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HYGIENE STUDY OF PORTABLE TOILETS USED AT SINGLE DWELLING CONSTRUCTION SITES

Prepared for
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1.0 Introduction

A study was commissioned by Aim Hire Pty Ltd to assess the hygiene status of portable toilets under normal operational conditions.
The key purpose of this study was to determine some sound microbiological data on the status of portable toilets and how various aspects of their use in the field may or may not contribute to the hygienic state of toilets and /or their perceived hygienic state.
This study was also to coincide with the review being undertaken by WorkSafe Victoria of the portable toilets guidelines.
The proposed changes do not appear to be evidence based policies nor do they account for some of the very significant differences between sites, toilet types and their mode and frequency of use. A one policy fits all approach has been implemented in developing the Guidance note.
Sharp&Howell were engaged to undertake an independent study of portable toilet hygiene to specifically attempt to answer how the status of the sewage tanks may or may not influence the hygienic state of the toilet. That is, does the frequency of emptying sewage tanks have an influence on the microbiology of the toilets? Furthermore the study was to assess the current cleaning technique (service) being performed and attempt to determine other factors contributing to the cleanliness and status of portable toilets.
The study was commenced at the beginning of March 2011 and operated for a period of two weeks across more than 50 building sites in the northern suburbs of Melbourne.

2.0 Methodology and Research Design

The study plan was developed to generate data that represented the most common portable toilet variety utilized by Aim Hire and at construction sites that represented the largest sector of that market.

2.1 Portable toilets

The study only incorporated fresh water flush, water seal chemical toilets. These have a 110 litre fresh water flush tank and a 390 litre sewage tank. A seal exists between toilet and sewage tank. The toilets when commissioned at the construction sites or during their subsequent full service were charged with the standard tank treatment chemicals as specified by Aim Hire. This study did not attempt to determine the effects of differing levels of chemicals or attempt to compare varieties of chemicals. All the toilets included in the study were already commissioned at the construction sites and represented normal Aim Hire contracts and standard servicing agreements.

2.2 Type of Construction sites

A significant factor in this study was the choice of construction sites. All construction sites were single dwelling construction sites with one hire portable toilet on site. This represents the largest market sector for Aim Hire Pty Ltd and would allow for ready comparison of data between sites. Commercial construction sites and multiple dwelling sites may have multiple toilets and distinct patterns of use and frequency of service and thus comparative analysis could have a different degree of complexity. In this study all toilets were comparable in type and mode of use.
There is considerable data that the FTE (Full time equivalents) on these sites are approximately 2. This is significantly different to alternate sites and the levels of FTEs referred to in various international guidelines.

2.3 Number and distribution of Construction sites

The sites for the study were chosen on the basis of ease of access and proximity to facilitate economic runs during which significant numbers of sites could be evaluated within one day.

All the sites were located in the northern suburbs of Melbourne:

Mernda, Doreen, Epping, Wollert and South Morang.

A total of 13 building companies were represented in this study with a total 51 portable toilets included in the study.

The following building companies were represented:

Metricon, Porter, Glenvil, Simonds, Formula, Orbit, Prime, BPG, Carter, PDH, NBG, Long Island, Minniti.

2.4 Microbiological testing

To assess the standard of hygiene of the portable toilets microbiological tests were undertaken of the toilet seats which represent the direct user contact area.

Each toilet seat was swabbed on three locations on the seat: rear, left and right parts of seat with a single swab. The total area swabbed was 100 sq cm. Thus the test results presented in this report per swab represent a composite view of the microbiological status of the toilet seats on each occasion that they were tested. The swabs were refrigerated and returned to the laboratory for analysis on the same day the swab was taken.

Two indicator tests were performed.

a) ***Total Viable Aerobic Count*** – This measures the total number of bacteria recovered from the swab. It is a non specific test which does not differentiate between bacterial species but simply quantifies total bacterial levels.
b) ***Escherichia Coli*** – E coli represents one of the predominant species found in the faeces of animals and man. It is regarded as the universal indicator of faecal contamination and is routinely used in a multitude of applications to measure the level of faecal contamination.

For the purpose of statistical analysis the bacterial counts were transformed into Log (Counts) and subjected to basic statistical analysis such as Geometric means and standard deviations. The use of log (counts) is a common convention for the analysis of microbial counts.

The testing was undertaken by an independent NATA accredited laboratory[1].

2.5 Visual Assessment

In conjunction with the microbiological hygiene testing visual assessments were also undertaken during field visits to the designated portable toilets. The toilets were inspected for cleanliness and given a score on a scale from 1 to 5.

The score categories can be defined:

1 Very Clean
2 Clean
3 Adequate
4 Dirty
5 Very Dirty

Within the survey data the descriptive scores were turned into quantitative measurements and mean measurements were utilized to compare categories of toilets.

Note 1: Microbiological Testing undertaken by Silliker Australia Pty Ltd

2.6 Aim Hire Service Teams

During these studies two service teams were utilized to either empty, clean and/or service the portable toilets. Each team processed approximately 50% of the toilets designated for these trials. The teams were not briefed on any specific cleaning regimes required.
All aspects of servicing the portable toilets were undertaken as per normal routine procedures and protocols currently utilized by Aim Hire.

2.7 Hygiene Survey 1: Baseline Measurement of cleaned toilets with empty sewage tanks.

Up to 30 portable toilets already commissioned at various construction sites had their tanks emptied and the toilets cleaned and serviced.
Immediately after this the toilets were swabbed for microbiological analysis. Only 28 of the toilets available could be analysed for microbiological tests.
The purpose of this survey was to assess the baseline measurement of bacteria levels in Toilets that had had just been emptied and cleaned.
The data from this survey would enable us not only to assess the standard of the cleaning Protocol but also allow us to compare other microbiological results to the baseline measurement.

2.8 Hygiene Survey 2: Hygiene Status of Toilets after 14 days of use. (Sewage tank empty at start of test period)

Portable toilets that had their tanks emptied and cleaned were revisited 14 days later.
This survey was designed to assess the hygiene status of toilets that have been out in the field for 14 days under normal operating conditions.
On the 14^{th} day of use these toilets were swabbed for microbiological analysis and were assessed visually for cleanliness.
This data set was compared to the baseline measurement from survey 1 to determine the level of change in the microbiology and hygiene status of these toilets after having been used for 14 days.

2.9 Hygiene Survey 3: Hygiene Status of toilets after 14 days of use but whose tanks had not been emptied for 30 days or more.

A total of 24 toilets were identified that had not had their tanks emptied for at least 30 days or more. These toilets were cleaned utilizing the routine procedure and the same cleaning crews utilized in the other studies. However the tanks were not emptied.
After 14 days these toilets were revisited and swabbed for microbiological analysis. The toilets were also assessed visually for cleanliness.
This study was designed to assess if the relative fullness of the sewage tanks contributed to any microbiological or hygiene differences compared to toilets which had their tanks empty at the start of the test period.
The data generated from this study was compared to that of survey 1 (**section 2.7**) and survey 2 (**section 2.8**)

3.0 Results

3.1 Results of Hygiene Survey 1 and Survey 2

All the data pertaining to Survey 1 and Survey 2 is included in Table1. Furthermore the data is split such that the first part of the data represents portable toilets serviced by crew 1, while the remainder of the table pertains to crew 2.

Table 1

	Initial Testing 03 & 04/3/11		*Follow Up Testing 17&18/03/11*		
Asset Number	**log(bacteria) per swab**	**E. Coli**	**Visual Score 1 - 5**	**Log(bacteria)**	**E. Coli**
0431	2.973127	<10	2	2.041393	<10
5364	3.732393	<10	2	2.322219	<10
5169	3.431363	<10	1	3.633468	<10
1936	2.913813	<10	2	3.653213	<10
3030	2.301029	<10	1	2.431364	<10
4533	3.913813	<10	2	3.113943	<10
2933/4933	3.799341	<10	2	3	<10
4631	2.643452	<10	1	8.176091	<10
1456	2	<10	4-5	2.518514	<10
5688	2.924279	<10	1	3.653213	<10
4341	1.954242	<10	3-4	2	<10
5180	3.146128	<10	1	3.431363	<10
5882	1	<10	3	3.681241	<10
5217	2.869231	<10	1	2.431364	<10
5429	3.414973	<10	1	3.908485	<10
Geometric Mean	2.867812267	Average	1.9	3.333058067	
SD	0.795891553			1.491116251	
5838	4.204119	<10	3	3.662758	<10
5459	2.113943	<10	2-3	4.851258	<10
3057	3.70757	<10	3	4.986771	<10
5129	3.662757	<10	2	2.908485	<10
5971	3.653212	<10	2	4.079181	<10
0530	3.643452	<10	2	4	<10
0483	3.60206	<10	2	3.740363	<10
5786	2.863322	<10	4-5	4	<10
1376	3.079181	<10	2	4.653212	<10
5146	2.770852	<10	3-4	2.770852	<10
125	4.633468	<10	2	4.230449	<10
5218	4.278753	<10	2-3	2.322219	<10
5875	3.431363	<10	2-3	4.146128	<10
Geometric Mean	3.511080923	Average	2.6	3.873205846	
SD	0.680037157	All	2.2	0.800784899	
All G Mean	3.166472714			3.583840964	
All SD	0.800448881			1.230100301	

3.2 Results of Hygiene Survey 3

This data pertains to toilets that were cleaned at the start of the study period but did not have their tanks emptied. They were then surveyed 14 days after cleaning. All the data for Survey 3 is incorporated in Table 2. As per Table 1 the date is split into toilets serviced by crew 1 and crew 2.

Table 2

	14 days Follow Up Testing 17&18/03/11			
Asset Number	**Visual Score 1 - 5**	**Total Viable Aerobic Count**	**Log(bacteria) per swab**	**E. Coli**
1482	1	80	1.903089987	<10
0363	3	2900	3.462397998	<10
3022	3	970	2.986771734	<10
6810	3	5500	3.740362689	<10
510	2	860	2.934498451	<10
4275	3	1200	3.079181246	<10
1446	1	420	2.62324929	<10
3059	2	11000	4.041392685	<10
**15 (First 2 numbers lost)	3	5700	3.755874856	<10
4380	3-4	630	2.799340549	<10
4182	3-4	1300	3.113943352	<10
5795	3	13000	4.113943352	<10
Average	2.6	Geometric Mean	3.212837183	
SD	0.84	SD	0.641319891	
4580	4	10000	4	<10
5105	3	5500	3.740362689	<10
0444	3	2400	3.380211242	<10
4360	2	9200	3.963787827	<10
567	2	24000	4.380211242	<10
0890	4-5	360	2.556302501	<10
3045	2	250	2.397940009	<10
1286	2	1200	3.079181246	<10
5066	2	310	2.491361694	<10
011	1-2	10	1	<10
7122	3-4	1300	3.113943352	<10
Average	2.7	Geometric Mean	3.100300164	
All	2.6	SD	0.961936359	
SD	0.89	All - G Mean	3.15901513	
		All - SD	0.793441941	

3.3 Summary of Results

Table 3 summarizes all the data generated from the survey studies. In respect of the bacteria counts these are presented as the Geometric mean of that data set. The visual assessment results are presented as arithmetic means. For comparative purposes the data pertaining to the specific crews is also included in this table.

Table 3

Survey 1 Baseline measurement n=28			Survey 2 14 days after clean, tank emptied at start n=28			Survey 3 14 days after clean, tank Not emptied at start n=23		
	Log Bacteria	E coli	Visual	Log Bacteria	E coli	Visual	Log Bacteria	E coli
Mean	3.1665	<10	2.2	3.5838	<10	2.6	3.1590	<10
SD	0.80		0.98	1.23		0.89	0.79	
Crew 1	2.8678	<10	1.9	3.3330	<10	2.6	3.2128	<10
Crew 2	3.5111	<10	2.6	3.8732	<10	2.7	3.1003	<10

4.0 Discussion and Interpretation of data

4.1 Survey 1

The Survey 1 results indicate that the cleaning procedures utilized in this study achieved an adequate standard of sanitation. The mean bacteria counts presented are for test surface areas of 100 sq cm of the toilet seat. Generally for normal surfaces the level of bacteria after sanitation or disinfection is measured per **one** sq cm. Good sanitation practice can achieve <10 organisms /sq cm while disinfection would be <1 organism /sq cm. Table 4 presents the comparative performance of the cleaning procedures by total and by crew.

Table 4

	Log (bacteria)	Bacteria/100sq cm	Bacteria/sq cm	Ideal Standard per sq cm
Total Mean	3.1665	1,470	15	<10
Crew 1	2.8678	740	7	<10
Crew 2	3.5111	3,200	32	<10

It should be noted that the cleaning procedures used do not incorporate either a sanitizer or a disinfectant but simply a detergent. In this respect the residual levels of bacteria achieved were satisfactory and adequate; typical of such a cleaning process. Approximately 43 % of the cleaning results were equal to or <10 /sq cm. In respect of E coli all results of the cleaned toilets were <10 / 100 sq cm or < 0.1 E coli/sq cm.

4.2 Survey 2

The Survey 2 data indicates that after two weeks of use the toilets only experienced an increase in bacteria of less than 0.5 log per 100 sq cm. In microbiological terms this would not be regarded as significant. The differences between crews (0.54 log) were higher than what was measured after 14 days of use.
36% of the toilets were found to be at or <10 organisms/sq cm compared to 43% immediately after cleaning.
The E coli results showed no increase after 14 days after cleaning.
The average visual assessment score after 14 days of use was 2.2, indicating an acceptable perception of cleanliness. A score of 3 indicates an adequate standard.
The toilets originally cleaned by crew 1 scored 1.9 after two weeks of use. The toilets originally cleaned by crew 2 scored 2.6 after two weeks.
The level of microbiological contamination after two weeks of use was very low and less significant than the impact of different cleaning standards applied by different crews at the beginning of the test period.
No effort was made to examine or evaluate the cleaning procedures, if any, being used in the field by the various building companies. It was not part of this study to assess or measure these effects.
The data was generated from the perspective of the portable toilet servicing company, that is, what is the status of these toilets after two weeks in the field.
This data suggests that the level of microbial contamination after two weeks is not materially different than that achieved immediately after cleaning.
It is a well recognized and published phenomenon that by enlarge most bacterial species die off rapidly when deposited on dry inanimate surfaces. E coli have a die off rate in excess of 99% within an hour or two. It is therefore not surprising that bacterial numbers did not increase significantly or that E coli were not detected.

4.3 Survey 3 and Comparative data

The data from Survey 3 shows that there are no significant increases in bacteria counts above the baseline measurement and compared to the toilets whose tanks had been emptied in Survey 2.
There were no increases in E coli measured for this group of study toilets.
A total of 39% of the toilets remained at or < 10 organisms/sq cm. This is comparable to Survey 1 and Survey 2 toilets.
The data clearly demonstrates that the relative fullness of the tanks in respect of these toilets has no material effect on the microbiological status and hygiene of the toilets during their use.
All the toilets in this group had not had their tanks emptied for over 30 days. The majority had not had their tanks emptied for 8 weeks or more.
The average visual assessment of this group of toilets scored 2.6 compared to 2.2 in survey 2. This score is identical to that achieved by the toilets in survey 2 for crew 2.
Again the differences between crews appear more significant than the effect of the status of the tanks.
A review of the visual assessment data over both Survey 1 and Survey 2 showed that a total of 9 toilets out of 51 surveyed after 14 days showed scores of 4 or 5 on visual assessment. These scores indicate that the toilets were dirty or very dirty. Of these 56% of the toilets belonged to one building company. Approximately one third of this company's toilets were deemed to be dirty. A total of 77% of the dirty toilets could be attributed to two companies.
The ongoing maintenance of toilets on site is the responsibility of the building companies. This data suggests that the standards of toilet maintenance between building companies is widely different.

5.0 Conclusions

It is a commonly held view , but largely scientifically unfounded, that toilets, in particular public toilets pose some form of health risk. The evidence to support transmission of disease directly from toilets is virtually non existent. The public perception of risk is disproportionate to the reality.

Contrary to this there is considerable evidence that the human hand as a vector in the transmission of disease is a very important factor and is a well studied public health subject. The washing of hands post toilet is important and regarded as crucial in public health. Most of the significant diseases require the faecal-oral route for transmission, hence the importance of hand washing.

A large proportion of the few scientific papers published on public toilets and related matters, promoting the dangers of toilets, have been sponsored by chemical, cleaning or disinfection companies. Globally there is a conspicuous absence of regulations pertaining to toilets, largely because it is not a major public health issue.

This study has shown that the risk of any significant contamination coming from a toilet seat, the direct user contact area, is very low. Toilets in the field and in use for two weeks showed no significant increases in microbial loadings of the toilet seats compared to when they were freshly cleaned. Some deterioration in appearance was experienced over the 14 days but this was not materially translated into higher microbial numbers.

The data also clearly demonstrated that the status of the tanks, for these varieties of portable toilets, have no significant impact on the hygiene of the toilet. The data cannot support the concept of an arbitrary prescriptive timeframe for emptying tanks without consideration of the toilet type and its mode of use.

Some of the current cleaning practices are adequate but could be significantly improved by the incorporation of disinfectants in the cleaning procedure.

In this regard it should be noted that disinfectants in Australia are regulated by the TGA (Therapeutic Goods Administration, Commonwealth –Dept Health & Ageing). Thus any proposed guidelines incorporating disinfectants should make reference to the use of a "Commercial" or "Household Grade" disinfectant compliant with these National regulations.

Any proposed Guidelines or regulations should take into account the following factors highlighted in this study:

Types of toilets and size of tanks,
FTEs per site and frequency of use
Cleaning procedures
Ongoing maintenance by building companies
The low risk factor
Evidence to support prescriptive servicing timeframes
Cost benefit analysis

This study has attempted to objectively measure the microbiological and hygiene status of portable toilets at single dwelling construction sites. The data does not support that such portable toilets as currently being used pose a significant public health risk.