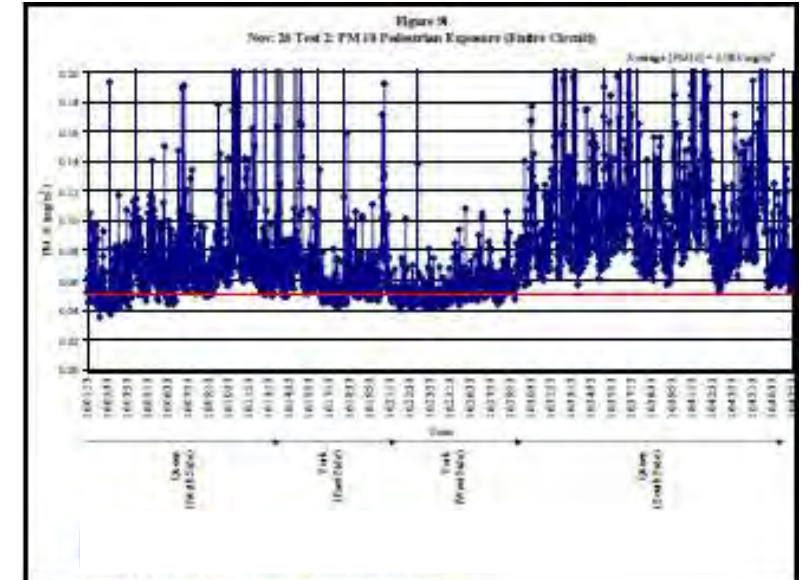
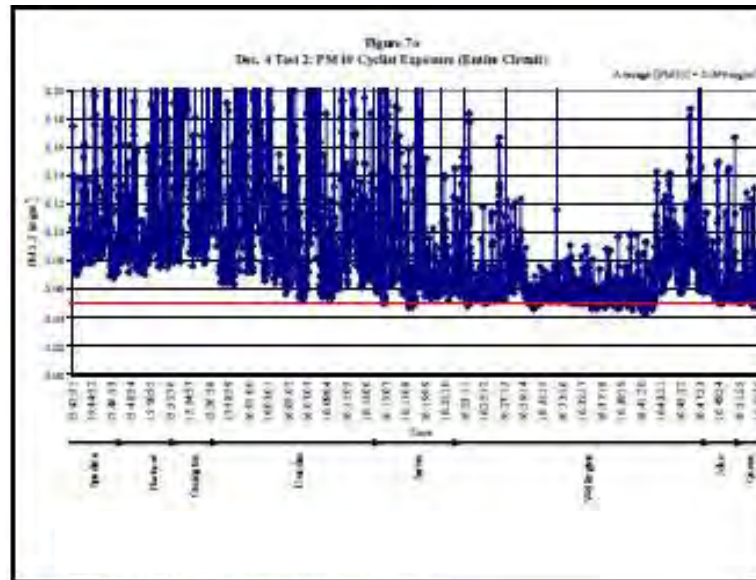
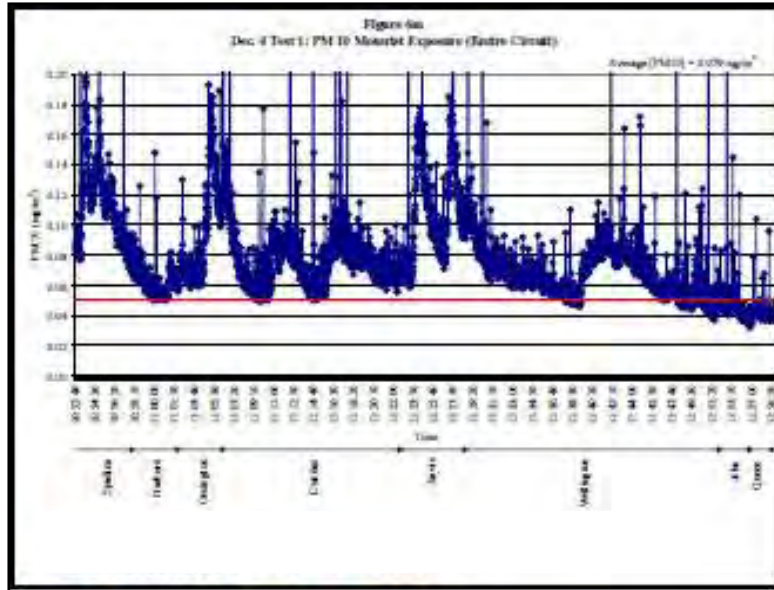
Summary statistics for PM₁₀ (µg/m³) as measured from mobile monitor, before and after workshop.

	Minimum	Maximum	Average	Standard deviation
Pre-workshop	0	2000	114	224
Pre-workshop (minus Strathearne Avenue)	0	2000	103	200
Post-workshop	1	800	73	75
Post-workshop (minus Strathearne Avenue)	1	800	70	72

2006 and 2007 the City's Public Works Department replaced its entire complement of older street sweepers with a fleet of new Tymco DST-6 regenerative air sweepers, chosen because of its proven ability to control and remove PM_{10} and $PM_{2.5}$ contained in road dust. This followed participation in extensive research and testing undertaken by the nearby City of Toronto, where they created a testing protocol to test any street sweeper's efficiency in removing PM_{10} . ETV (Environmental Technology Verification) Canada was contracted to verify results of the protocol, with the Tymco DST-6 sweepers scoring the highest at 90% efficiency. This

of Hamilton. Fourth, there has been an increased emphasis on street sweeping by the City. Prior to the workshop, the City employed street sweeping around the Strathearne Avenue area, as this had been long identified as a problematic area for road dust. Following the workshop, the City agreed to increase street sweeping service levels that extended to include a broader area within the Industrial Core, primarily focusing on problem areas that were identified by the mobile monitoring. This service is performed nightly, 2–3 times per week. Along with the increased sweeping, the Public Works department of the City undertook a program entitled the “Industrial Zone Air Quality Initiative”. The intent of this program is to respond to concerns regarding poor air quality (airborne dusts) in the industrial area, providing increased regenerative street sweeping and increased frequency of boulevard, median and street flushing. Also, included in this program,

2002 TORONTO Ambient Air Quality Monitoring



Background

- At the April 9th, 2002 TIE meeting the **Toronto air quality preliminary model** results were presented, indicating that a major local source of fine particulate matter (PM₁₀) is attributable to fine road dust.
- New street sweeper technology are **reportedly** capable of removing at least 80% of fine road dust.
- An 80% removal of fine road dust (PM₁₀) could result in **25%-30% improvement** in the City's PM₁₀ air quality and even greater improvement is expected for pedestrians and cyclists on the City's arterial roads.

Toronto's Reality

- PM₁₀ and PM_{2.5} levels in Toronto routinely **exceed** the acceptable Provincial AAQC and CWS values
- Both PM₁₀ and PM_{2.5} are **significant** health concerns and year round health hazard especially at **"nose-level"** on City's arterial roads
- 1,200 premature deaths attributable to **chronic exposure** to PM_{2.5}
- 180 premature deaths attributable to **acute exposure** to PM₁₀
- Fine particulates **cause** respiratory and cardiovascular problems

See City of Toronto Public Health report July 2004 entitled, "Air Pollution Burden of Illness in Toronto"

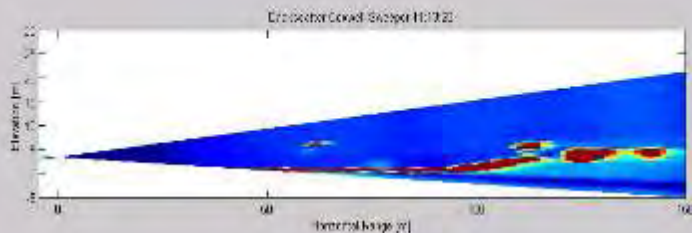
CRCA Program

PM Criteria and Thresholds

- Pick-up Removal Efficiency (%) **More than 90%**
- Deposit on Sidewalk Efficiency (%) **Less than 0.08%**
- Air Contamination PM₁₀
 - Maximum Concentration **Less than 0.08 mg/m³/kg**
 - Total Concentration **Less than 11 mg/m³/kg**
- Air Contamination PM_{2.5}
 - Maximum Concentration **Less than 0.02 mg/m³/kg**
 - Total Concentration **Less than 5.0 mg/m³/kg**

LIDAR Ambient Air Observations of On-Street Sweeping and Subsequent Vehicle travel

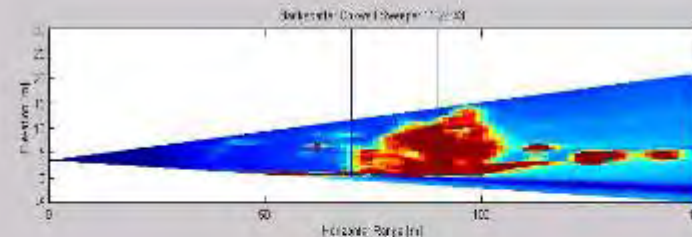
1



Car Travels North in East Curb Lane
11:13:28

Prior to the street sweeper cleaning the street, the majority of material resides in the curb area where it is out of the path of traffic. If left, however, this material will be washed into catch basins / Storm Sewers connected to Rivers and Lakes

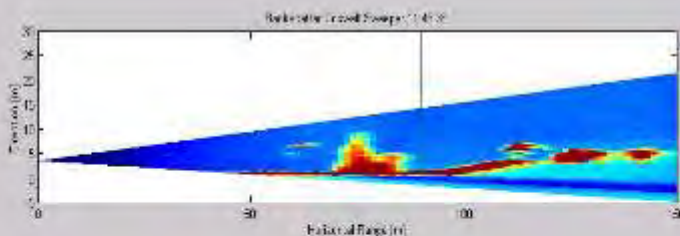
2



Mechanical Sweeper Travels North in East Curb Lane
11:26:43

The Mechanical Sweeper is distributing material into the center of the traffic lane for subsequent pickup. This occurs one time at this location. The next slide shows what happens when a sweeper's pickup mechanism is inefficient and leaves material behind

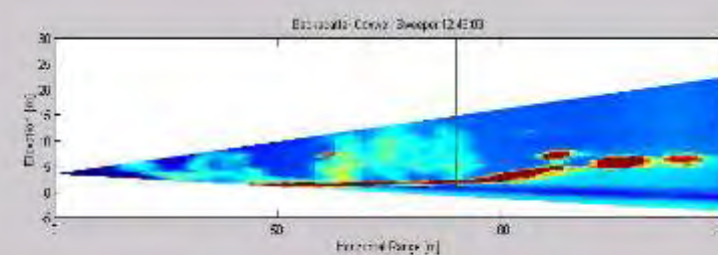
3



Car Travels North in East Curb Lane
11:46:38

All passing vehicles propel this material into the air. This will occur thousands of times with any City's traffic volume. This hazardous Fine Particulate material remains suspended in the air for hours, being inhaled by citizens, cyclists, vehicle cab air intakes, or wind-strewn

4



Wind Effects on Loosened Fine Dust
12:46:03

Disturbed material can be readily churned into the air by wind alone and vehicular traffic contributing to poor air quality and hazardous particulate being inhaled by citizens resulting in adverse health effects.

Sweeping occurs on all paved surfaces, especially HIGH USE industrial, commercial, and public residential spaces.

If debris is left behind by a Sweeper, it will be propelled into the air by passing Vehicles and Equipment or washed by rain into the storm sewer system.

This causes pollutant materials to contaminate local air, stormwater run off, local receiving water bodies and jeopardize human health.





Partners With



PM10 & PM2.5 Street Sweeper Efficiency Test Protocol

First Test - July 23-26, 2004

Second Test - September 26-29, 2005



Operational On Street Test Protocol October 18-21, 2005



	2007 Total Tonnage (Regen. Air Sweepers)	2006 Total Tonnage (Mechanical Sweepers)	2005 Total Tonnage (Mechanical Sweepers)
TOTAL TONNES	3702.28	2083.1	1893.54
TOTAL WILSON CHARGES	\$179,243.76	\$138,757.86	\$73,966.62
TOTAL REPUBLIC CHARGES	\$77,007.42	\$43,222.72	\$37,189.13
TOTALS	\$256,251.18	\$181,980.58	\$111,155.75
COST PER TONNE	\$69.21	\$87.36	\$58.70

YEAR	EQUIPMENT	TOTAL TONNAGES
2005	Mechanical	1893
2006	Mechanical	2083
2007	Regenerative Air	3702
2008	Regenerative Air	4231

- **City of Toronto** actual yard Street Waste Removal Tonnages

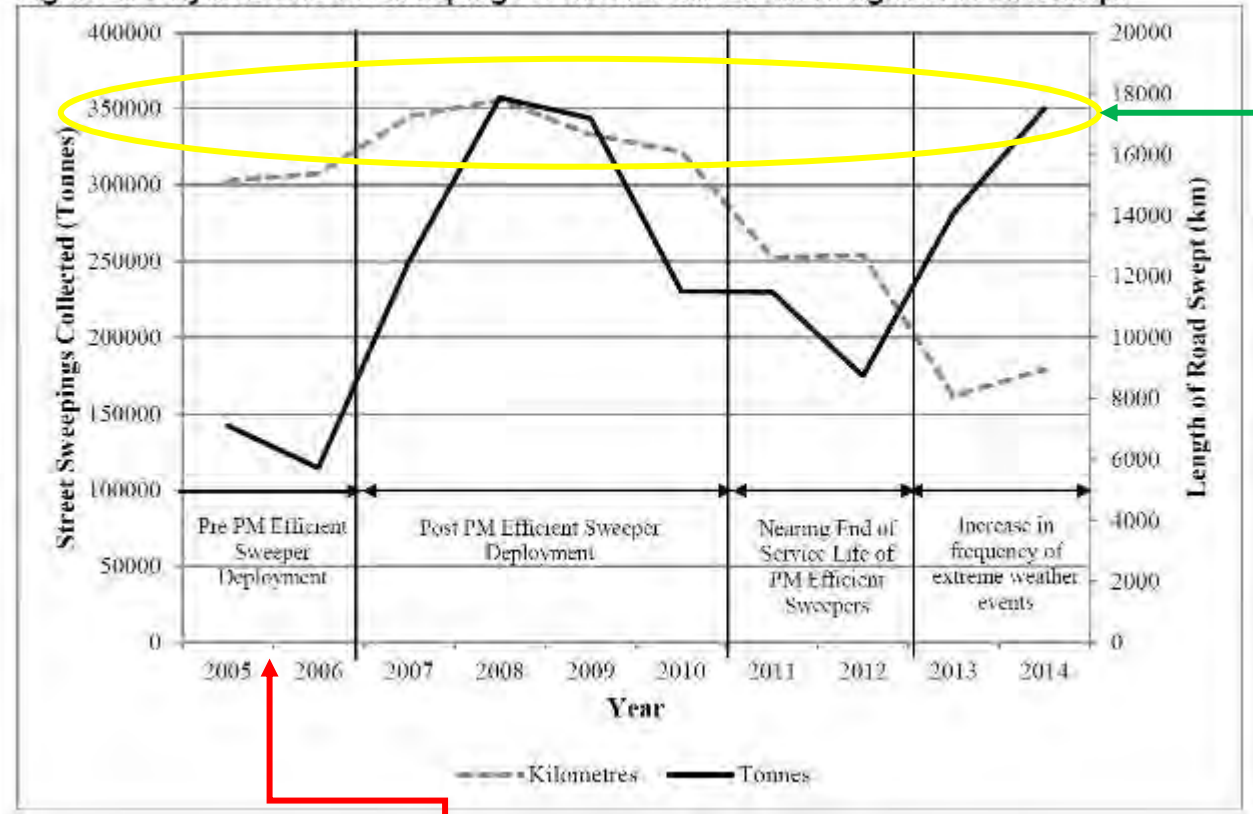
- Six Tymco Regenerative air Sweepers picked up **3702** tonnes of material from street surface in **Scarborough District, City of Toronto.**

- Observing 10% decrease in pickup removal efficiency, six competitive units would be leaving **370** tonnes of material on street per year. (**61.6** tonnes of material per unit)

- A Fleet of 50 units would mean **2960** tonnes left per year (**equivalent of 197 dump trucks**)

Toronto Staff Report Oct 21, 2015 – PW9.13

Figure 1: Citywide Street Sweepings Collected and Total Length of Road Swept



Documented Operational and Environmental Enhancements

TYMCO DST 2-3x Street Debris Collected while reducing operating costs by 50%.

Table 2: Sweeper Units Annual Operating Cost IN \$CAD

Item	Units	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Number of Units	#	22	37	39	64	55	56	54	52	50	50
Total	\$	1,958,807	1,899,189	2,509,973	3,012,223	2,610,720	2,672,415	2,448,001	2,455,984	2,287,996	2,220,980
Cost per Sweeper Unit	\$	89,037	51,329	64,358	47,066	47,468	47,722	45,333	47,230	45,760	44,420

REDUCTION OF OPERATING COSTS BY 50%

Transportation Association of Canada – Environmental Achievement Award

- In 2017, Toronto won the Environmental Achievement Award from the Transportation Association of Canada for its research and deployment of the highest rated independently verified sweeper technology.
- In their award acceptance, Toronto states that their fleet of independently verified high efficiency DST6 and DST4 street sweepers achieved a 27% improvement in ambient air quality of the City and USD\$130,000,000-USD\$217,000,000 of annual social benefit from reduced incidents of hospitalization and death from acute exposure to hazardous fine particulate material.
- As of today, this **Annual Social Benefit** would be **USD\$222,615,000-USD\$371,025,000.**



Social Benefit Award for High Efficiency Environmental Sweeper Fleet

- Toronto utilized the United States Department of Transportation’s Benefit-Cost Analysis Guidance which have developed “Benefit Per Ton (BPT)” estimates to calculate the social and environmental benefits (in \$USD) from each ton of removed/reduced emission type.
- These figures are scientifically quantified factoring hospitalizations, lost workdays, deaths, and other social impacts from emissions.
- Primary PM_{2.5} emissions reductions produce the largest social benefits of all emitted pollutants due to direct reductions in ambient PM_{2.5} concentrations and associated risks –
Government of Canada

Benefit-Cost Analysis Guidance for Discretionary Grant Programs



*Table A-6: Damage Costs for Emissions per Metric Ton**

Recommended Monetized Value(s)				
Emission Type	NO _x	SO _x	PM _{2.5} * *	CO ₂
2022	\$16,600	\$44,300	\$796,700	\$56
2023	\$16,800	\$45,100	\$810,500	\$57
2024	\$17,000	\$46,000	\$824,500	\$58
2025	\$17,200	\$46,900	\$838,800	\$59
2026	\$17,500	\$47,800	\$852,100	\$60
2027	\$17,900	\$48,700	\$865,600	\$61
2028	\$18,200	\$49,500	\$879,400	\$62
2029	\$18,600	\$50,400	\$893,400	\$63
2030	\$18,900	\$51,300	\$907,600	\$65

Health Canada - Social Benefit Metrics



December 2021

HEALTH BENEFITS PER TONNE OF AIR POLLUTANT EMISSIONS REDUCTION

Region-, Sector-, and Pollutant-Specific Estimates for Two Canadian Regions

Table 4. BPT estimates for southwestern British Columbia (SWBC) and the Windsor–Quebec City corridor (WQCC) by source sector and emitted pollutant.

Emitted pollutant ^{a,b}	Source sector	BPT (\$/tonne) ^{c,d}	
		SWBC	WQCC
Primary PM _{2.5}	On-road mobile	410,000	520,000
	Off-road mobile	470,000	480,000
	Manufacturing + Ore and mineral industries	340,000	380,000
NO _x	On-road mobile	-140 ^e	15,000
	Off-road mobile	-2,700 ^e	12,000
	Manufacturing + Ore and mineral industries	-3,900 ^e	4,900
VOC	On-road mobile	13,000	3,900
	Off-road mobile	9,900	5,100
	Manufacturing + Ore and mineral industries	3,900	2,300
NH ₃	On-road mobile	100,000	130,000
	Agriculture ^f	46,000	26,000
SO _x	Manufacturing + Ore and mineral industries	— ^g	10,000

Traffic Related Air Pollution

Slide taken from February 28 2024 presentation for
Clean Air Hamilton

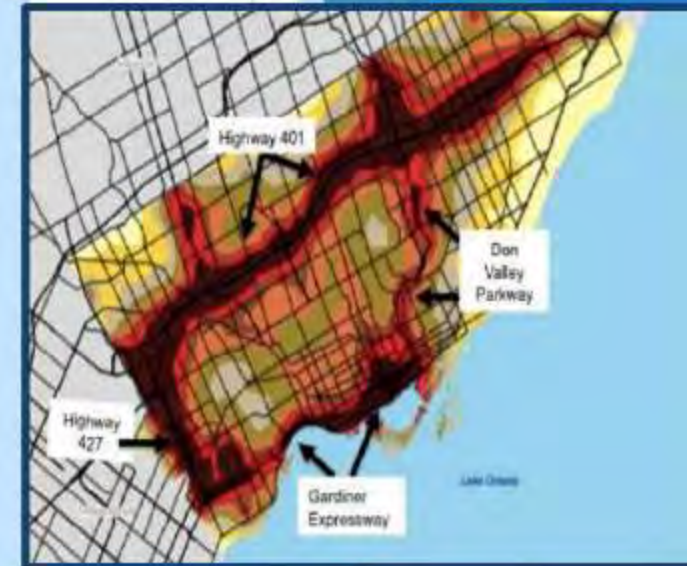
Health Risk Factor - Transportation Sector Traffic Related Air Pollution (TRAP)

Air Pollution:

- ❑ 15,300 deaths/year - \$120 Billion/year

TRAP: 100-500 meters

- ❑ 1200 deaths/year - \$9.5 Billion/year
- ❑ Increases risk of asthma in children, CVD, lung cancer & premature deaths
- ❑ Likely to cause childhood leukemia & lung cancer in adults; may cause breast cancer
- ❑ Neighbourhoods with higher levels of material deprivation - more likely to be near highways

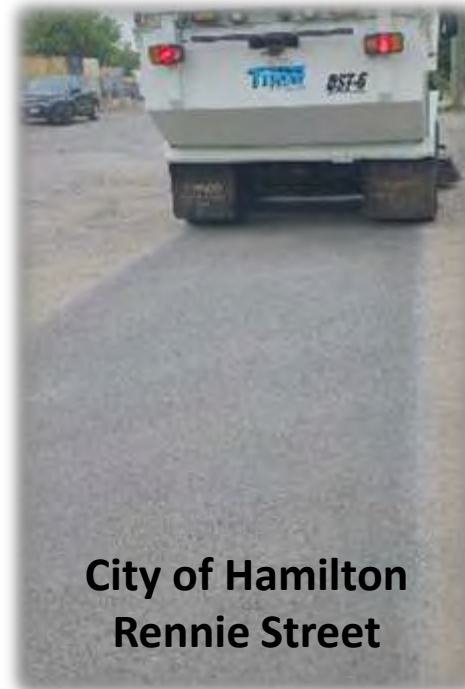


What do we Sweep?

- [Emissions Analytics](#) in the United Kingdom found that 1,850x more Particulate Mass Pollution comes from Vehicle Tires than Tailpipes
- Brake and Tire wear contributes 2-3 times more than exhaust emissions to PM_{10} concentrations. [Brake and Tire wear contributes as much or more](#) than tailpipe exhaust emissions to $PM_{2.5}$ concentrations.
- Research from Switzerland suggests that [30-40% of all microplastic pollution](#) in water originates from Vehicle Tire Wear.
- [Washington State Department of Ecology](#) found that tire chemicals were the source of local aquatic wildlife die offs.
- The first comprehensive regional study in San Francisco of microparticle and microplastic pollution showed that nearly [50% of microplastic fibers](#) that entered San Francisco Bay were Tire Wear



City of Toronto



City of Hamilton
Rennie Street



Air vs Broom
Removal

Why do we Sweep?

High Efficiency Sweeping is the most cost-effective Method of Transportation Pollution Mitigation



- $PM_{2.5}$ ($<2.5\mu m$) is an ultra small dust particle capable of travelling through the lungs into the blood stream. These small particles can pass through the Blood Brain Barrier, exposing the brain and other organs to toxic chemicals including *microplastics and heavy metals*.
- Traffic related Non-exhaust particle emissions generated by the **wear of brakes, tires, and the road surface**, together with the resuspension of road dust, are unregulated and exceed exhaust emissions in many jurisdictions
- Research have found that On- and Near-road environments routinely exceed recommended safe levels of air contamination.
- Street Sweeping appears to provide the most benefit for collection of small particles and prevention of re-entrainment in local air/water.
- Environmental Technology Verification allows users to identify Verified Sweeping Technology that will collect all sized debris, including $PM_{2.5}$.

Key Takeaways



ETV /
ISO14034
GLOBE PERFORMANCE SOLUTIONS



- **High-efficiency regenerative air sweeping is the most cost-effective method** of mitigating traffic-related particulate pollution for both air and water quality
- **Non-exhaust emissions** (tires, brakes, road dust resuspension) are the dominant and growing source of roadside PM — and they are **currently unregulated**
- Real-world deployments in **Toronto and Hamilton** delivered measurable, peer-reviewed improvements in air quality with enormous social and economic returns
- **Environmental Technology Verification (ETV) under ISO 14034** provides independent confirmation of sweeper manufacturer performance claims
- **ISO14034:ETV verification** is essential — not all sweepers are equal; inefficient sweepers may actually **worsen** air contamination.
- TYMCO DST-6 holds the highest verified surface removal efficiency, filters exhausted air to 95% of particles <0.3 microns, and is capable of dry surface debris removal for maximum surface removal and containment
- Testing by Pacific Water Resources showed regenerative air sweepers outperform all other types; notably, **water spray for dust suppression reduced pickup by 10.5% and increased remaining fine particles by 121–153%**

High Efficiency Environmental Sweeping



Thank you

Appendices

- Following slides are included as additional supporting information underscoring importance of high efficiency sweeping.

What's the Big Deal about Sweeping?

- Historically, sweeping was done for aesthetic purposes, to pick up litter and trash. After decades of significant scientific analyses, high-efficiency sweeping is a fundamental environmental contamination abatement method.
- The US EPA designates PM₁₀ and PM_{2.5} as a hazardous pollutant causing severe environmental and human health consequences. ([Particulate Matter \(PM\) Pollution | US EPA](#)). High-efficiency sweepers directly mitigate PM pollution in Municipal, Construction, industrial and public service applications generated from personal and commercial road transportation.
- Between 2003-2008, City of Toronto's Clean Roads to Clean Air initiative in collaboration with Toronto Public Health, Environment Canada, and others determined that Fine Particulate contamination from Road Transportation is the largest source of Air Contamination within the City. It found through scientific methods that high-efficiency Street Sweepers can directly mitigate this Air contamination, while inefficient sweepers exacerbate it.

What's the Big Deal about Sweeping?

- Fine Particulate Pollution (PM_{10} and $PM_{2.5}$) in areas near Commercial or Personal vehicle or equipment activity at Nose Level routinely exceeds Ministry of Environment maximum exposure thresholds.
- Due to this reality, many Scientific Industrial and Municipal Air quality tests have been performed since 2000.
- It has since been scientifically confirmed through LIDAR testing, air quality monitoring and Environmental Technology Verification (ETV) protocol tests that the negative impact from these emissions can be significantly reduced directly and consistently by high efficiency Street Sweeper Technology.
- ISO14034: ETV - Environmental Technology Verification of Street Sweeper Technology. Independent verification of Manufacturer Performance claims.
- It was hypothesized that the removal of fine road dust from Toronto's streets would improve air quality by at least 25-30%.
- In 2014, this was confirmed during Toronto's Ambient Air Quality study wherein it was concluded that the ETV verified dustless regenerative air sweepers reduced airborne fine particulate matter, at street level, by at least 27%

City of Hamilton Air Quality Study - McMaster

Table 2

Summary statistics for PM₁₀ (µg/m³) as measured from mobile monitor, before and after workshop.

	Minimum	Maximum	Average	Standard deviation
Pre-workshop	0	2000	114	224
Pre-workshop (minus Strathearne Avenue)	0	2000	103	200
Post-workshop	1	800	73	75
Post-workshop (minus Strathearne Avenue)	1	800	70	72

“...Contributing to the above, the City Public Works Department replaced entire complement of older street sweepers with a fleet of new regenerative air sweepers chosen because of their proven ability to control and remove PM10 and PM2.5 contained in road dust. This followed participation in extensive research and testing undertaken in City of Toronto where they created a testing protocol to test any street sweeper’s efficiency in removing PM 10. ETV Canada was contracted to verify results of the protocol and these sweepers scored the highest at 90% efficiency. This protocol subsequently has had a considerable influence on the technology of street sweeper design in North America...”

What's the big deal about PM?

Air Quality

- In 2018, after over a decade of running these highest rated machines, Hamilton Public Health established an inclusion to its Streets By-Law 86-77 to include Street Sweeping Enhancements citing Environmentally Verified Technology with the ability to collect and contain, by filtration, particles as small as 0.3-microns in size as well as operational guidance of these assets to reduce hazardous airborne particulates in the City of Hamilton



Storm Water Testing – Cambridge, Massachusetts

Table 14. Source Loading and Management Model (SLAMM) estimated percent reductions of total and particulate solids and phosphorus using single passes by three different street-cleaning technologies at various frequencies in a predominantly commercial subcatchment, Cambridge, Massachusetts.

Constituent	Mechanical brush street-cleaning percent reduction	Vacuum-assist street-cleaning percent reduction	Regenerative-air street-cleaning percent reduction
Monthly street cleaning			
Total solids	2.7	5.2	16
Total particulate solids	4.2	8.2	27
Total phosphorus	1.4	2.7	8.0
Total particulate phosphorus	2.0	4.0	12
Bimonthly street cleaning			
Total solids	3.3	7.0	18
Total particulate solids	5.1	11	30
Total phosphorus	1.7	3.7	8.3
Total particulate phosphorus	2.5	5.4	12
Weekly street cleaning			
Total solids	4.2	9.6	18
Total particulate solids	6.6	15	31
Total phosphorus	2.1	5.0	8.7
Total particulate phosphorus	3.1	7.5	13
Street cleaning three times per week			
Total solids	6.0	14	19
Total particulate solids	9.5	24	32
Total phosphorus	3.0	7.4	9.3
Total particulate phosphorus	4.5	11	14



Estimated total P reductions for monthly use of mechanical brush and vacuum assisted street cleaners were about 1 and 3 percent, respectively, and 8 percent for the regenerative air machine. An operational frequency of three times per week increased potential reductions of total solids for mechanical brush, vacuum assist and regenerative air street cleaners to about 6, 14 and 19 percent respectively. Simulated percent reductions of total P were about 3, 7 and 9, respectively, when streets were cleaned 3 times per week.

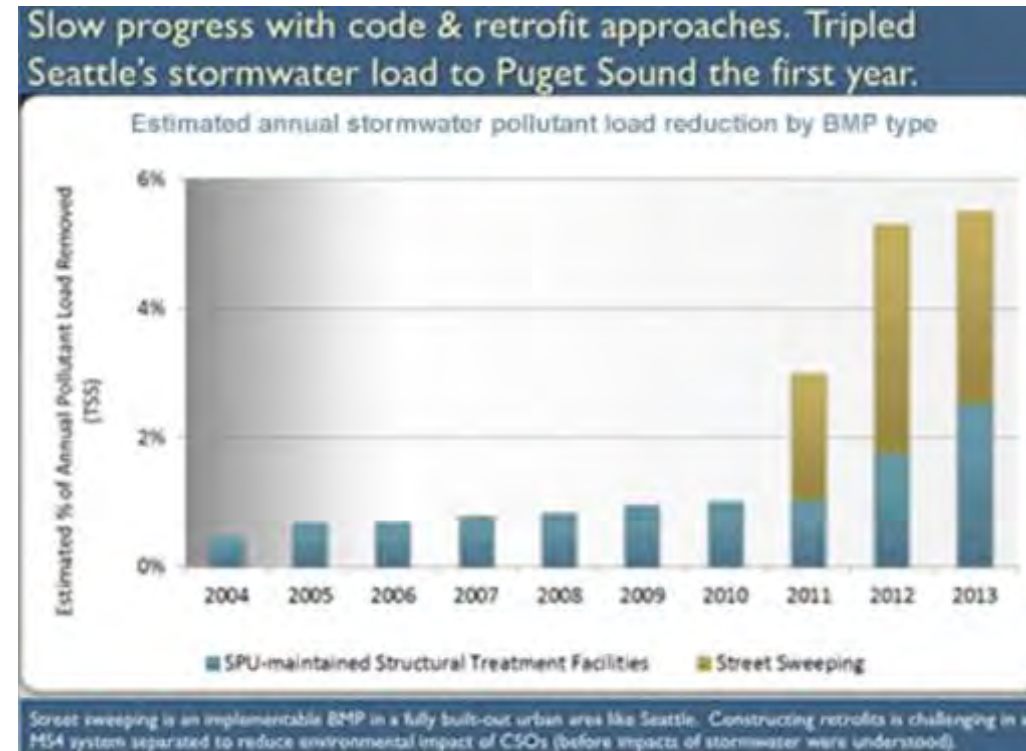
Not only is there a proven correlation between effective street sweeping to remove and contain fine particulate from the roadways and a reduction in particulate matter in the air but also a reduction in storm water contaminants. Not only does this improve storm water run-off which ultimately ends up in our lakes but also decreases catch basin loading which has a considerable expense to remove, contain and dispose of (re-classified as hazardous waste when it enters the sewer).

City of Seattle Stormwater Quality Testing

“In 2011, the first year of enacting the sweeping program as an adjunct to existing end-of-the-pipe solutions, the amount of Seattle's stormwater pollutants entering Puget Sound was reduced by a whopping two-thirds”

“... their team realizes it is significantly less expensive to remove pollutants from arterials via street cleaning than by any other method”

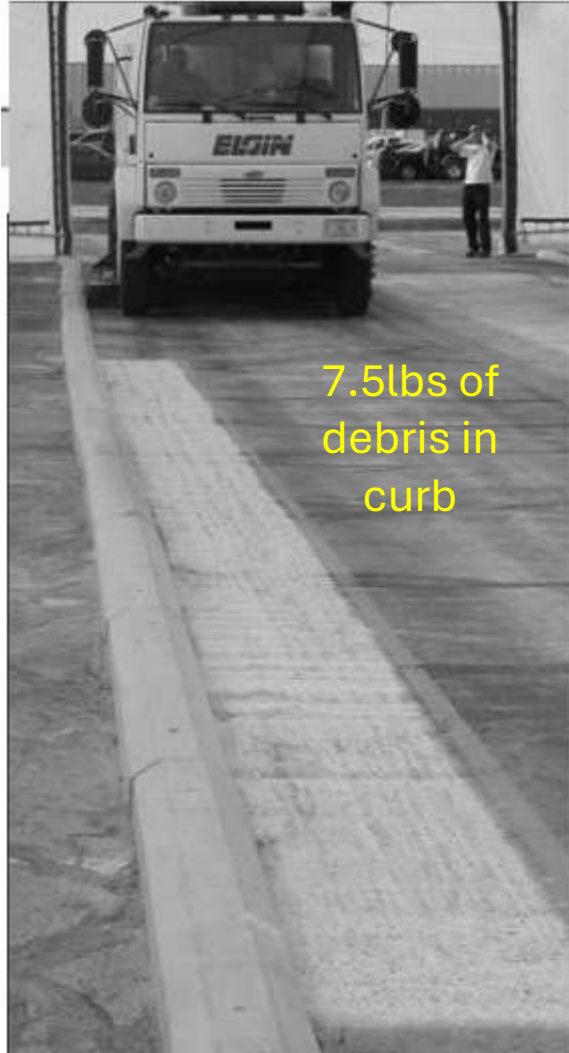
"We have been able to show definitively that street sweeping is one of the most cost-effective measures we can use to protect our waterways from street runoff," Basketfield said. The city has developed data that show street sweeping costs 4-to-10 times less than treating polluted water with conventional stormwater treatment.



[City of Seattle Doubling its Sweeping Program to Address Stormwater Pollution \(worldsweeper.com\)](http://worldsweeper.com)

REAL WORLD STREET CLEANER PICKUP PERFORMANCE TESTING

Roger C. Sutherland, PE, Pacific Water Resources, Inc., Beaverton, OR



According to PWR's test results, Elgin Sweeper's prototype Crosswind NX (a high-performance filter regeneration sweeper with dust control) performed the best, the standard regenerative Crosswind came second; the Vacuum broom assist Whirlwind MV was third; and the mechanical Waterless Eagle FW was fourth.

"The Fifth-place finisher was the mechanical Eagle (FW) operating with a water spray... This was also expected since researchers have known for some time that the use of water spray to control fugitive dust reduces a machine's ability to pickup particulate matter. **In fact, the Eagle test that used water spray for dust control was some 10.5% lower than the measured pickup of the Eagle without water**". **"The use of water resulted in a 121% increase in the remaining mass for particles 250 to 1000 microns and a 153% increase in remaining material for particles less than 250 microns."**

"The latter test supports the theory held by this author, as well as other industry watchers, that use of water for dust suppression creates a 'PM10-slurry' that inhibits pickup of the smaller particles, those targeted both under the USEPA Clean Air Act and Clean Water Act."

Microplastics Research – Published Dec 1 2025 Germany

communications earth & environment

Article

A Nature Portfolio journal



<https://doi.org/10.1038/s43247-025-02980-0>

Composition, interactions and resulting inhalation risk of micro- and nano-plastics in urban air

Check for updates

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Airborne micro- and nano-plastics represent an underestimated threat to urban environments and human health. We characterized their concentrations and polymer composition in size-fractionated particulate matter collected in Leipzig, Germany, using pyrolysis gas chromatography mass spectrometry. Total concentrations of plastic particles $<10 \mu\text{m}$ averaged $0.6 \pm 0.2 \mu\text{g}/\text{m}^3$, with fine and coarse fractions contributing equally. Tire wear particles dominated, accounting for about 65% total plastics, followed by polyvinyl chloride, polyethylene, and polyethylene terephthalate. These polymers correlated strongly with carbonaceous aerosol markers, indicating co-emission and atmospheric mixing. Exposure and risk assessment suggest that inhalation of approximately $2.1 \mu\text{g}$ of these airborne plastic particles per day may increase cardiopulmonary mortality by 9% and lung cancer mortality by 13% in humans. By integrating exposure, risk assessment, and analytical data, these findings highlight the need for global policy action, emphasizing the value of region-specific research for air quality and public health initiatives.

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Sources of Traffic PM Study

'Only a third' of traffic pollution caused by exhaust

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Study suggests majority of particulate matter PM10 emissions comes from sources such as brake and road surface wear

Vehicle exhausts are responsible for only a third of traffic pollution, according to research led by the University of Hertfordshire.

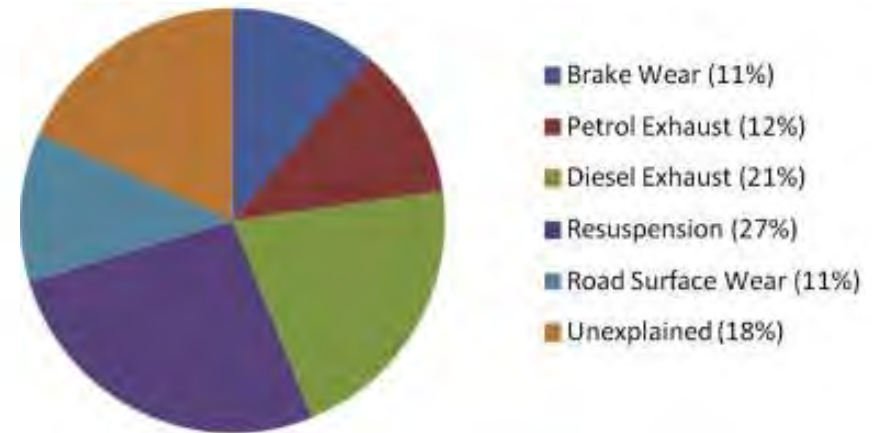
The study, published in the journal *Atmospheric Environment*, says nearly half of the air pollution from road traffic is down to non-exhaust sources such as brake-wear, road surface-wear, and particles launched into the air from the road by passing vehicles.

As a result, Professor Ranjeet Sokhi of the University of Hertfordshire, who led the study, is calling for greater control of non-exhaust pollution.

He said: "In terms of mass, non-exhaust sources can be more important than exhaust fumes, but legislative control has focussed on exhaust emissions."



The sampling equipment used to measure PM10 emissions in the Hatfield Tunnel, Hertfordshire (photo: Samantha Lawrence)



This traffic pollution test was conducted in the Hatfield test in England. Through this testing, it was determined that vehicle exhaust only account for a third of traffic pollution and more alarming and less focused on is non-exhaust sources such as brake wear, tire wear and particles launched into the air by passing vehicles. This material was already being focused on in the joint testing with the City of Toronto and City of Hamilton several years earlier. In Toronto's Clean Roads to Clean Air Program, a street sweeper's ability to effectively pickup and contain hazardous fine particulate while controlling fugitive dust emissions in the process contributes to improving a City's air quality by targeting this material.