Car Wash Noise and EPA Regulation – A Case Study

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ABSTRACT

Car wash business, “Washed”, was shut down by the local Council in a blue-chip residential area of Melbourne after numerous neighbourhood complaints about the excessive noise levels being emitted. This paper investigates the impact of Environmental Protection Agency (EPA) regulations on such a car wash operation, in a built-up residential area and the solutions implemented to make the car wash facility EPA-compliant. On-site noise measurement results are reported for ‘before’ and ‘after’ remediation.

1 INTRODUCTION

A car wash business called ‘Washed’ was built in Camberwell, a high-profile, blue-chip residential suburb of Melbourne, Victoria, that is located 15 km east of the Melbourne CBD, and as shown in Figure 1.

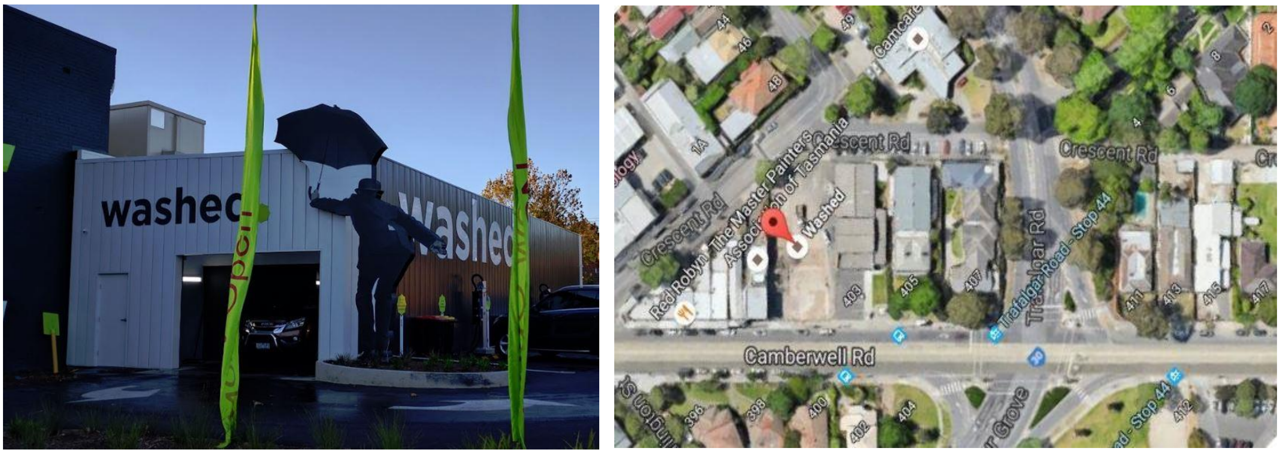


Figure 1: The car wash facility and its surrounding residential area in Camberwell (**Source**: Google Maps)

The facility was closed-down by local council after numerous neighbourhood complaints about the excessive noise levels.

Our on-site investigation revealed that:

- Commercial buildings are located adjacent to the car wash facility on the east and west side - no noise restrictions applicable.
- However, residential buildings located to the north and south of the establishment (i.e. in Crescent Road and Camberwell Road, as shown in Figure 1) are protected by noise emission limits as outlined in the Victorian State Government’s Environmental Protection Agency (EPA) guidelines.
- The car wash exit at the southern end of the premises is where the majority of the excessive noise was occurring.

1.1 EPA requirements

EPA qualification of the car wash area is an “Area with some commerce or industry;” hence, an acceptable maximum equivalent noise level on weekdays between 7 am and 6 pm is 59 dB(A).

The local Council issued 'Washed' with a certificate of operation that required compliance to EPA noise limit requirements, as stated in 'State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N–1 ('SEPP N–1'),' as summarised in Table 1.

Table 1: Maximum Noise Level Limits for Mainly Residential Areas
as per Environmental Protection Agency (EPA) Regulations

Area description	Typical Noise Limit dB(A)		
	Day*	Evening	Night
	7:00-18:00	18:00-22:00	22:00-7:00
Mainly residential area	50-54	44-48	39-43
Area with some commerce or industry	54-59	48-52	43-47
Commercial district or bordering an industrial area	59-63	52-57	47-52
Predominantly industrial area	63-68	57-61	52-56

*The evening noise limit applies on:
1. Saturdays between 13:00 and 18:00
2. Sundays and public holidays between 07:00 and 18:00.

1.2 Noise measurement results

Initial noise measurements indicated that noise levels at the car wash exit door were around 108 dB(A) to 110 dB(A), and on the far-side footpath of Camberwell Rd, around 84 dB(A) to 87 dB(A). Both these results well exceeded EPA mainly residential noise regulations.

2 Possible solutions

Washed needed a noise solution that enabled it to operate again under full capacity while complying with the noise emission limits outlined in Table 1.

2.1 Noise source analysis

The car wash facility comprised two sections:
1.) A wet, fully automated car wash with rotating brushes, and 2.) A drying section.

The car wash exit is shown from different viewpoints in Figure 2 and Figure 3.

Figure 2: Exit from the car wash, with drying section at the front
and wet section at the back

Figure 3: Car wash exit towards Camberwell Rd, with a residential house positioned opposite in the background

The doors located at both ends of the car wash remain open for the entire operating hours, being 7 am to 6 pm on weekdays, and 9 am to 5 pm on weekends.
The noise levels detected at various points of the car wash layout are provided in the following:

- **Car washing area**: the noise generated by the wet car wash section was barely audible outside.
- **Drying section**: six powerful air fans installed in this area generated extremely annoying high levels of noise. Significant sound pressure levels, from 108 dB(A) to 110 dB(A), were measured at a distance of 1m from the floor and approximately equi-distanced from each fan.

It is evident that the main noise source were these drying fans. Background noise levels measured on Camberwell Rd were around 45 dB(A), but this increased to 87 dB(A) when the fans were operational (intermittent readings were taken when no road traffic was present).
The analysis considered the worst-case scenario by assuming that the background noise level on Camberwell Rd was already at 45 dB(A), due to significant road traffic (including trams and trucks). A passing tram or truck generated intermittent noise levels around 85 dB(A) to 90 dB(A). Although these levels were not verifiable at the time of testing, We assumed that the true equivalent background level on weekdays was around 60 dB(A) to 65 dB(A). On weekends when the general noise environment is different, We anticipated that equivalent noise background noise levels would be in the range 50 dB(A) to 55 dB(A), which is still well above the 45 dB(A) used for modelling a worst-case scenario.

2.2 Acoustic design analysis

Preliminary noise readings indicated that a 20 dB(A) noise reduction from the car wash would meet EPA guidelines of not exceeding 59 dB(A) for the Camberwell residential area. Thus, an acoustic design analysis was undertaken of the electrical fans and building construction.

2.2.1 Electrical fan noise

An initial proposal of ways to reduce the fan noise was as follows: 1.) Replace the type of fans with a quieter system, 2.) Line the internal fan housing with sound absorption material to reduce air-borne noise, 3.) Apply damping treatment on the fan housing to reduce resonating noise, 4.) Reduce the fan speed to reduce the noise output, and 5.) Replace the fan mounts with more sound-absorbing efficient and effective ones.
As the air fans had been imported directly from the USA at a cost of over $30,000 USD, replacing these was not financially viable.
However, the air fans had been supplied with specially designed soft mounting pads. These were checked for correct installation and no rigid bridges were found between the fan body and the shed frame. It was evident that the efficiency of these pads was very limited, while a lot of structure-borne noise was in the shed frame. However, the proposal to replace existing mounts with softer mounts was rejected by the owner due to warranty concern.
It was noted that by lowering the electrical motors' drive frequency from a default of 60 Hz to 50 Hz, there was an approximate reduction of the fan noise of 6 dB(A). As every air fan requires approximately 220 m^3/hr of air flow, a sufficient amount of air space must be provided around the fans to ensure this air flow rate is met. Based on these air flow conditions, the owner accepted our proposal to operate the fans at the two inverter frequencies.

2.2.2 Building construction

The car wash building is of very light construction, and similar to that of a conventional garden shed. Generally, the calculated sound transmission loss of such a construction varies between 10 dB(A) to 18 dB(A) in the frequency range of interest. Within the building structure, there were no sound absorbing components either; rather, highly reflective surfaces.

2.3 Possible noise reduction solutions

Given the car wash's operating constraints, the following options were considered to reduce noise propagation:

1. **Lining the inside of the air fan housing using an acoustic sound-absorbing material which is combined with vibration damping material**

   This approach did not interfere with the already installed car wash equipment. However, after some experimental work with one of the fans, this option was abandoned due to insufficient noise reduction: only a small 4.5 dB(A) noise reduction was achieved.

2. **Installing sound-absorbing materials in the drying section and adding a sliding door, which would close when the air fans operate**

   This concept was verified by simply blocking the exit door with 25-millimetre-thick medium-density fibreboard – the noise level measured on the far-side of Camberwell Rd reduced from 87 dB(A) down to 75 dB(A). Final tuning could be easily achieved by installing a small amount of sound-absorbing materials. This option was the simplest, most economic and quickest to install. However, the owner rejected this option as being impractical and unreliable.

3. **Encapsulation of the air fans in a semi enclosure using heavy plasterboard and sound-absorbing material**

   This option was approved by the owner and a full design undertaken.

2.4 Product selection

We conducted material selection as follows for Option 3:

2.4.1 Sound transmission loss of a fan semi-enclosure

For installing sound-absorption product in a fan semi-enclosure, the design target was a Rw (Weighted Sound Transmission Loss) of 35 dB(A) at 500 Hz. To meet this requirement, the system comprised a timber frame cladded on one side with two layers of 16-millimetre-thick Gyprock Fyrchek MR (27 kg/m^2). It was assumed that actual Rw would be less than 35 due to the structure-borne sound transmission and huge opening of the enclosure for air intake.

2.4.2 Selection of sound absorption materials

A key requirement for the chosen sound absorption material was that it must be water-resistant due to the car wash's humid environment. Details are as follows:

a) A high sound-absorption co-efficient at low-to-mid frequencies (for the fan noise)

b) A water-repellent facing to prevent the product from getting wet

c) The facing to be tough and vandal-proof

d) Fireproof to minimise a potential fire hazard

e) Quick installation time, with a self-adhering product preferred.

An initial selection of glass fibre or rockwool material was rejected by the owner due to concerns of: 1.) Potential mould growing in a wet environment, and 2.) The breakdown of fibre material under high air velocity conditions.

The materials needed to be high sound-absorbing at about 250 Hz to 500 Hz, yet with a thickness of no more than 50 mm. We identified that the Soundmesh G8 seems to be the solution.

Initial testing on 25mm thick acoustic materials showed very encouraging results. (1) the peak sound absorption was shifted from 5,000 Hz to about 1,000 Hz; (2) the noise reduction coefficient (NRC) from 0.55 to 0.85. Test data results are shown in Figure 4.

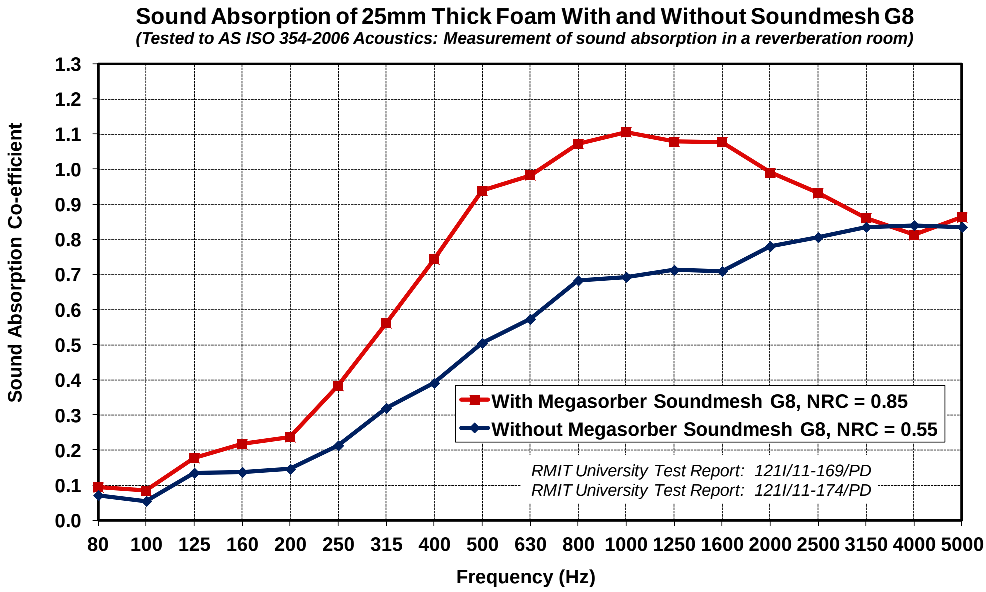


Figure 4: Test results for 25-millimetre-thick acoustic foam with (in red) and without (in blue) Soundmesh G8 facing

Megasorber FG50 was selected, as Megasorber FG50 has high sound absorption well within the design range, and a peak sound absorption at about 500 Hz, as indicated by the test results provided in Figure 5. Also included in the graph are the 25mm thick and 100mm thick version for comparison. It is evident that the FG25 (25mm thick) has a peak sound absorption at 1,000Hz, which is not the most suitable product. FG100 (100mm thick) is excellent for the project, but it exceeded the space limit of 50mm.

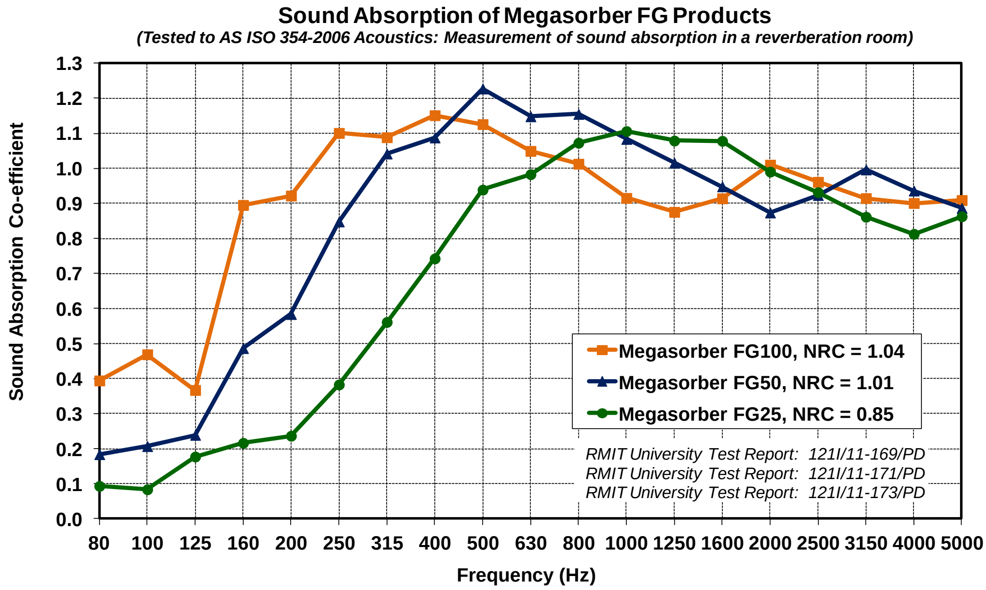
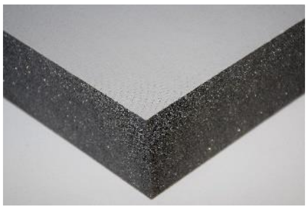


Figure 5: Reverberation sound absorption coefficient test results for Megasorber FG50 (as shown in blue)

The product with a water repellent facing is shown in Figure 6.



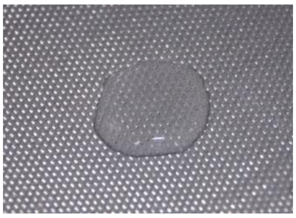


Figure 6: Megasorber FG50 and
Soundmesh G8 water-repellent facing respectively

(Note: a hydrophobic version of FG50 is available and the product code is Megasorber FM50H after the completion of the project).

2.5 The installation of the noise insulation materials

The installation of the soundproofing materials is shown in a perpendicular cross-section of the car wash's drying area in Figure 7 and Figure 8.

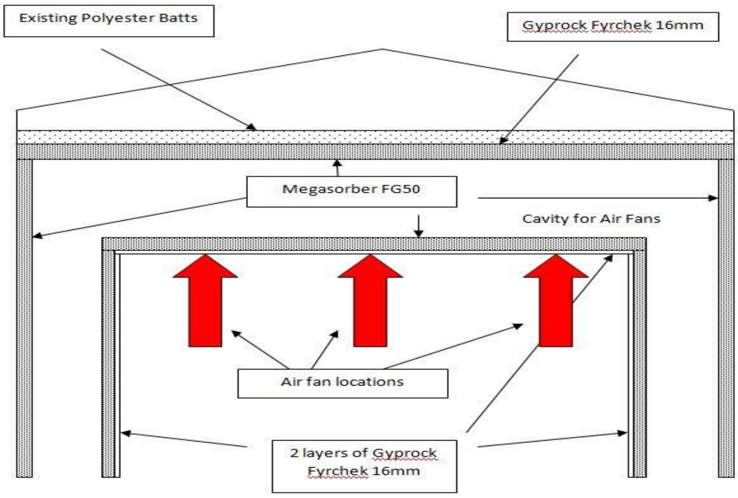


Figure 7: A perpendicular cross-section of facility's drying area,
with acoustic treatment of the top air fan cavity above 4 fans

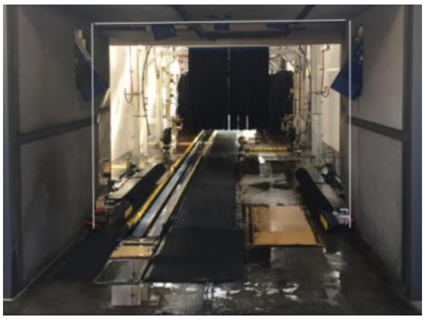


Figure 8: The white line shows the cross-section illustrated in Figure 7.

A longitudinal perspective of material installation in the central ceiling area, where 4 air fans are located in the drying area, is shown in Figure 9 and Figure 10.

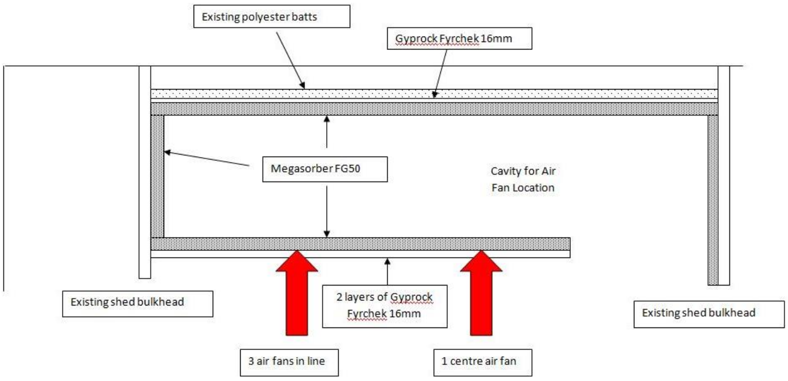


Figure 9: A longitudinal cross-section of the facility's drying area, with acoustic treatment of the top air fan cavity above 4 fans

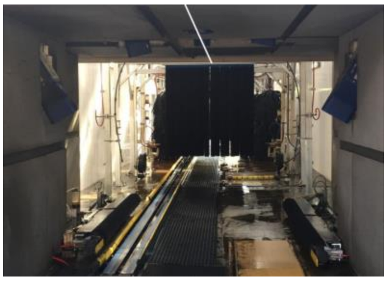


Figure10: The white line shows the cross-section illustrated in Figure 9.

Further provided in Figure 11 and Figure 12, is a cross-section through the side cavities of the drying area, where the side air fans are located.

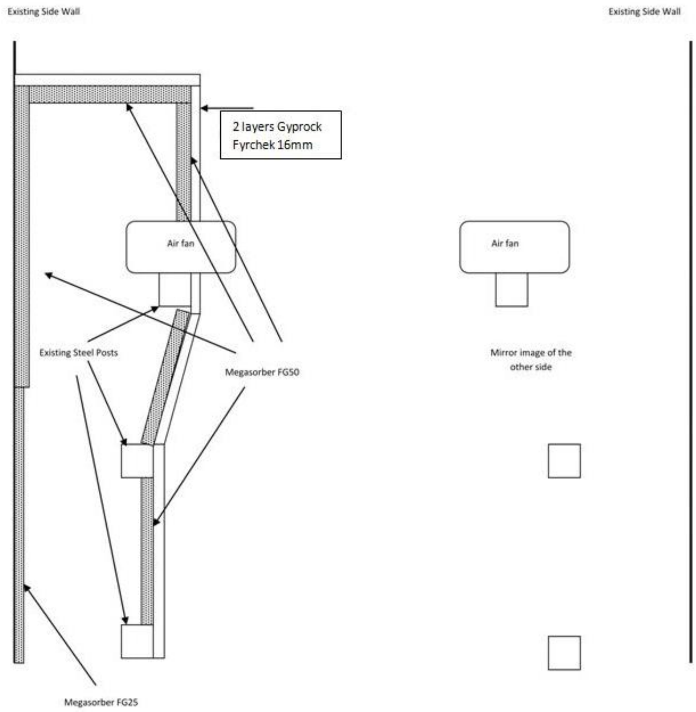


Figure 11: A longitudinal cross section of the facility's drying area, with acoustic treatment through the side air intake

Figure 12: The white line shows the cross section illustrated in Figure 11.

The selection of the right acoustic material and overall acoustic design enabled the installers to complete the whole project within 3 days, including the additional installation of external sound absorbing pads.

2.6 Test results

The final noise emission levels were again measured at two fan running conditions: 1.) inverter frequency of 60 Hz, and 2.) an inverter frequency of 50 Hz. The fan noise level was now lower, as fan speed decreases when the inverter frequency changes from 60 Hz to 50 Hz. The trade-off of this result is that car drying takes a bit longer. The noise readings before and after Megasorber product installation are summarised in Table 2.

Table 2: Comparison of the Measured Sound Pressure Levels at Various Car Wash Locations

Measurement Location	Air Fans at 60 Hz (dB(A))	Air Fans at 50 Hz (dB(A))
Entry to the car wash	55.5	52.5
Crescent Rd	48	48
Exit from the car wash	92.5 (down from 108-110)	87.5
Camberwell Rd	67.5 (down from 84-87)	61.5

It is evident from Table 2 that noise levels were reduced by 20 dB(A) after the acoustic treatment was installed. Sound quality also improved significantly, as indicated by the reduced amount of high frequency noise emitted.

Taking into account the car wash's cycle time and an estimated number of cars washed per hour, equivalent noise levels were computed and compared with EPA requirements. Table 3 and Table 4 display the results for the reduced fan drive frequency of 50 Hz and full fan speed frequency of 60 Hz respectively.

Table 3: Comparison of the Predicted Noise Levels on the Far-Side of Camberwell Rd's Footpath during Fan Operation at 50 Hz, along with Equivalent Noise Levels

No of Cars washed per hour	Fans on (sec)	Fans on Noise Level (dB(A))	Fans off (sec)	Fans off Noise Level (dB(A))	Equivalent Noise Level (L_{eq} dB(A)) hourly
5	300	61.5	3300	45	51.7
6	360	61.5	3240	45	52.3
7	420	61.5	3180	45	52.8
8	480	61.5	3120	45	53.3
9	540	61.5	3060	45	53.8

10	600	61.5	3000	45	54.2

Table 4: Comparison of the Predicted Noise Levels
on the Far-Side Camberwell Rd's Footpath during
Fan Operation at 60 Hz, along with Equivalent Noise Levels

No of Cars washed per hour	Fans on (sec)	Fans on Noise Level (dB(A))	Fans off (sec)	Fans off Noise Level (dB(A))	Equivalent Noise Level (L_{eq} dB(A)) hourly
5	300	67.5	3300	45	57
6	360	67.5	3240	45	57.7
7	420	67.5	3180	45	58.4
8	480	67.5	3120	45	58.9
9	540	67.5	3060	45	59.4
10	600	67.5	3000	45	59.8

3 CONCLUSION

EPA requires that acceptable noise levels within the Camberwell residential area on weekdays between 7 am and 6 pm be no more than 59 dB(A). The on-site measurement confirmed that the noise level well exceeded the EPA limit.

Car wash operation presented a lot of construction and design constraints, such as high air velocity and extremely wet working conditions and so on. A comprehensive solution was designed and implemented. The final result was a noise emission reduction of 20 dB(A). The car wash is finally allowed to operate at full capacity without any more neighbourhood complaints. On weekends, however, the owner was advised to run the fans at 50 Hz to ensure that EPA regulations were met.

ACKNOWLEDGEMENTS

We would like to thank Washed for the opportunity to undertake this study, as well as their permission to publish the test results obtained. A special thank you if also given to Camberwell City Council for providing related study information.