

Research implications for future sustainable building drainage systems



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BUILDING AUSTRALIA'S FUTURE 2013



Two key areas of drainline research –

1. Waste media research –

Influence of waste media on WC drainline performance

2. Drainline profile experimental research –

Influence of drainline profiles on WCs drainline performance

1. Waste media research - Waste combinations in domestic installations



ASFlow Investigation drainline blockages in WA

Toilet paper by experience is a significant factor in drainline and fixture blockages in the field

Waste combinations – commercial installations



Blockages in commercial installations predominantly occur in women's toilets

Waste combination – toilet paper



In all WC blockage cases, toilet paper has been identified as a key factor

Drainline research – solids test media



Aus/DIN media



**Modified MaP media US
(latex)**



**MaP media US
(uncased)**

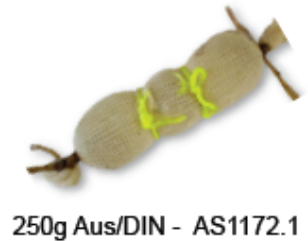
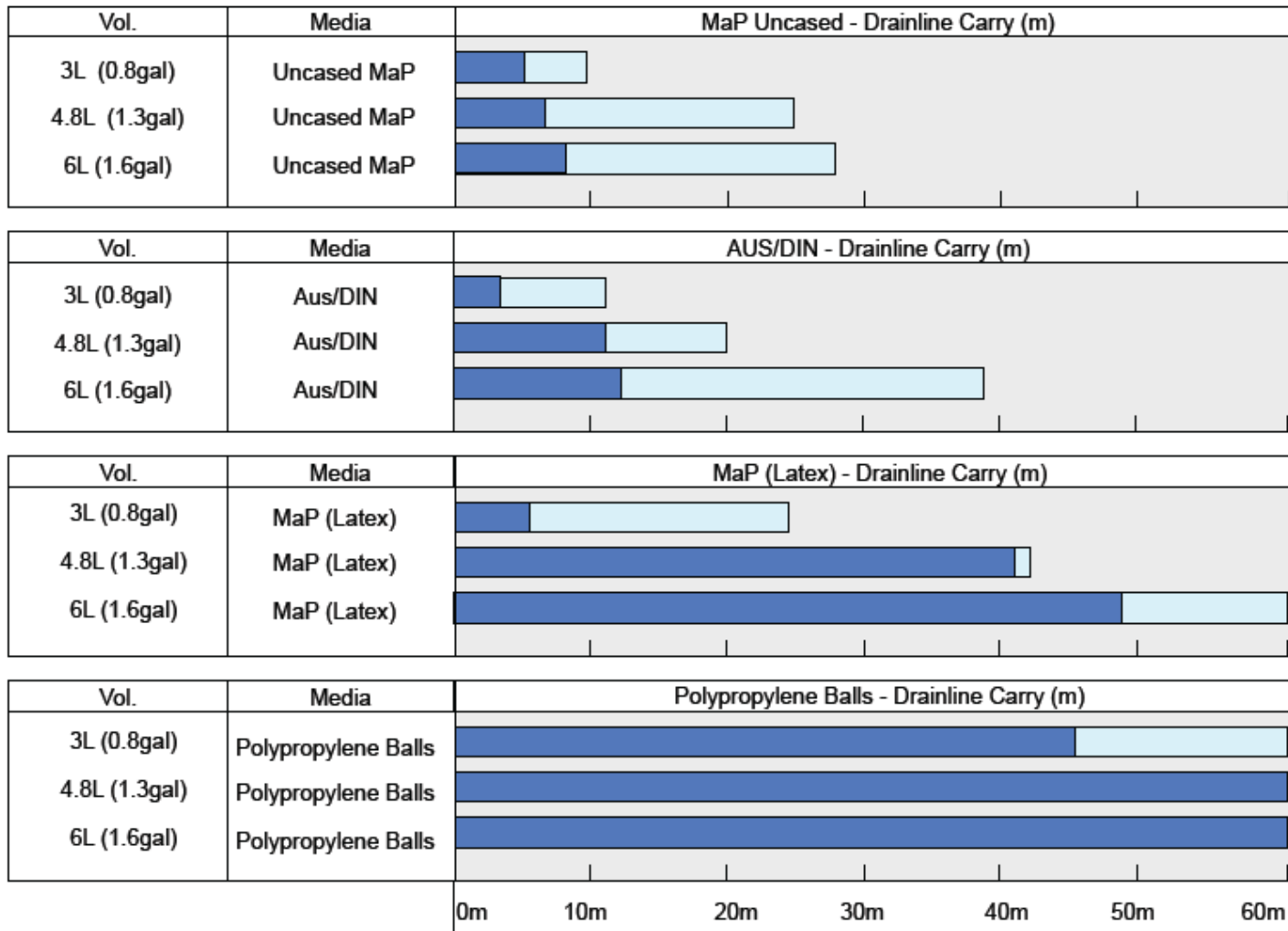


**ASME US
Polypropylene balls**

Internationally researchers have focused on solids test media to evaluate drainline transportation

Varying types of solid test media used in standards test

Drainline research – Performance variation between types of solid test media



Results show significant difference in drainline transportation between types of test media

Toilet paper research study – impact on drainline transportation



Typically women's use of WCs consume more toilet paper than male toilets - urination

Preferred methods and positions during female urination in public restrooms

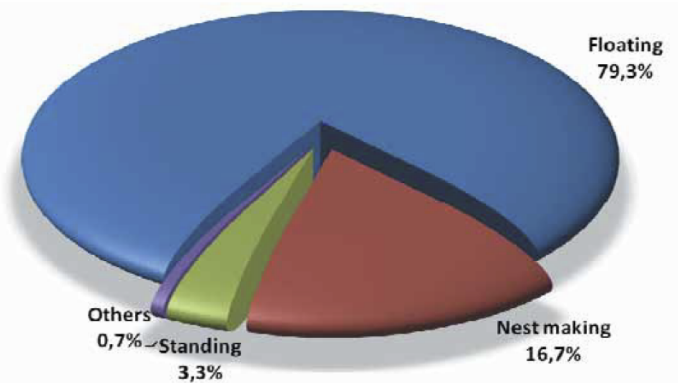
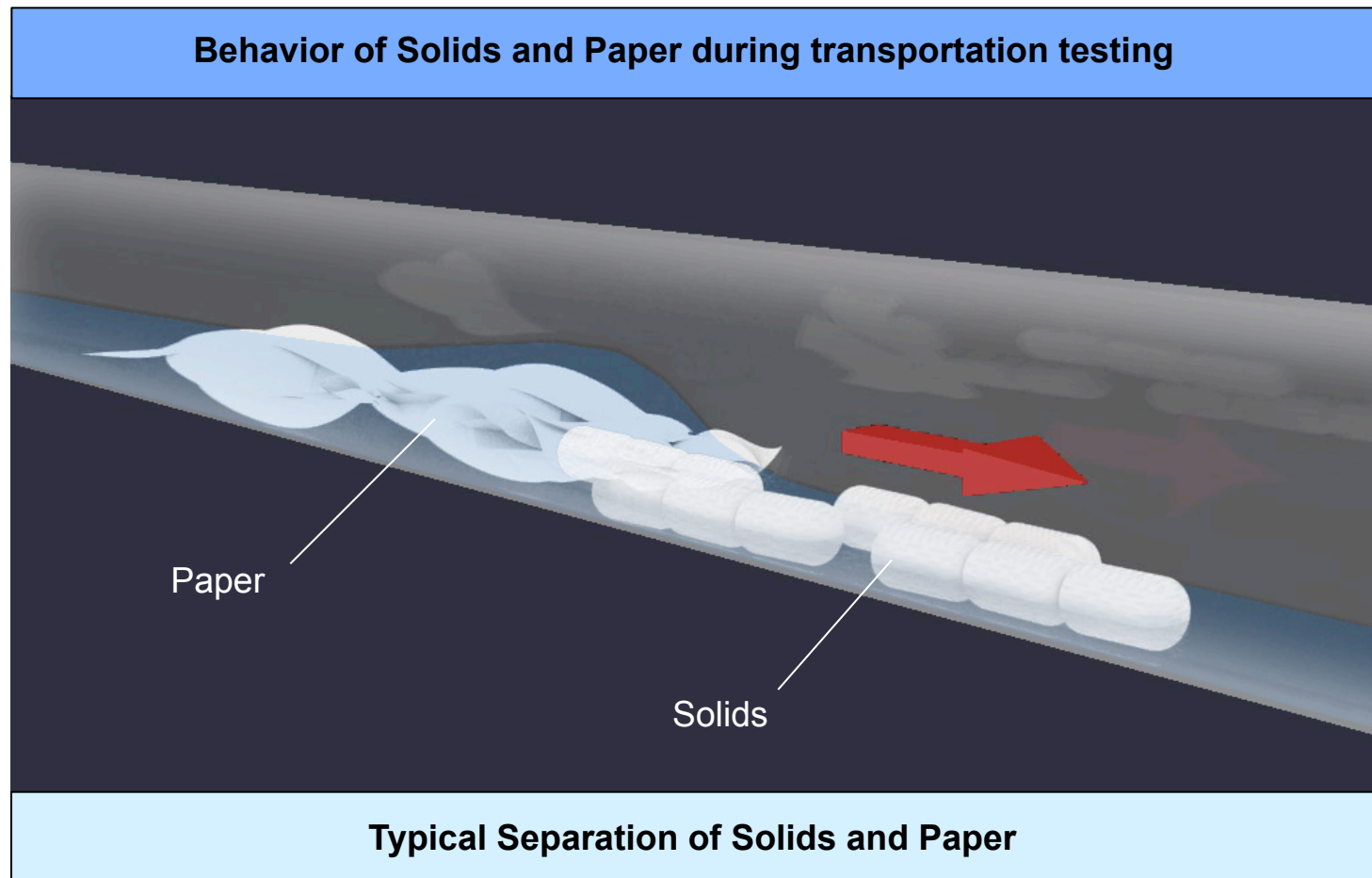


Figure 2 – Preferred methods and positions

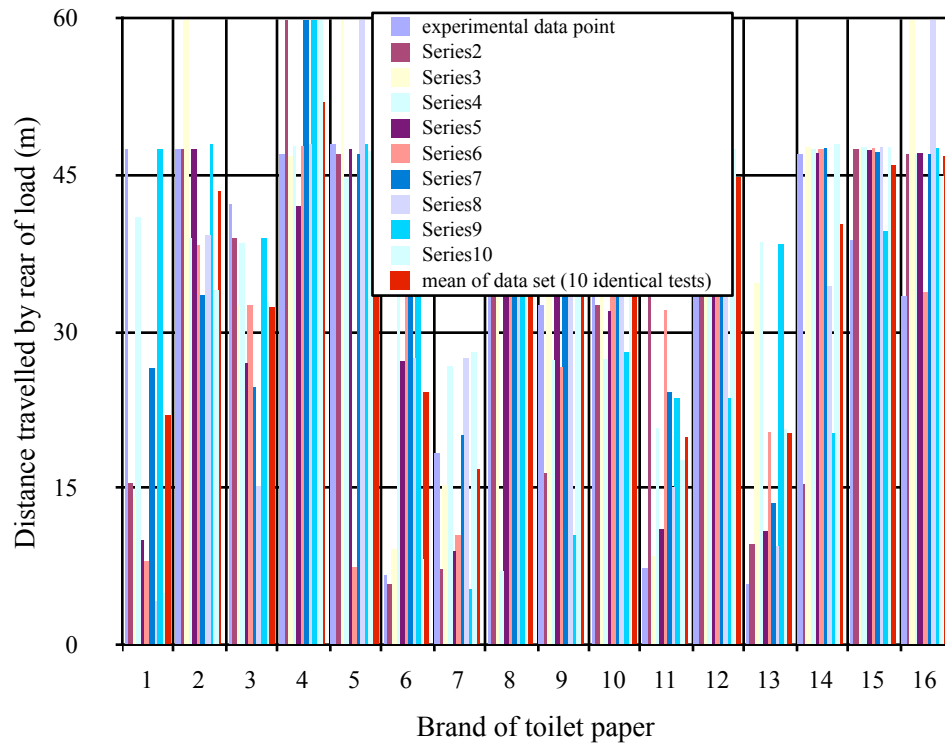
Demiriz, M. (2010). 'Female Urinals'. Gelsenkirchen University of Applied Sciences.

Toilet paper research – Results



Observation that generally solids accelerate away from paper

Toilet paper research – Initial research



Toilet paper was never identified as having a key impact on drainline transportation

Early studies indicated that toilet paper and paper type have an influence on WC drainline transportation and fixture performance

WC drainline transportation evaluation of 22 commercially available toilet paper brands



Australasian Scientific Review of Reduction of Flows on Plumbing and Drainage Systems

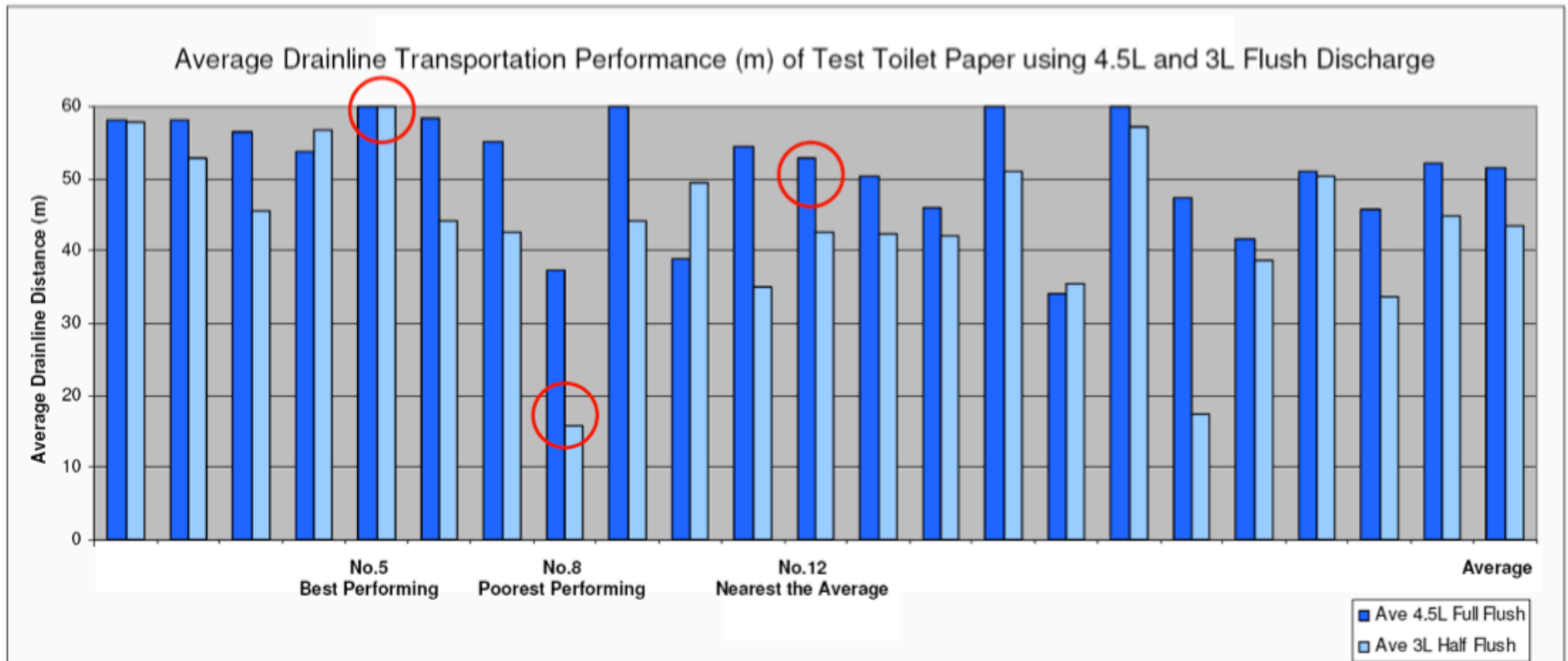
The ASFlow Committee conducted research into the performance of toilet paper and the identification of appropriate test media.

Toilet paper research – 60m drainline testing rig



Comprehensive drainline testing conducted on 60m drainline testing rig

Toilet paper research – Results



Results of our 2010 research produced significant results.

Toilet paper research – Results

No.5
Test Paper Characteristics



Best Performing

No.8
Test Paper Characteristics



Poorest Performing

No.12
Test Paper Characteristics



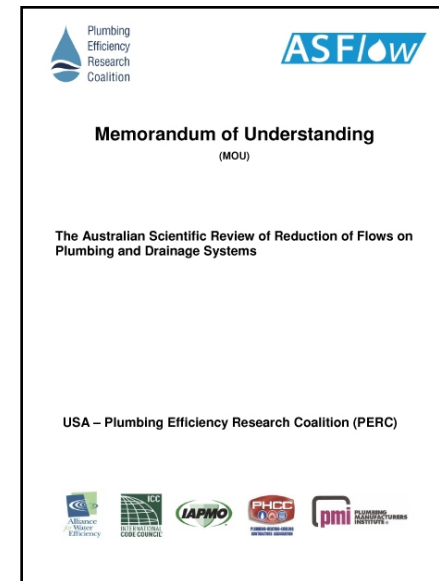
Nearest the Average

Breakdown of 30 sheets of paper after a 4.5L full flush with
1 metre drainline carry



PERC research – The Drainline Transport of Solid Waste in Buildings (2012)

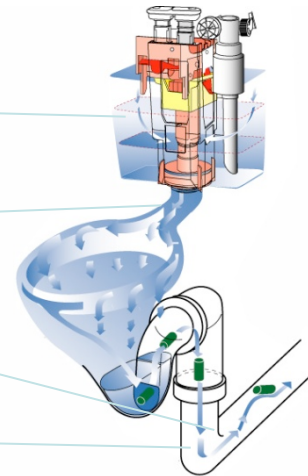
- **PERC /ASFlow research collaboration**
 - Sharing of research findings
- **PERC Design of Experiment**
 - The “Real World”: too variable to duplicate / characterize
 - Need to understand what’s really important
 - Build a perfect drainline
- **The Test Apparatus**
 - 4” clear PVC
 - 135 feet long (~41 M)
 - Slope adjustable – 1%, 2%



PERC research – toilet paper test

- **Test Procedure**

- 40 test runs consisting of 100 flushes into the drainline
- Each flush contained either solids (300, 200, 100 gm) and paper or only paper – no empty flushes to clear the line
- Flush characteristics varied in each run by:
 - Flush volume (3.0, 4.8, 6.0L)
 - Flush rate (3.5 or 2.5 L/sec)
 - % trailing water (75% or 25%)
 - Drainline slope (1% or 2%)
 - Paper tensile strength (high or low)
- Key measurement for analysis is the average number of flushes to clear the drainline (AFO - Average Flushes Out)



PERC research – key findings

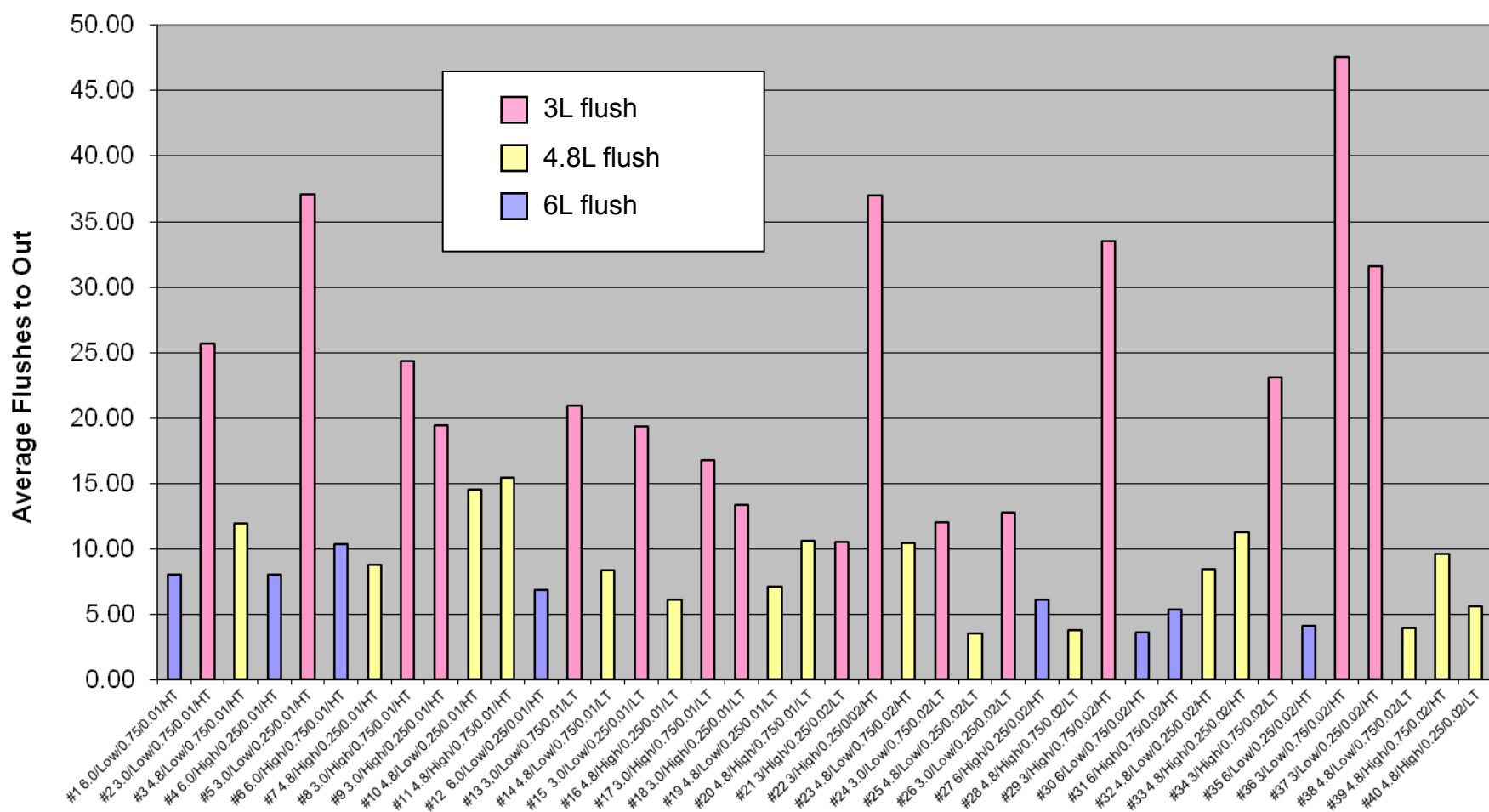
Ranking of test variables:

Significant Variables

Insignificant Variables

Slope > Paper > Volume > % Trailing Water > Flush Rate

PERC research – toilet paper test results

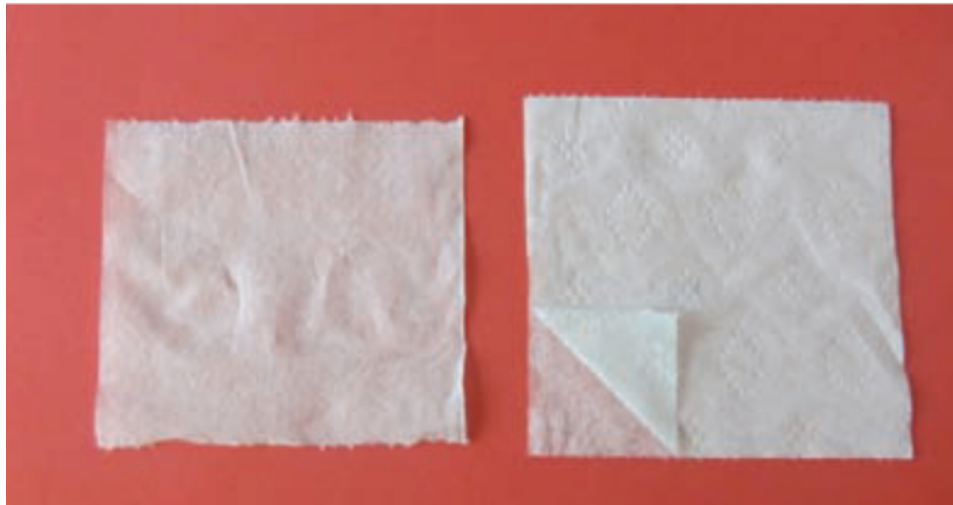


PERC research – toilet paper test results

PERC performed further testing that proved a definite correlation between the wet tensile strength of toilet paper and drainline transportation.

Low Tensile Strength Paper

High Tensile Strength Paper



“The higher the Tensile Strength of the Paper the lower the drainline transportation.”



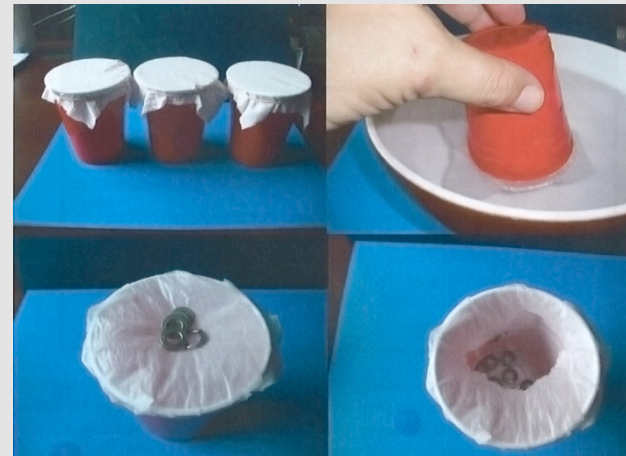
PERC research – toilet paper test results

Toilet paper characteristics have the potential to drastically impact DLT distances

- Strong inverse correlation between wet tensile strength and DLT distances
- Caution: Potential demonstrated in the PERC DOE characterizes the extremes of toilet paper influence
- Easy test to determine relative wet tensile strength developed
- Possible low-cost solution to mitigate DLT related blockages
- **Inline with ASFlow findings**

• PERC paper wet tensile strength test

- Secure a single sheet of toilet paper to a cup with a rubber band
- Soak in water for 60sec
- Place washers (or similar) on to paper until it ruptures
- Number of washers gives a numeric value for wet tensile strength

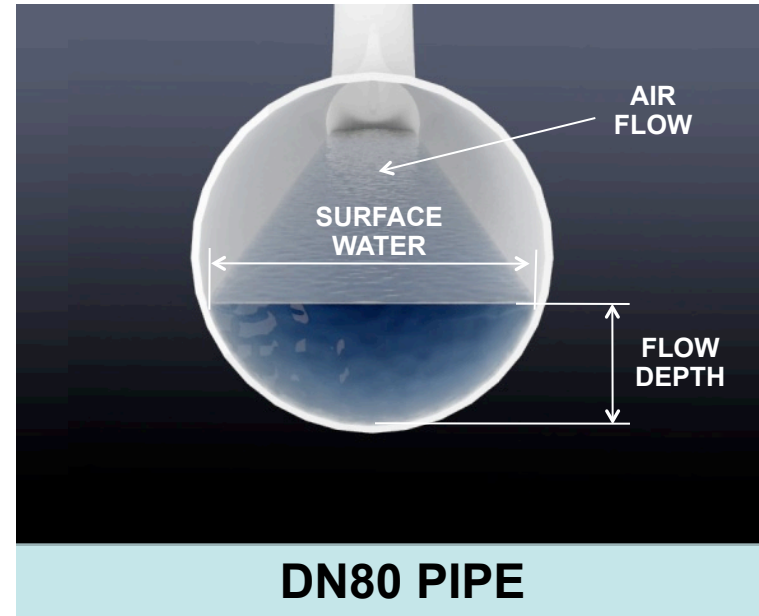
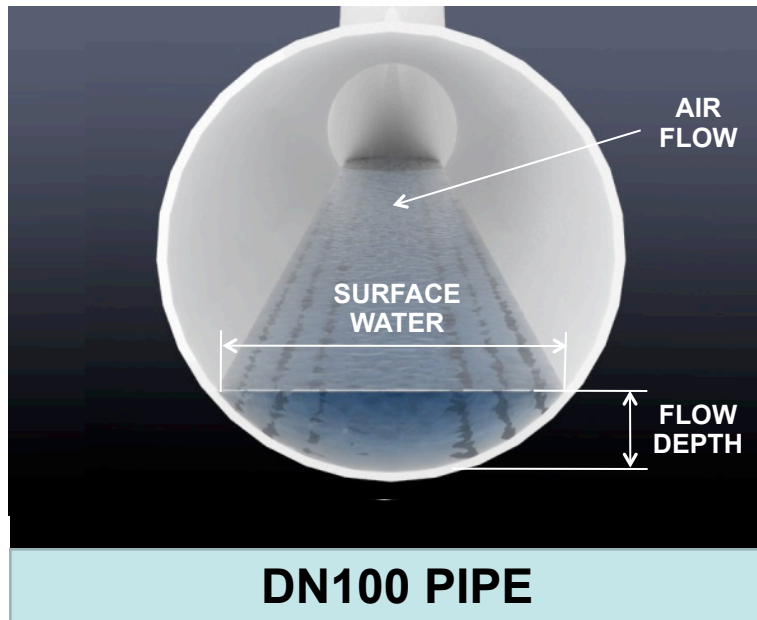


2. Drainline profile experimental research

Influence of drainline profiles on WCs drainline performance



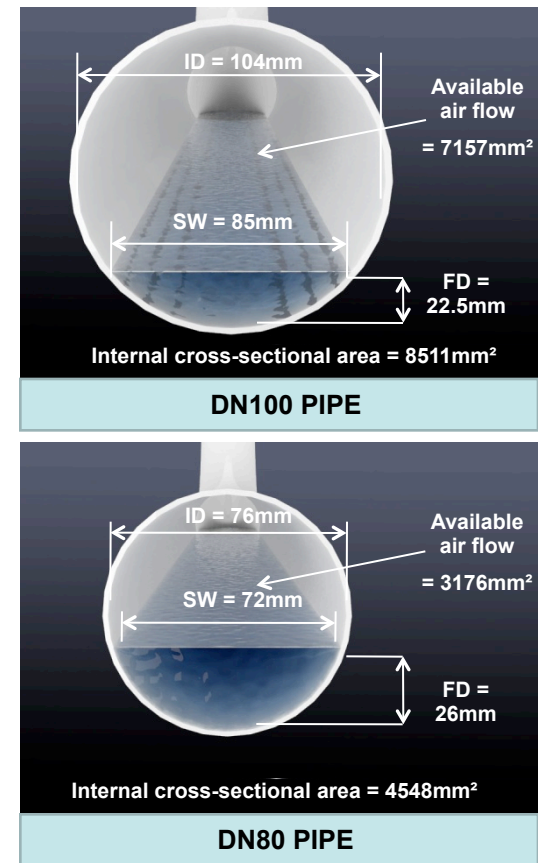
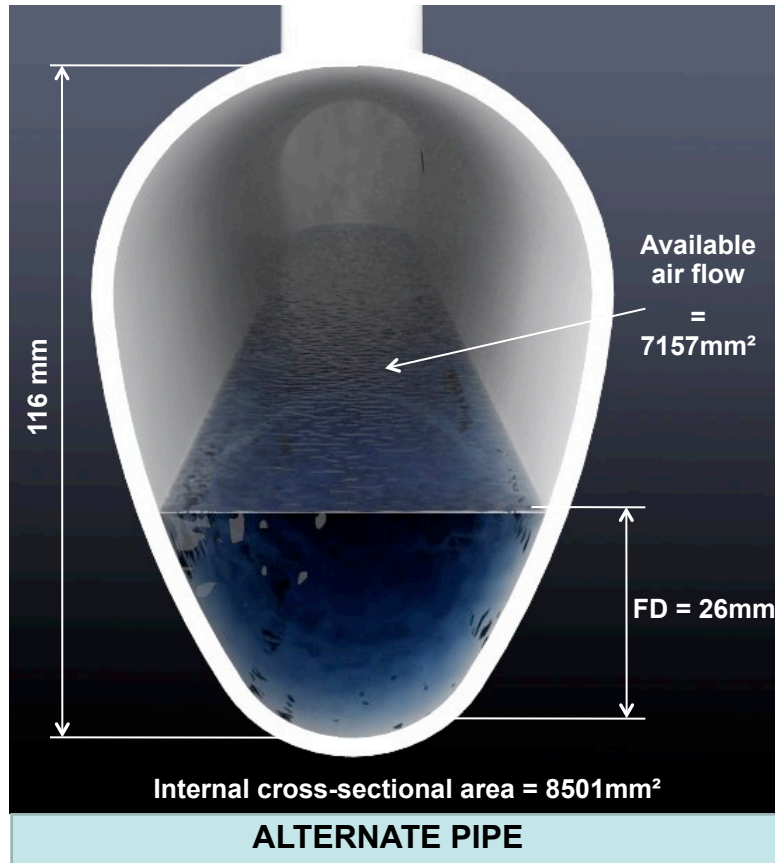
Drainline profile design– 100DN & 80DN pipe



Typical Australian WC drainline installation configurations use DN100 and DN80 pipe

In the search for improved WC drainline transportation alternative drainline profiles were explored

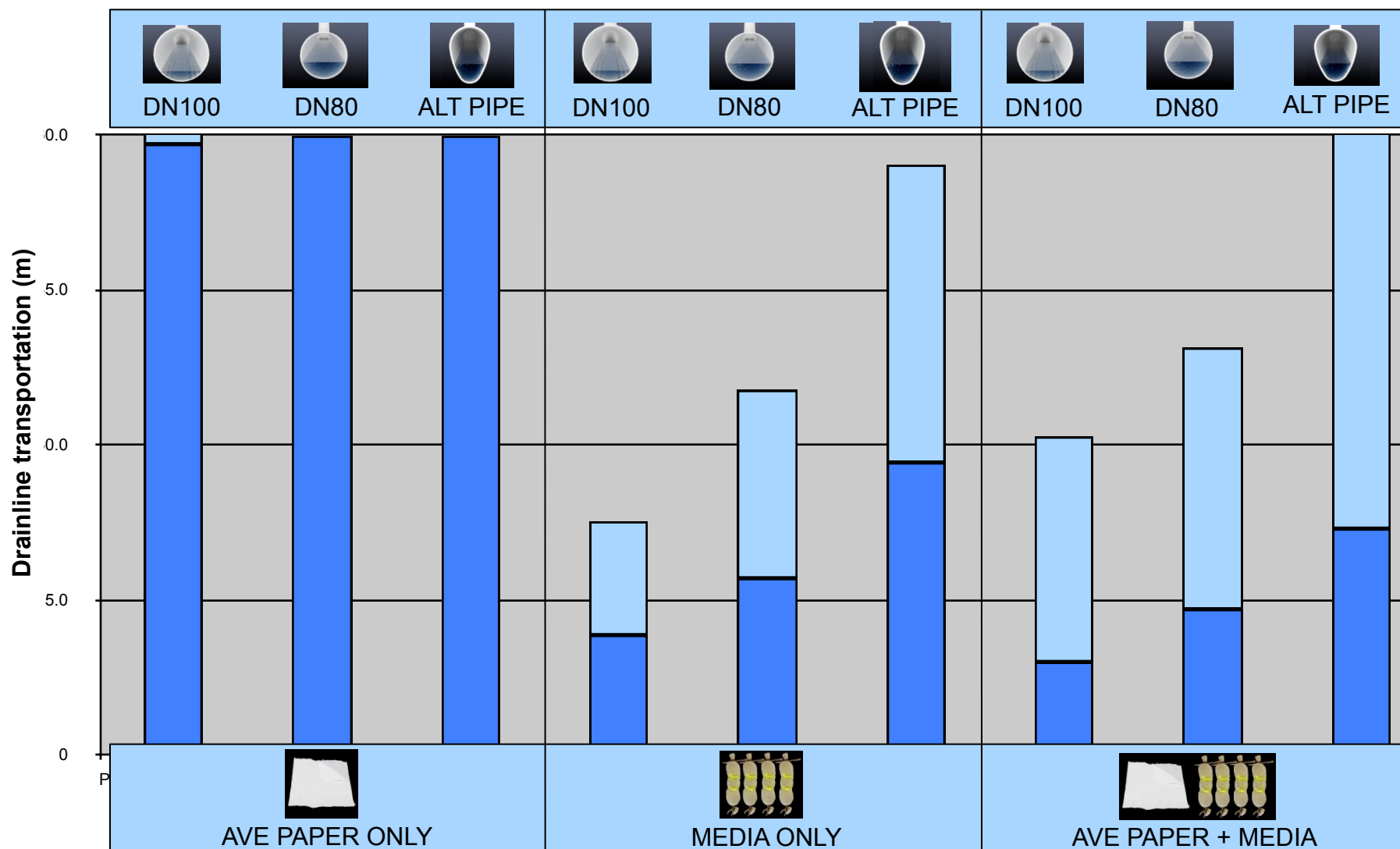
Drainline profile design – waste transportation performance



An alternate drainline was developed based on a combination of the cross-sectional air flow associated with DN100 pipe and the waste transportation characteristics associated with the DN80 pipe.

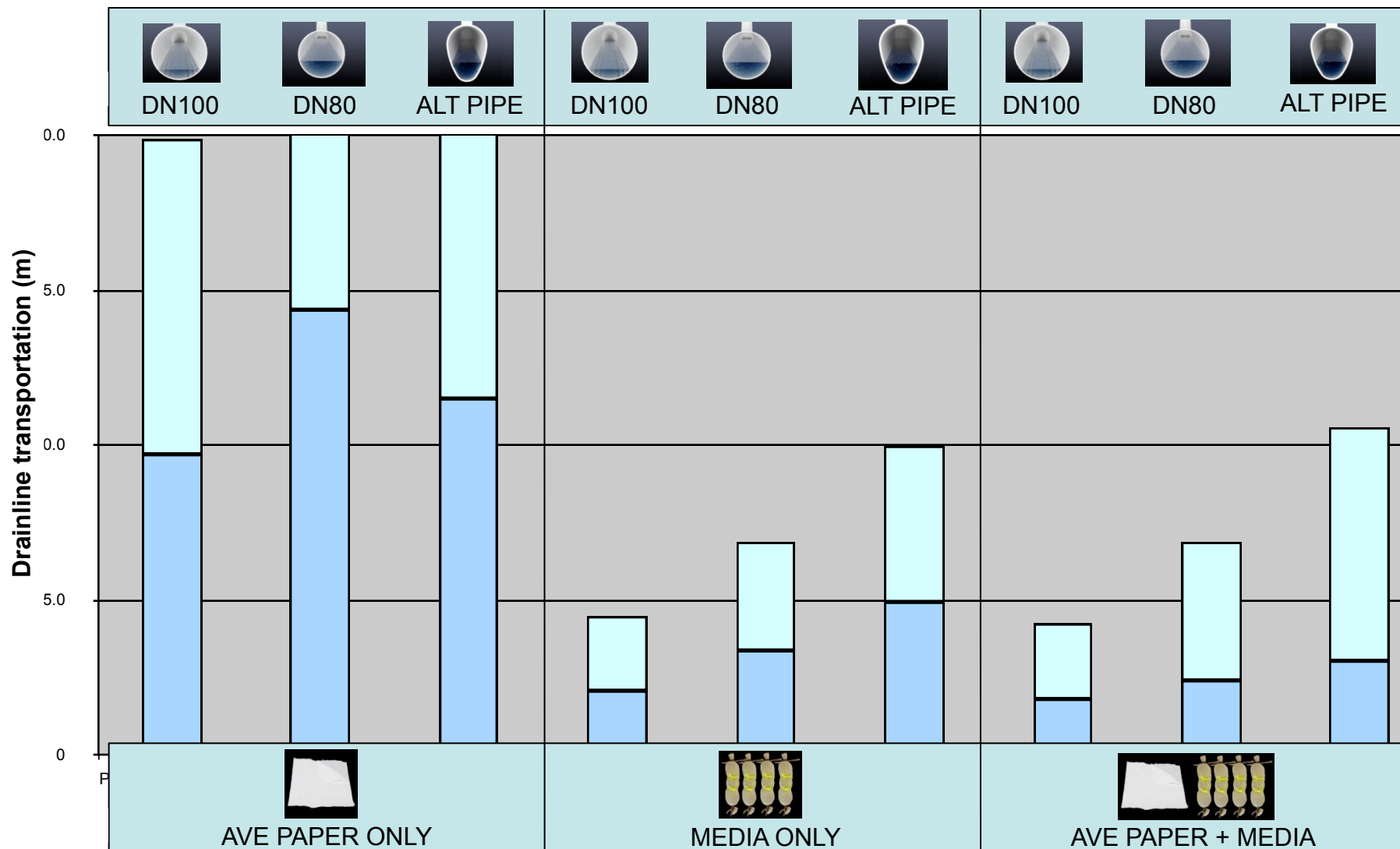
Experimental Drainline Testing – Comparison results

Transportation comparison of paper only, solids only & paper + media on DN100, DN80 & alt drainline at 4.5L using ave paper



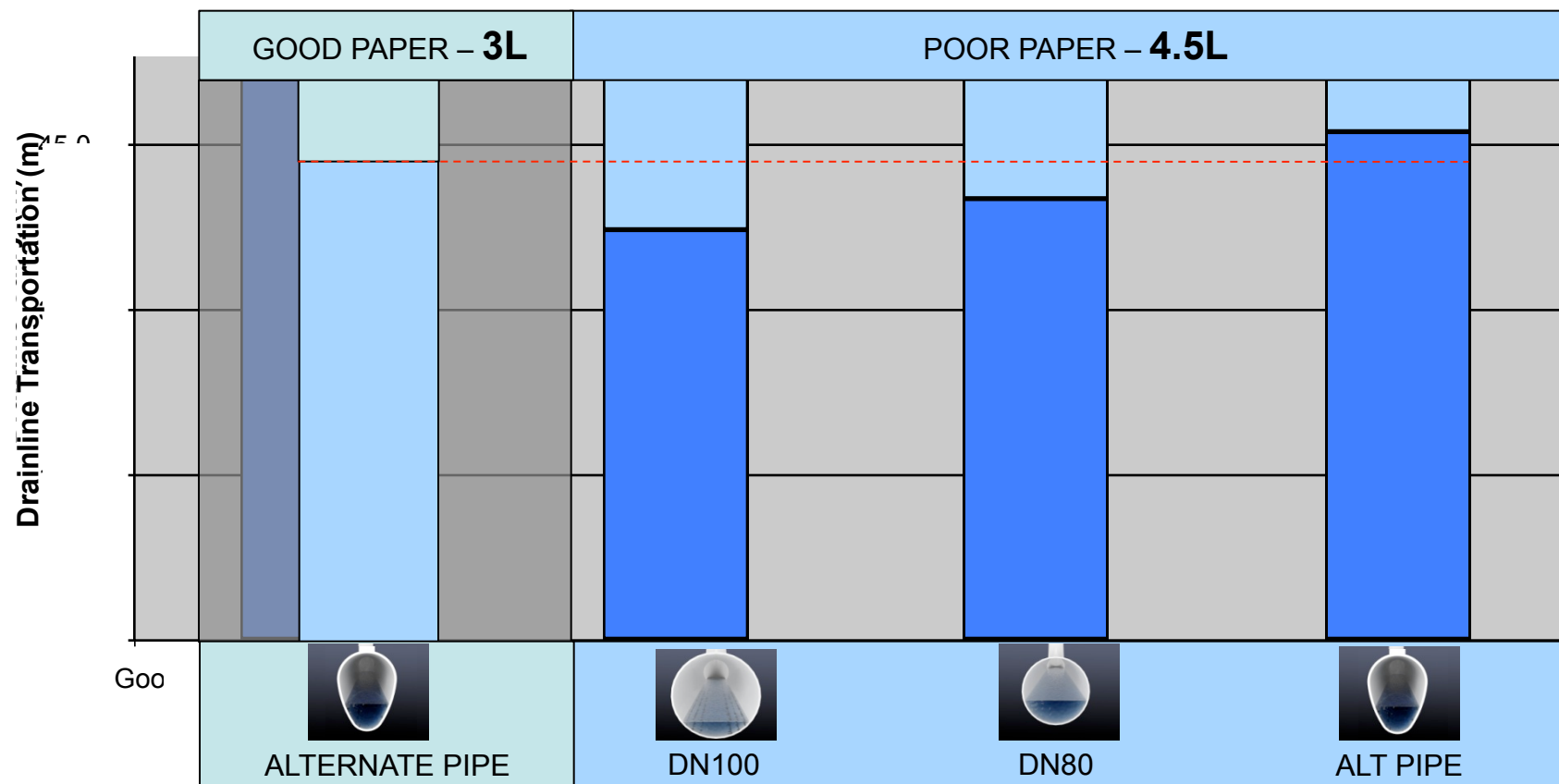
Experimental Drainline Testing – Comparison results

Transportation comparison of paper only, solids only & paper + media on DN100, DN80 & alt drainline at 3L using ave paper



Experimental drainline study – waste transportation performance

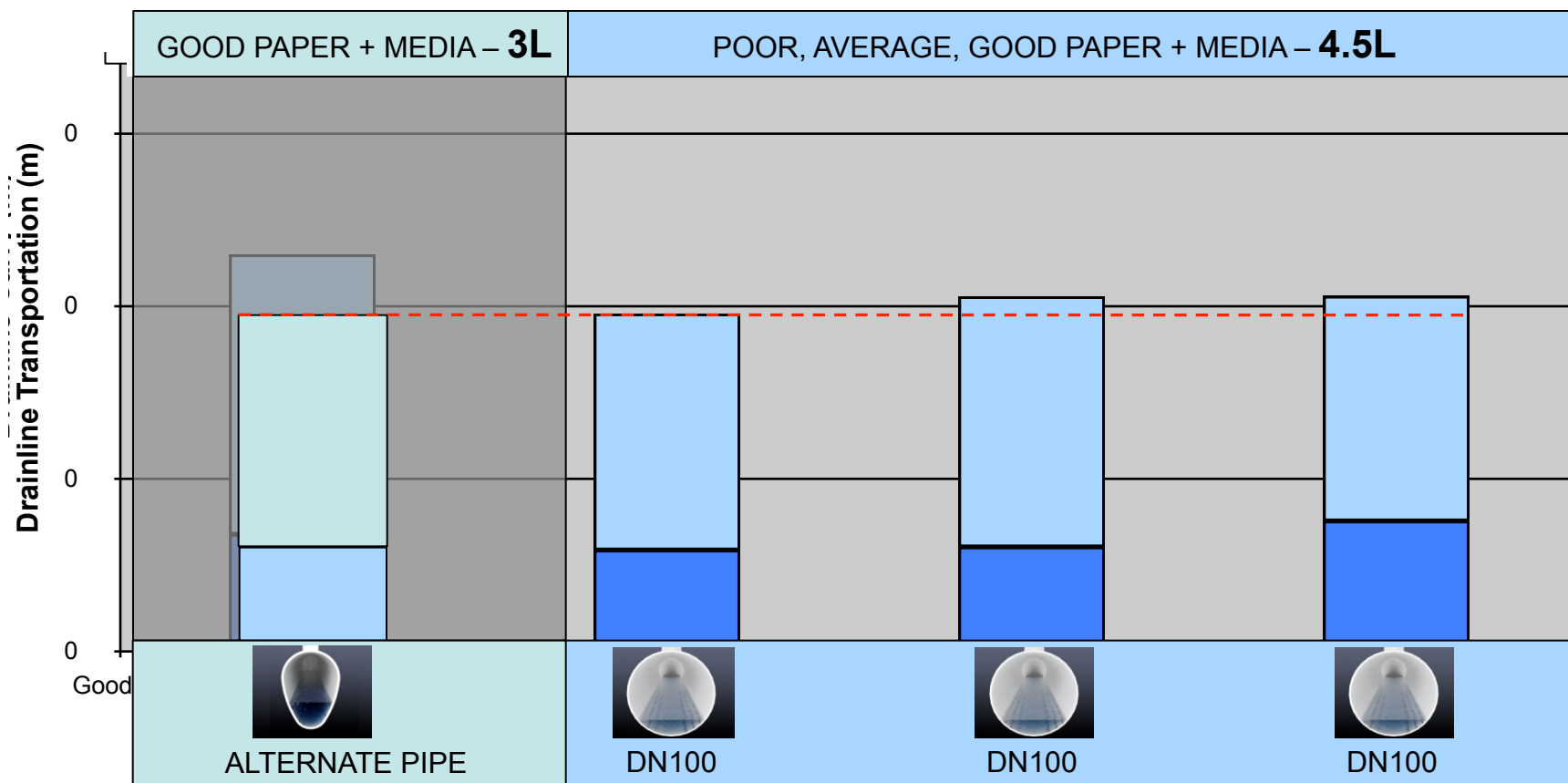
Drainline Carry Comparison of Good Paper at 3L vs Poor Paper at 4.5L



Better drainline carry results were achieved using good paper on the Alternate Pipe at 3L half flush – compared with 4.5L full flush using poor paper on DN80, DN100 and alternate drainline

Experimental drainline test– solids media + paper transportation performance

Drainline transportation comparison of good paper + Media at 3L vs Poor Paper + Media at 4.5L



Improved drainline transportation results were achieved using good paper + solids media in the alternate drainline profile with a 3L reduced flush – compared with poor, average and good paper + solid media on DN100 at 4.5L.

Experimental Drainline Testing – Conclusions

Simple variables – Paper media and drainline profiles have a significant impact on WC drainline transportation.

As with PERC direction, research and Standards must consider appropriate test media in future developments.

Thank you