Zephyr Environmental

Novel techniques for evaluating wind erosion potential over surfaces

Field wind tunnel, Confined Air Burst Chamber and AP-42 sieving

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Overview

01 Site-specific wind erosion data

02 Method 1: Portable wind tunnel testing

03 Method 2: Confined Air Burst Chamber

04 Method 3: AP-42 Tyler sieves

05 Operational dust control

Generic emission factors

- US EPA AP-42 factors date from the late 1970s and early 1980s
- They reflect different geology, equipment scale and operating practice
- Constrained sites need site-specific data to rank sources and target controls

Method comparison

Technique	Scale	What it measures	Best used for
Open-floor field wind tunnel	Full-scale, in situ	Wind erosion potential; threshold friction velocity (u^*_t)	Material-specific thresholds and control efficiencies
Confined Air Burst Chamber (CABC)	Portable, small-footprint	Relative PM_{10} emission potential	Rapid multi-surface screening and suppressant durability tracking
US EPA AP-42 nested sieving	Bulk sample, in situ or laboratory	Grain-size-based threshold estimate	Quick estimate, conservative

Open-floor field wind tunnel

- 280 mm square test section, 3.6 m long, open floor
- Four fans drive flow to 16 m/s
- PM_{10} by photometer, velocity by digital manometer
- 15-point velocity profile gives z_0 and u^*_t

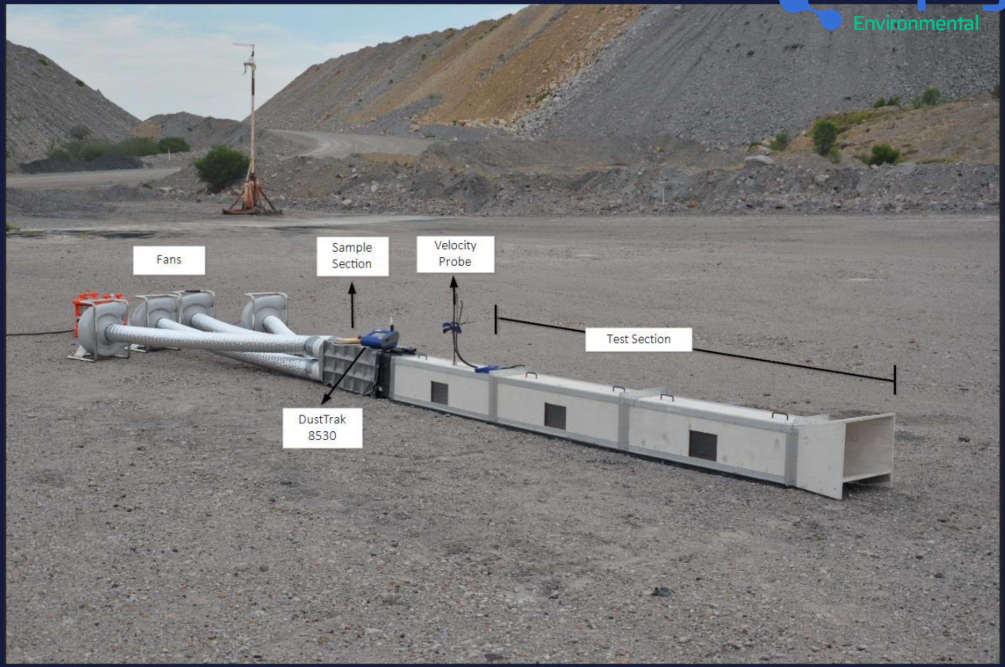
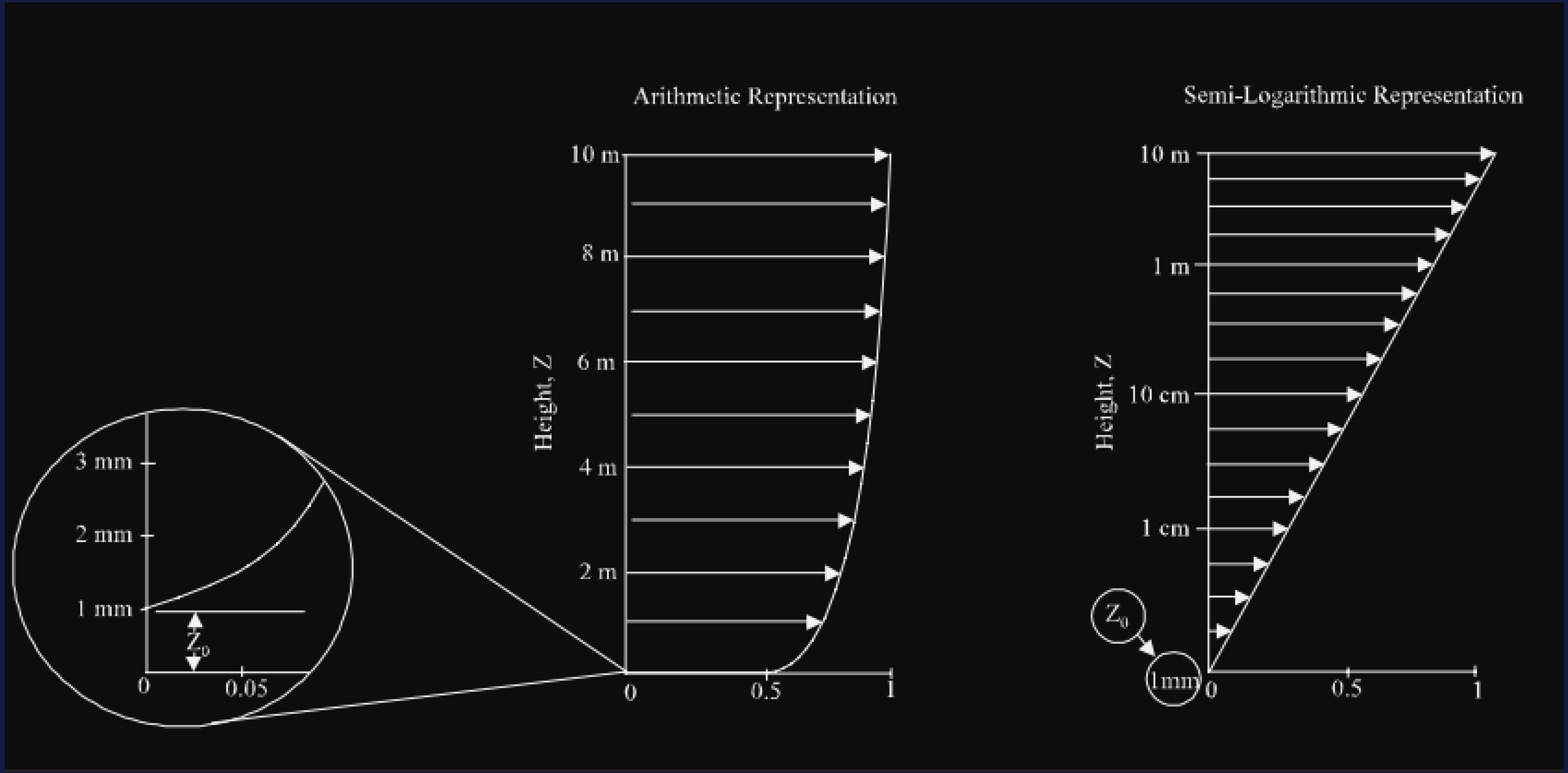


Figure: open-floor wind tunnel set up over a mine surface

Boundary layer parameters

- Surface roughness (z_0): the height at which wind speed falls to zero
- Friction velocity (u^*): wind shear stress, from the slope of the log velocity profile
- Threshold friction velocity (u^*_t): the lowest u^* at which particles lift



Wind tunnel results

Two overburden emplacements, weathered and freshly raked

Tested surface regime	z_0 (mm)	u^* (m/s)	u^*_t (m/s)
Overburden 1 – weathered	1.7	0.89	0.58
Overburden 1 – disturbed	2.8	0.74	0.49
Overburden 2 – weathered	0.6	0.52	0.40
Overburden 2 – disturbed	1.7	0.69	0.39

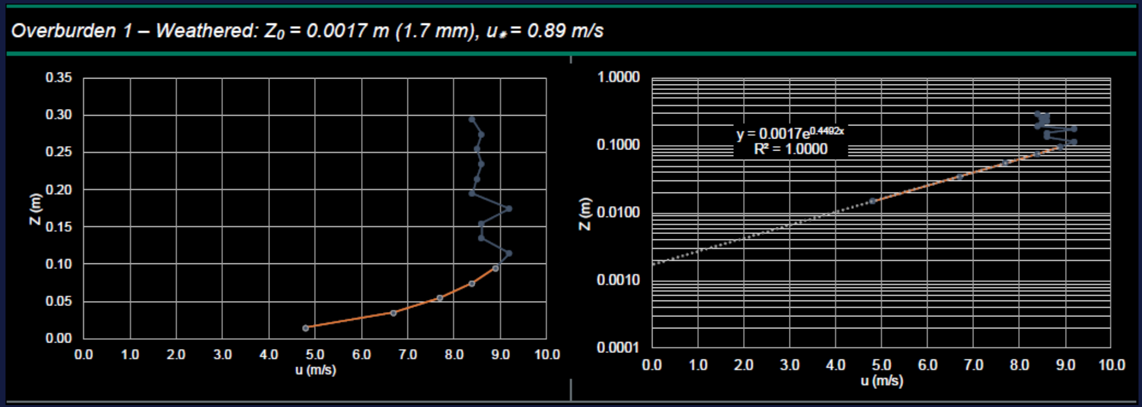
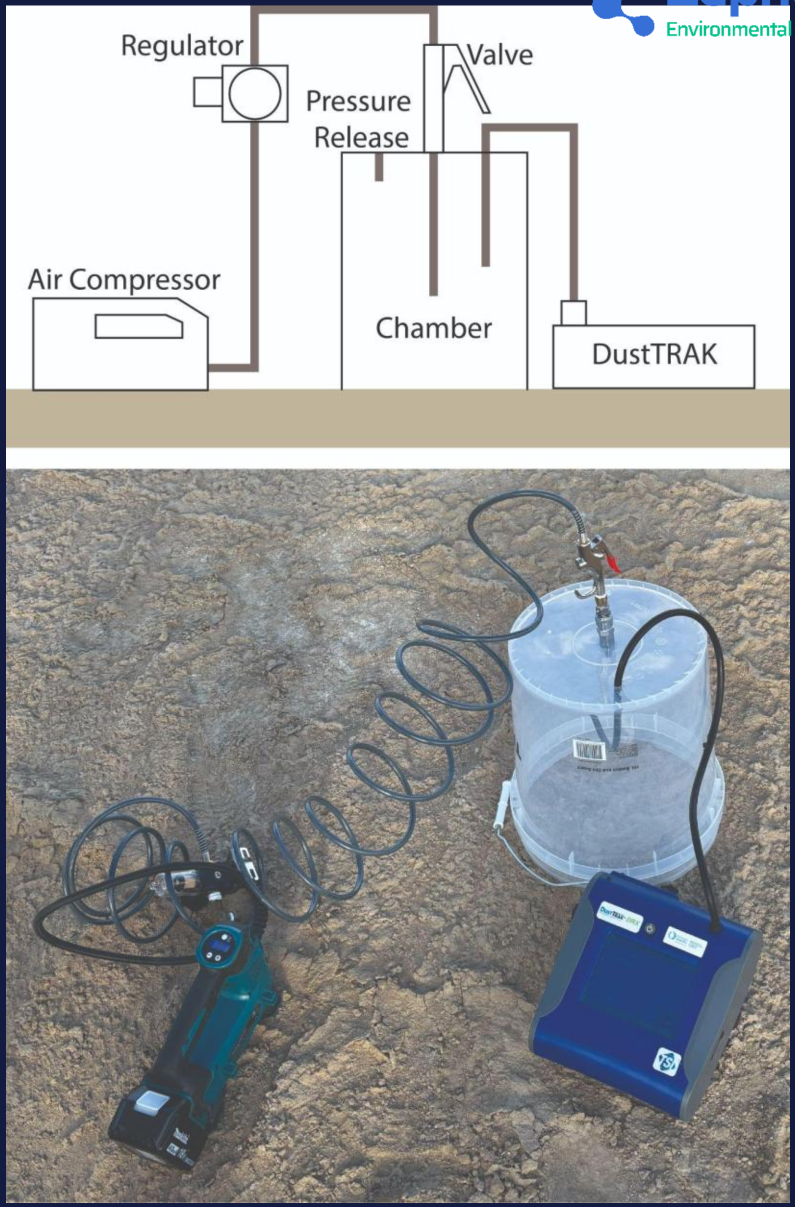


Figure: log-linear derivation of surface roughness, Overburden 1 – Weathered

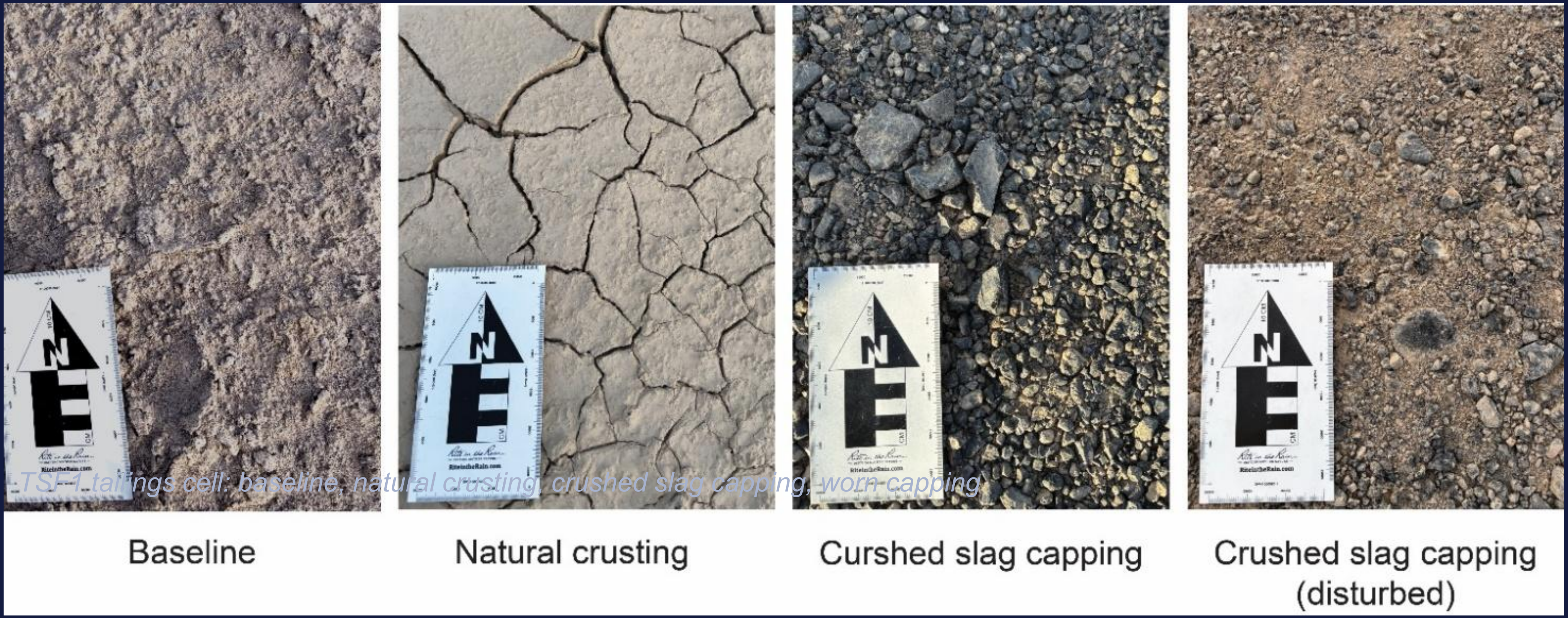
Raking lowered u^*_t on every surface tested.

Confined Air Burst Chamber (CABC)

- 9.4 L open-floored chamber sits over the test surface
- 50 psi air burst; laser photometer logs peak PM_{10}
- Relative and semi-quantitative, against an untreated baseline
- Many surfaces and treatments in a single site visit



TSF Surface treatment evaluation



TSF1 tailings cell: baseline, natural crusting, crushed slag capping, worn capping

Tailings cell surface treatment evaluation

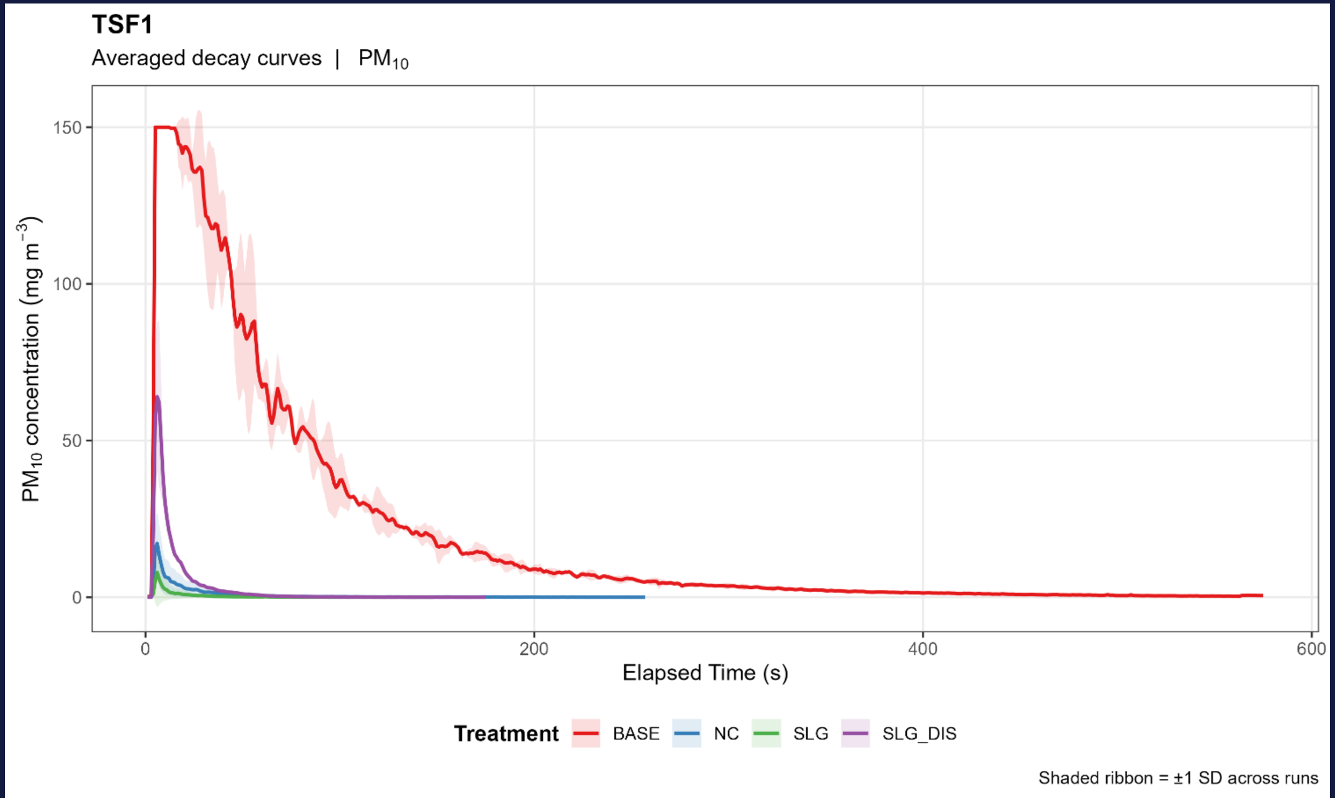


Figure: average PM_{10} concentration profiles at the TSF1 tailings cell

Surface condition	Control measure	Efficiency
Uncontrolled / disturbed	None	0%
Naturally crusted	Natural crusting	**88%**
Worn / disturbed capping	Crushed slag capping	66%
Intact capping	Crushed slag capping	**94%**

Wind tunnel and CABC comparison

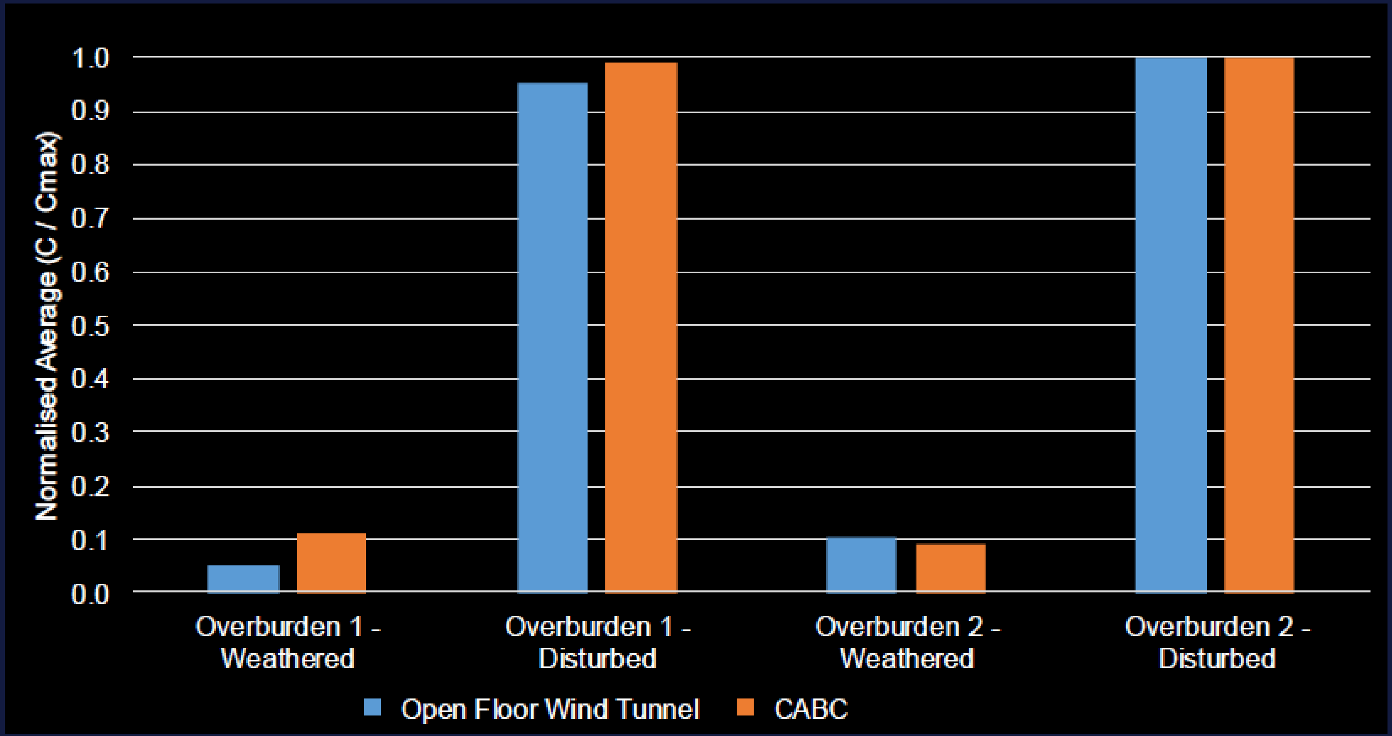


Figure: normalised (relative) emissivity – open-floor wind tunnel vs CABC

- Both methods rank the four surfaces the same way
- Natural crusting cut emissivity roughly tenfold
- CABC works as a portable proxy for the full-scale tunnel

US EPA AP-42 nested sieving method

- Bulk sample passed through five nested Tyler sieves
- The sieve holding the greatest mass fraction sets the sieve mode
- Sieve mode converts to u^*_t and a lift-off wind speed
- Fast, but overstates thresholds against field testing (i.e. is conservative)

Tyler Sieve No.	Opening (mm)	Midpoint (mm)	u^*_t (cm/s)
5	4		
9	2	3	100
16	1	1.5	76
32	0.5	0.75	58
60	0.25	0.375	43

Test results to trigger systems

- Survey results set the TARP triggers
- 10 m wind speed drives the ring-main sprinklers
- Polymer crusting agent held 98.9% CE five months after application
- Verified CEs guide dosing when water supply is short

Thank you

Questions and discussion welcome