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Our Ref: PSM5665-091L Rev1

13 August 2025

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Attention: Thanh Bui

Dear Thanh

RE: MCCRAE LANDSLIDE - RESPONSE TO SMEC SUBMISSIONS

1. Introduction

This letter presents my opinion regarding the following documents with respect to the Board of Inquiry into the McCrae Landslides:

- Results of permeability testing (document ref. *FW: OFFICIAL: Fw: McCrae Board of Inquiry - SMEC Response to Matters in Hearing on 05.07.2025 [ME-ME.FID8979461]* referred to herein as "**SMEC Permeability Testing**"
- Groundwater travel time calculator (document ref *FW: OFFICIAL: BOI into the McCrae Landslide - flow calculation spreadsheet [ME-ME.FID8979461])* referred to herein as "**SMEC Groundwater Travel Time Calculator**"
- McCrae Landslide Geochemistry report prepared by Christopher Jewell dated 8 August 2025 (document ref J1812.4R) referred to herein as the "**Jewell Report**".

The Jewell Report is outside my area of expertise, and no opinion is provided in this letter.

2. Referenced Documents

The following documents are referenced in this letter:

- **"WSP Causation Report**" (ref. DPA.0004.0001.0001, 21 July 2025)
- **"SMEC Causation Report"** (ref. SMEC 002 Rev0, 21 July 2025)
- **"2025 PSM Causation Report"** (ref. PSM5665-075R, 21 July 2025).

3. SMEC Permeability Testing

Table 1 and Inset 1 present a summary of results of Slug Testing presented in the SMEC Permeability Testing documents. I note:

- SMEC borehole BH03 may have tested permeability across two geological units. The in-situ strength tests (SPT N of 3) at 1.5 to 1.95 m is not consistent with other results in RESIDUAL SOIL (refer to my

CPT interpretation in PSM5665-075R). For example, PSM CPT01B (ref. PSM5665-GFR Rev1, pdf page 145) does not show a softening of the RESIDUAL immediately beneath saturated soils and has a cone resistance in the order of 4 to 6 MPa.

- SMEC borehole BH04 indicates that groundwater was observed in a 400 mm thick layer of SAND, coarse grained from 4.2 m to 4.6 m below ground level. This observation of groundwater depth is similar to that reported for 5 Prospect Hill Road during the initial site classification at that site (par. [31] of the 2025 PSM Causation Report). Based on my observations documented in the PSM GFR/2025 PSM Causation Report, in my opinion it is unusual for the water observation to be within RESIDUAL only and not at the contact between COLLUVIUM/RESIDUAL or both. I note that this is possible to occur, however it is at odds with my observations throughout my investigations.
- Permeability of RESIDUAL SOIL is likely to be lower than that of COLLUVIUM. In my opinion this was broadly agreed by experts during the hearing on 4 to 5 August 2025.
- Testing both units at once may bias the results to the RESIDUAL SOIL and therefore lower bound permeabilities.

Inset 2 presents a summary of “Permeameter Testing” presented in the SMEC Permeability Testing documents. I have annotated in red what I have inferred to be the geotechnical unit based on SMEC borehole data where available. I note that it is not clear to me:

- What geotechnical unit is being tested with each test. For example, does the tested material comprise RESIDUAL SOIL, COLLUVIUM, FILL etc.
- How SMEC make allowances for unsaturated soil behaviour (i.e. matric suction) external to the testing location (e.g. from established vegetated areas such as the Bayview Road reserve). I would expect the measured permeability to be affected by the influence of the vegetation in the area, and this can result in reported permeabilities orders of magnitude lower (ref. Van Genuchten, 1980), Inset 3.
- How SMEC make allowances for structure in the near surface soils. For example, desiccation cracking. Based on first principles engineering, the permeability of the same soil with cracks is fundamentally higher than a homogeneous mass without cracks.
- How SMEC extrapolates these results to apply to the coarser layers within the COLLUVIUM (for example, as observed in PSM borehole NDT13 and the 2025 Landslide headscarp.

Table 11: Slug test results

Test	Date	Screen Interval Depth (m)	Filter Pack Interval Depth (m)	Static Water Level Depth (m)	Permeability or Hydraulic Conductivity (m/d)	Screened Material
BH01	8/7/25	19.7 to 25.7	18.4 to 25.7	13.805	0.007	Extremely Weathered (XW) Granite
BH02	9/7/25	22.6 to 25.6	21.8 to 25.9	19.383	0.2	XW Granite
BH03	8/7/25	2 to 6	1.5 to 6	1.967	6	Clayey Fine to Coarse Sand, Clay Low to Medium Plasticity. Below 3.7m Silt Clay to 4.2m then Fine to Medium Sandy Clay
BH04	8/7/25	3.5 to 7.5	3 to 7.5	5.82	0.3	Clayey Fine to Medium Sand, Clay Low Plasticity with silt
WR174 BH01	12/6/25	13.3 to 22.3	12.3-22.3	14.217	0.02	XW Granite

Inset 1: Table 11 of SMEC Causation Report

Table 1 – SMEC Slug Testing Results

BH	Screen Depth[1]	SMEC Geotechnical Unit Tested[2]	Hydraulic Conductivity (m/day) [3]	PSM comment
BH01	19.7 – 25.8	Slightly to Highly Weathered GRANITE	7.3E-03	
BH02	22.6 – 25.6	Moderately to Highly Weathered GRANITE	2.3E-01	
BH03	2.0 – 6.0	RESIDUAL SOIL	6.3	Possibly COLLUVIUM to 3.7 m. SPT N value of 3 and “Very loose” in RESIDUAL SOIL unlikely unless disturbed by drilling. May have tested two units (RESIDUAL SOIL/COLLUVIUM)
BH04	3.5 – 7.5	RESIDUAL SOIL	3.5E-01	Possibly COLLUVIUM to 4.6 m. May have tested two units (RESIDUAL SOIL/COLLUVIUM)
WR174 BH01	13.3 – 22.3	Moderately to Highly Weathered GRANITE	1.8E-02	

(1) Refer to Table 11 of SEW.0001.0002.4817_0137
(2) Refer to Appendix B of SEW.0001.0002.4817_0137
(3) Refer to SMEC Permeability Testing documents.

Table 10: Permeameter test results

Test	Location	Depth (m)	Infiltration / Permeability (m/d)	Infiltration / Permeability (mm/h)	Material	Geotechncial unit reported on SMEC borehole log
TP1	Bayview - 2m south of leak site	0.27	1.2	52	Silty Fine Sand	N/A
TP2	WR174 BH01	0.31	< 0.008	0.3	Extremely weathered Granite (Saprolite)	WR174: RESIDUAL SOIL BH01: FILL
TP3	Charlesworth Street (opposite street side from BH03)	0.5	1.3	56	Silty Fine Sand	N/A
TP4	BH02	0.5	1.1	44	Silty Fine Sand	FILL
TP5	BH03 Charlesworth (above sewer)	0.5	< 0.01	0.5	Clay Fill	FILL
TP6	BH03 Charlesworth (3m away)	0.5	1.6	66	Silty Fine Sand	N/A
TP7	Coburn at Charlesworth DP2a DP2b	0.5	6.1	255	Silty Fine to Medium Sand Fill	FILL at DP2a. Not reported on borehole log at DP2
TP8	Prospect Hill near DP3a DP3b	0.5	0.1	4	Silty Fine Sand with Clay at base	FILL
TP9	View Point DP6a DP6b	0.5	0.8	33	Silty Fine Sand	Not reported on borehole log

Inset 2: Table 10 of SMEC Causation Report . PSM annotations in red.

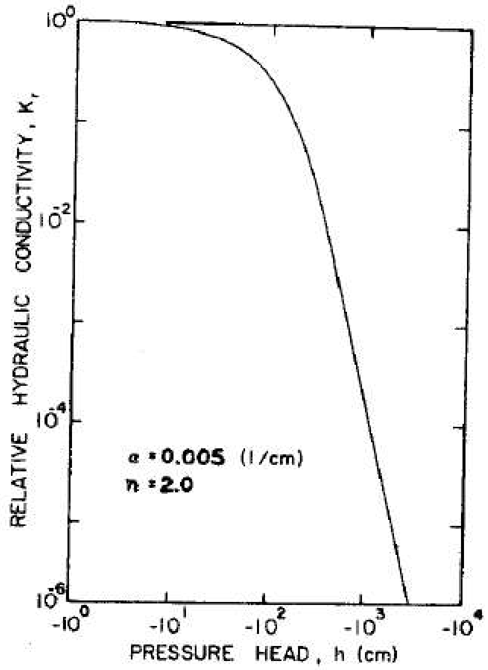


Fig. 2—Plot of the relative hydraulic conductivity vs. pressure head as predicted from knowledge of the soil-water retention curve shown in Fig. 1.

Inset 3: Excerpt from Van Genuchten (1980).

4. SMEC Groundwater Travel Time Calculator

The SMEC Groundwater Travel Time Calculator calculates the travel time of water from the Outlook Water Main Burst Site to the 2025 Landslide and adopts the parameters reproduced in Inset 4.

		Groundwater Travel Time			
			units		
Hydraulic Conductivity	K	6	m/d		
Hydraulic Gradient	i	0.10			
	q	0.6	m/d		
effective porosity	n_e	0.3			
average linear velocity	V avg linear	2	m/d		
distance	d	465	m		
travel time	t_t	**232.5**	**days**	334800	minutes
Assumptions and limitations					
Calculation is based on one dimensionsal Darcy flow equation and assumptions					

Inset 4: Excerpt from SMEC Groundwater Travel Time Calculator

5. Discussion

I am not a specialised hydrogeologist. However, understanding of groundwater is required by any geotechnical engineer for most projects. This is especially the case when working in landslide assessment and remediation.

5.1 Range in Permeability

Table 6.2 of the WSP Causation Report:

- Presents a permeability range for "Transported Soils" which includes COLLUVIUM of 10^{-5} to 10^{-3} m/s
- Calculated permeability of 2 x 10^{-1} m/s between NDT01 and the 2025 Landslide.

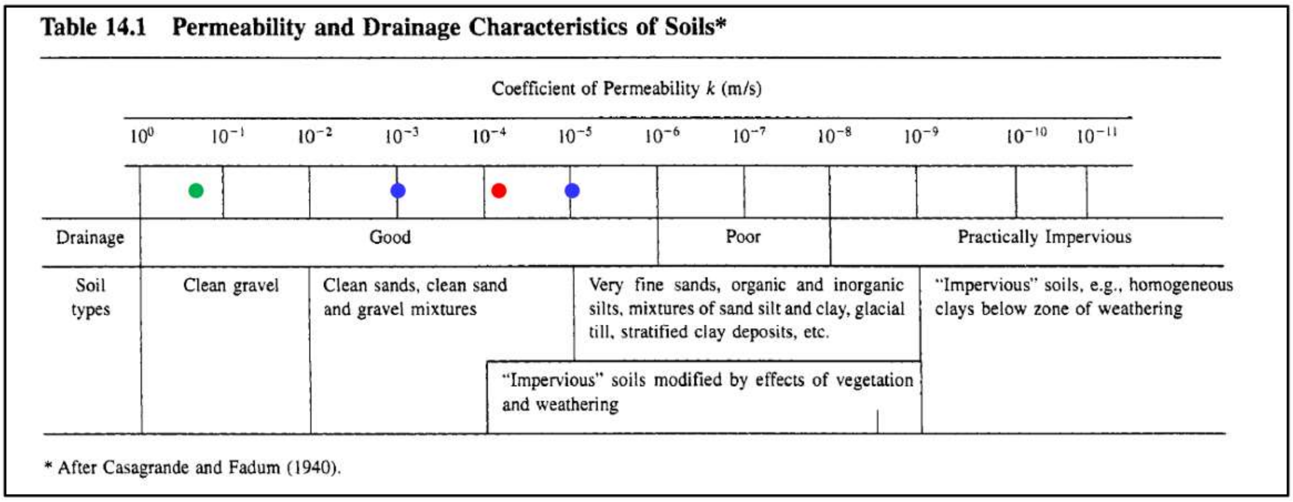
SMEC adopts a permeability of 6 m/day or approximately 7 x 10^{-5} m/s, Inset 4.

The WSP and SMEC permeability values are presented on Inset 5.

My review of the SMEC permeability testing indicates that minimal in-situ permeability testing of the COLLUVIUM has been undertaken. It is my opinion that COLLUVIUM may have inadvertently been tested in SMEC boreholes BH03 and BH04. One of the larger scale indirect permeability tests of the COLLUVIUM is that based on the results of PSM dye testing at NDT01 and as interpreted by WSP, Inset 6. This indicates a permeability no less than three orders of magnitude higher than adopted in the SMEC groundwater travel time calculations.

In my opinion the permeability laboratory tests, and in-situ tests will have both a bias and potentially scale issues. In my opinion a single borehole or laboratory test on small diameter tube samples are unlikely to represent the boulder/cobble influence in the COLLUVIUM. This is because you cannot sample the boulders with tubes and some boulders have bigger diameter than the borehole itself and these zones may not have been tested. It is likely that they have been indirectly tested with the PSM dye testing at NDT01.

I provided comments to SMEC with regards to testing aquifers at scale during the hearing on 5 August 2025.



Inset 5: Excerpt from Terzaghi et al (1996) – Permeability with mark up of SMEC estimate (red) and WSP estimate (blue) and WSP interpretation of dye test at NDT01 (green).

Transported Soils	Local aquifer, restricted in area and continuity. May be unsaturated or hold perched groundwater at times.	Unconfined porous media. K may range from around 10^{-5} m/s to 10^{-3} m/s. Likely to be variable depending on composition. Some parts possibly as high as 2 × 10^{-1} m/s based on dye trace between Borehole NDT01 and landslide escarpment.

Inset 6: Excerpt from Table 6.2 of the WSP Causation Report

5.2 Discussion of Groundwater Travel Time

Where experts agree that permeability can vary by orders or magnitude, it then follows that the time for water to flow a distance should vary by a similar range. For example, where there are clean sands/gravels it may only take days to flow from Bayview Road to the escarpment. I have used the SMEC Groundwater Travel Time

Calculator to calculate the travel time for the range of permeabilities presented on Inset 5 and summarised the results in Table 2. In my opinion it is likely that flows have occurred via a series of varying permeability flow paths.

I provided comments to SMEC in the hearing on 5 August 2025 regarding the inability to validate the 232 day estimate against field observations during 2025.

Table 2 – Calculated groundwater travel time

Permeability (m/s)	Calculated Travel Time (days)
2×10^{-1}	0.1
1×10^{-3}	16.1
7×10^{-5}	232
1×10^{-5}	1614

5.3 Porosity

My calculations for porosity (n) used in Section 8.6 of PSM5665-075R are based on the relative density of the sands within the COLLUVIUM which I have tested via CPT, SPT and DCP, Particle Size Distribution laboratory testing (11 tests in total in the COLLUVIUM and reported in the PSM GFR and PSM5665-075R) and published ranges. For example, the published results for loose to dense Silty Sand in Table 4.5 of Holtz and Kovacs (2011) range from 0.23 to 0.47.

In my opinion, the SMEC laboratory testing results do not warrant a revision of my parameters.

6. Closure

Based on the SMEC factual information and calculation spreadsheet provided I do not alter my original opinions presented in PSM5665-075R or the Joint Conclave report.

Yours Sincerely

I & S

DANE POPE
PRINCIPAL