



Impact of Male Sanitary Systems Non Flushing (Waterless) Urinals on the Plumbing System

A study prepared by GHD

June 2012

Please note that the findings of this report do not necessarily
reflect the views of the ABCB or its committees.



Contents

Executive Summary	iii
1. Background and Scope	1
1.1 Purpose of the Research	1
1.2 Scope of the Research	1
1.3 Risks and Opportunities	2
1.4 Credibility	3
2. Research Methodology	4
2.1 General Methodology	4
2.2 Identifying the Issues	5
2.3 Identifying the Sources / Causes of the Issues	9
3. The Issues and its Sources	11
3.1 Issues and Sources Identified in the Brief	11
3.2 Issues and Sources Identified in the Literature Search	11
3.3 Issues and Sources Identified by Facility Managers	13
3.4 Issues and Sources Identified by members of the Master Plumbers and Hydraulic Services Consultants	15
3.5 Issues and Sources Identified by representatives of the Manufacturers and Suppliers	18
4. Findings and Observations	19
4.1 From the Literature Search	19
4.2 From the Survey and consultations with Facility Managers	20
4.3 From the Plumbing Industry	21
4.4 From the Manufacturers	22
4.5 Observations from Technical Team	22
4.6 Other Issues Associated with Non Flushing Urinals	26
5. Potential Solutions	27
5.1 Potential Solutions Identified in the Literature Search	27
5.2 Potential Solutions Suggested by Survey Participants	30
5.3 Potential Solutions Suggested by Representatives of the Industry	31
5.4 Potential Solutions suggested by The Innovation Zone	31



6.	Potential Solutions Suggested by Technical Team	37
6.1	General solutions	37
6.2	Detailed Technical Suggestions	37
7.	Conclusion and Recommendations	42
7.1	General Conclusions	42
7.2	Summary of Recommendations	43
7.3	Details of the Recommendations	45

Table Index

Table 1	Risks Identified	2
Table 2	Typical key players associated with non flushing urinals	4
Table 3	List of Recommendations	44

Figure Index

Figure 1	DN40 Drains	39
Figure 2	Urinal Inspection Outlet	40
Figure 3	Fixture Range	40
Figure 4	Fixture Range Tundish	41

Appendices

- A Bibliography
- B Summary of select relevant research material
- C Questionnaires and Results of Survey of Facility Managers



Executive Summary

This century has seen advances that have reduced the amount of water required for safe and hygienic operation of sanitary fixtures. This has resulted in sanitary plumbing and drainage systems that are less tolerant of the transport of wastes through gravity pipework. The sanitary plumbing and drainage systems now also require increased attention and resources on fixtures which, previously only required basic hygiene precautions.

In support of the World Health Organisation goals on liquid waste disposal, the Plumbing Code of Australia and the referenced Standard AS/NZS 3500.2 provide simple and low maintenance solutions for the safe and reliable operation of the sanitary plumbing and drainage systems. Providing non-complex operational solutions is the primary objective of AS3500.2; however there are times when measures that introduce complexity, such as pump systems, are required.

“Liquid Waste Disposal Goals

- Liquid wastes should be disposed of promptly and hygienically;
- Drainage systems should be of an adequate size and easily cleaned;
- Drainage systems should be equipped with liquid seal trap;
- All drains should be adequately vented;
- Deleterious substances should be excluded from sewers; and
- Backflow of sewage should be prevented.”

World Health Organisation, Health Aspects of Plumbing, Section 6.2

This report investigates one of the challenges to our sanitary plumbing and drainage systems; the effect that non flushing urinals are having on gravity sanitary pipework and fittings. In reviewing this issue, it is important that it is seen in the context of the whole sanitary plumbing and drainage system, including other stresses being placed on the system.

Prepared in consultation with representatives of the plumbing industry, facility managers, hydraulic design engineers and manufacturers of non flushing urinals, this report confirms the links between blockages caused by struvite build up and corrosion of copper piping caused by undiluted discharges in non flushing urinals. This report also identifies suggested solutions, such as:

- ▶ Increased public awareness of the concepts behind the operations of non flushing urinals, methods of operation, cleaning and maintenance as well as hygiene, health, and environmental consequences; and,
- ▶ A general education to building cleaners, facility managers, maintenance service providers on the importance of following specific cleaning and maintenance procedures on these fixtures.

These relatively cost effective and practical solutions to the issues will assist in further promoting the benefits of non flushing urinals in conserving our water environment, whilst further research is continuing to find the safest and most cost effective design and installation of non flushing urinals. Ongoing research and tests will also identify any requirements to amend the existing Plumbing Code of Australia.



1. Background and Scope

As an initiative to reduce water consumption, non flushing (waterless) urinals have increasingly been installed in newly constructed and recently renovated buildings.

Recent researches conducted in Australia have attempted to make the link between the introduction of non flushing urinals in these buildings and issues relating to:

- ▶ Blockages from struvite (magnesium ammonium phosphate scale) build up; and
- ▶ Corrosion of copper pipe, copper alloy pipe and fittings.

However, these researches had not adequately consulted with representatives of the industry in Australia and none of the researches to date have been able to identify the extent of the problem nor the cost of an effective solution.

1.1 Purpose of the Research

The ABCB engaged GHD to conduct a study on this topic to meet the following objectives:

- ▶ Quantify the extent of the impact of non flushing urinals on sanitary plumbing systems in new and existing buildings; and
- ▶ Identify system design limitations and develop clear, cost effective installation standards whilst supporting water conservation.

1.2 Scope of the Research

To meet the above objectives, the following tasks were undertaken:

- ▶ Studied the extent of the impact of non flushing urinals on sanitary plumbing systems as presented by research literatures to date;
- ▶ Supported findings and recommendations established by conducting independent surveys amongst representatives of the building industry canvassing their concerns over the non flushing urinals; and
- ▶ Collaborated with the industry to confirm the findings and jointly identify and formulate clear and cost effective recommendations to improve the system design of non flushing urinals whilst supporting water conservation.

Through the above literatures research, surveys of facility managers, and discussions with representatives of the building and plumbing industry, the study completed the following activities:

- ▶ Reviewed the compatibility of non flushing urinals being used with current sanitary plumbing and drainage system materials and design practices, and identifying whether there are any problems associated with current practices;
- ▶ Considered the performance and operation of non flushing urinals installed in new buildings and retrofitted installations in existing buildings;
- ▶ Confirmed the existence of the problems and established the extent and quantity of the reported problems; and



- ▶ Identified a number of potential solution options and provided recommendations for the preferred or most pragmatic option (s).

With agreement of the ABCB, the study excluded the following:

- ▶ Proving that non flushing urinals save water;
- ▶ Conducting any physical testing to establish the issues or formulate any solutions;
- ▶ Reviewing installations of non flushing urinals which reported no problems to date; and
- ▶ Costs borne by building owners associated with addressing the problems.

1.3 Risks and Opportunities

1.3.1 Risks

GHD has identified and successfully mitigated the following risks associated with the study.

Table 1 Risks Identified

Risk Identified	Mitigation Strategies Adopted
Defining the extent of problem and likelihood of occurrence	<ul style="list-style-type: none"> ▶ Conducted a thorough literature research ▶ Prepared survey and consultation questions which support or deny issues raised in literature research
Confining the perceived operational problems	<ul style="list-style-type: none"> ▶ Clearly separated the perceptions and facts raised about operational problems through a good design of the survey and consultation questionnaires
Understanding the consequences and likelihood to be measured	<ul style="list-style-type: none"> ▶ Gained a clear understanding of the issues revealed during the literature research ▶ Designed a survey and consultation questionnaire which assisted in identifying the consequence and likelihood
The limited time frame to conduct thorough research on the topic, consulting widely across the building industry and finding the most cost effective way of solving the issues	<ul style="list-style-type: none"> ▶ Undertook diligent planning and preparation time, ▶ Provided sufficient early notification for representatives of the industry to participate and provide responses ▶ Listened well to the options presented and prioritising them accordingly
Dependent on industry response and cooperation	<ul style="list-style-type: none"> ▶ Consulted widely across the industry to encourage participation ▶ Provided sufficient time for industry representatives to participate in the survey and consultation session



1.4 Credibility

GHD has identified the following opportunities in undertaking the study and utilised these to mitigate some of the risks above:

- ▶ A number of hydraulic consulting engineers across Australia and overseas, who were able to provide support and input into the research;
- ▶ Involvement in the design and construction of new and refurbished installation of urinals in various buildings in Australia; and
- ▶ Long established working relationship across the building industry, including:
 - the Federal and State Branches of the Master Plumbing Association;
 - the Association of Hydraulic Consulting Engineers Australia;
 - the Facilities Management Association Australia; and
 - the Property Council of Australia.



2. Research Methodology

2.1 General Methodology

This report provides an objective and non bias study, which will produce findings and recommendations which will not either highlight or isolate any particular product or model of non flushing urinals. Consequently the study included consulting with as many people as possible within available resources, literature research, surveys and consultation processes to establish:

- ▶ the issues and their potential sources, associated with the installation, operation, cleaning and maintenance of non flushing urinals;
- ▶ the general findings of the study; and
- ▶ the potential solutions and recommendations.

2.1.1 Relevant Instruments of Legislation

The following codes are relevant to the design supply, installation, operation, cleaning and maintenance of non flushing urinals:

- ▶ AS/NZS 3500.2:2003 2010 Amendments;
- ▶ AS/NZS 5200 – 2006;
- ▶ Plumbing Code of Australia;
- ▶ Plumbing regulations applicable to each separate state and territory;
- ▶ Relevant Sections of the Building Code of Australia; and
- ▶ Work Health and Safety Act as applicable to ACT, NSW, QLD, SA and NT, and relevant OHS Act in WA and VIC

2.1.2 Key Players in the industry

To ensure diverse consultation, key players were identified in the supply, installation, operation, cleaning and maintenance of non flushing urinals.

Table 2 Typical key players associated with non flushing urinals

Role	Typical organisations or industry
Design, Manufacture and Supply	Companies who design, manufacture and supply non flushing urinals
Regulators	State and Territory Regulators
Standard Setting Bodies	Standards Australia, ABCB
Product Certification	Standard Australia
Installation	Hydraulic engineers who design the installation, and develop the specifications for the type of urinals to be installed typically belong to the Hydraulic Services Consultants Australia



Role	Typical organisations or industry
Plumbing Contractors	Plumbers, including those associated with building services installation companies, typically engaged by the building owners and typically belong to the Master Plumbers Association groups
Operation	Facility/ building/ property managers associated either with the building owners or the organisation leasing the buildings typically belong to the Facilities Management Association
Cleaning	Cleaners and cleaning service companies engaged typically by either the building owners or the organisation leasing the buildings typically belong to the Facilities Management Association
Maintenance	Plumbers, including those employed by building maintenance service providers engaged typically by the building owners typically belong to the Facilities Management Association

The study took place between November 2011 and April 2012.

2.2 Identifying the Issues

2.2.1 The methodology adopted

To identify the extent and level of concerns found in existing installations, the following activities were conducted:

1. A literature search of publicly available or published research, accessible via the web, industry publications, and other relevant sources;
2. A survey amongst members of the Facilities Management Association (FMA) of Australia, representing the users and providers of the cleaning and maintenance services of the systems;
3. Correspondence and teleconferences with representatives of the plumbing industry, including members of:
 - The Master Plumbers Association (MPA) in various States, including the Master Plumbers and Mechanical Services Association of Australia;
 - The Association of Hydraulic Services Consultants Australia (AHSCA); and
 - Various manufacturers and suppliers of non flushing urinals.
4. Consultation through the GHD Innovation Challenge group, here on referred to as the Innovation Zone.

2.2.2 Literature Search of the issues

The literature search was aimed at collating the issues established by various researches conducted to date, both in Australia and overseas. The search of 23 published papers included:



- ▶ International research, including the work of Prof. Mete Demiriz - Gelsenkirchen University (Germany);
- ▶ Case Studies; and
- ▶ Existing market research.

A bibliography of literature reviewed is included in Appendix A, whilst a summary of select relevant publication is included in Appendix B.

Observations on the literature search

- ▶ Of the 23 papers reviewed, most were written overseas, with the exception of the articles written by the following authors, either commenting on the existing plumbing system in Australia or proposing recommendations to modified installations in Australia:
 - Dr Stephen Cummings;
 - The Chartered Institute of Building Services Engineers (CIBSE);
 - Plumbers Licensing Board of the WA Department of Commerce; and
 - The National Plumbing Regulators Forum.
- ▶ Most of the papers reviewed focused on the performance and efficiencies of non flushing urinal systems, both in new and retrofit installations. Others focused on methods of collecting and harvesting the phosphate contained in struvite found in non flushing urinals to support potential demands for phosphate in the future.

2.2.3 Survey amongst members of the FMA of Australia

The Survey process

Membership of the FMA of Australia consists primarily of Building or Facility Managers of public and private organisations around Australia as well as employees of organisations who provide maintenance and cleaning services to buildings. Members of the FMA typically represent the people who regularly use the non flushing urinals; receive reports of issues associated with the urinals; and manage the cleaning and maintenance of the urinals.

GHD and the FMA jointly developed a survey aimed to provide evidence or validation of the issues identified in the above literature search and quantify the extent and range of issues found in existing installations in Australia.

The aim of the survey was primarily to canvas:

- ▶ The number of Facility Managers who are experiencing problems with the non flushing urinals installed in their buildings;
- ▶ The types of installations;
- ▶ The nature of the problems; and
- ▶ The cleaning and maintenance services arrangements and regime.

The survey was conducted on line via the FMA network in early February 2012, requesting members to provide their input within a week. Besides providing responses to the survey questions, the survey also invited participants to provide any additional comments about their experience with non flushing urinals.



The survey questionnaire for the Facility Managers is shown in Appendix C.

Responses to the survey

49 responses were received from Facility Managers representing 28 public and private organisations around Australia, ranging from those working for small organisations with only a single building to those representing university or large national company who manage up to 500 buildings. The 49 respondents collectively manage more than 2,200 buildings of varying age across Australia, where approximately 15% of them, or 330 buildings, have been fitted with non flushing urinals.

The age of the buildings fitted with non flushing urinals range as follows:

- ▶ 10 buildings which are less than 5 years old;
- ▶ 10 buildings which are between 5-10 years old;
- ▶ 4 buildings which are between 10-15 years old; and
- ▶ 25 buildings which are older than 15 years old

The types of buildings fitted with non flushing urinals can be grouped as follows:

- ▶ 2 assembly buildings;
- ▶ 1 carpark building;
- ▶ 7 educational facilities;
- ▶ 1 hospital;
- ▶ 1 hotel/ motel;
- ▶ 2 laboratories;
- ▶ 5 'Premier'¹ Grade office buildings;
- ▶ 16 'A' Grade office buildings;
- ▶ 7 'B' Grade office buildings;
- ▶ 2 'C' Grade office buildings;
- ▶ 1 'D' Grade office building; and
- ▶ 4 public buildings (courthouse, exhibition hall etc).

Observations during the Survey

During the survey process, the following observations were made:

- ▶ Positive and enthusiastic responses from the Facility Managers (with 34 responses received within 24 hours upon release of the survey) to participate and provide feedback in the study as the non flushing urinals have been a concern to them for a while; and
- ▶ There was reluctance by some organisations to have their building(s) quoted in the report as examples of buildings included in the study, either due to fear of being 'named and shamed', or that formal involvement in the study requires approvals from senior management and/or representatives of the building owners.

¹ Building grading is based on Property Council's commercial building grading system.



2.2.4 Consultation with representatives of the plumbing industry and hydraulic engineers association

A teleconference was undertaken with representatives of the plumbing industry and hydraulic engineers association in mid February 2012, including representatives of the following organisations:

- ▶ The Master Plumbing Association (MPA) in various States, including the Master Plumbers and Mechanical Services Association of Australia; and
- ▶ The Association of Hydraulic Services Consultants Australia (AHSCA).

A representative from the Australian Building Code Board also attended this teleconference.

Participants of the teleconference were provided with brief background information about the study, and were each given an opportunity to share their experience and comments about the installation, operations and maintenance of non flushing urinals. To ensure independent and objective input was obtained from the participants, the findings of the literature search or the survey of the Facility Managers were not shared with the participants.

Observations on the consultation with the plumbing industry

During the consultation process the following observations were made:

- ▶ Positive and enthusiastic responses from the plumbing industry to participate and provide feedback in the study as the non flushing urinals have been a concern to them for a while; and
- ▶ There was a high degree of goodwill to provide feedback in the study to ensure that the study presents balanced and well consulted findings and recommendations.

2.2.5 Consultations with representatives of the Manufacturer and Suppliers

The original plan was to conduct a survey of Manufacturers and Suppliers and a survey of Architects and Designers. This plan changed when:

- ▶ Findings of the survey of Facility Managers were confirmed through discussions with representatives of the plumbing industry and hydraulic engineers; and
- ▶ These findings indicated that there are limited issues associated with the design, manufacture, supply and installations of the non flushing urinals.

A number of representatives from the manufacturers and suppliers of non flushing urinals contributed to the study either by participating in the FMA survey above, accepting the invitation to the teleconference with the plumbing industry, or by directly contacting the GHD Project Manager for this study. Rather than conducting further surveys, GHD conducted further consultations with representatives of the manufacturers and suppliers of non flushing urinals.

Observations on the consultation with the manufacturers of non flushing urinals

During the consultation process, the following observations were made:

- ▶ Eagerness from representatives of the manufacturers to provide feedback in the study to ensure that the study presents balanced and well consulted findings and recommendations; and



- ▶ Eagerness from representatives of the manufacturers, particularly those who have developed their cleaning and maintenance regimes and associated unique products, to support and work closely with the industry who install, operate, clean and maintain the non flushing urinals

2.2.6 Inspection of select sample installations

Inspections were conducted of select installations to verify the extent of the issues raised through the survey and teleconference. The inspections included visits to a number of buildings:

2.2.7 The Innovation Challenge

To support findings obtained through the above methods, GHD also utilised its Innovation Zone and canvassed issues identified by staff on this topic. The Innovation Zone is a platform to raise a 'challenge' to the technical engineers to suggest solutions. It is a purpose built innovation program that allows for collaboration across GHD business sectors, disciplines and geographic boundaries to share knowledge and apply it to create value within on projects and within industry.

The following challenge was raised on the Zone.

Male sanitary systems non flushing (waterless) urinals have increasingly been included in new and upgraded buildings in an attempt to reduce water wastage. With the introduction of waterless or non flushing urinals issues relating to blockages from struvite (magnesium ammonium phosphate scale) build up and corrosion of copper pipe, copper alloy pipe and fittings have been identified.

The project seeks to quantify, where possible the extent of the impact of waterless or non flushing urinals on sanitary plumbing systems in new and existing buildings. The intention is to identify system design limitations and develop clear, cost effective installation standards whilst supporting water conservation.

We are looking for input and comments on the problems experienced and how the problems are being addressed and rectified.

Using the Innovation Zone is just one of the methods we are utilising to compile our evidence.

We would really appreciate your input.

2.3 Identifying the Sources / Causes of the Issues

To identify the sources of the reported problems, the following activities were undertaken.

- ▶ Compared findings of the literature search and the returned survey responses against the WHO publication titled 'Health Aspects of Plumbing', the PCA Performance requirements and Deemed to Satisfy referenced standard AS/NZS 3500.2; and
- ▶ Shared the general findings of the FM survey to representatives of the plumbing industry and hydraulic engineers during a teleconference and sought their comments.

2.3.1 Observations

The study currently excludes the installation of non flushing urinals which are working efficiently with no or limited reported problems. This considerably distorts the study because it limits:



- ▶ Measuring the overall success of the installations in Australia, particularly the effectiveness of the current drainage system and associated codes and standards; and
- ▶ Identifying the positive aspects of the systems which need to be retained, when making recommendation to changes to resolve identified issues.



3. The Issues and its Sources

3.1 Issues and Sources Identified in the Brief

The ABCB has identified research conducted in Australia that had attempted to make the link between the installation of non flushing urinals in buildings and issues relating to blockages from struvite (magnesium ammonium phosphate scale) build up; and corrosion of copper pipe, copper alloy pipe and fittings. This includes the research and test rig conducted by Dr Steve Cummins, and the subsequent recommendations to modify the existing plumbing Code in Australia to address issues associated with blockages.

Whilst the corrosion of copper pipe, copper alloy pipe and fittings in non flushing urinals installation has been addressed in the Australian Standards, the scope and nature of the link relating to blockages from struvite build up is yet to be further investigated and the extent of the issues found in Australia need to be substantiated.

3.2 Issues and Sources Identified in the Literature Search

3.2.1 Issues linked to blockages from struvite build up

a. Mete Demiriz, - Application of Dry Urinals

Non flushing (Dry) urinals can be operated hygienically if they are maintained and cleaned according to manufacturers' specifications.

- ▶ Urine deposits and fanning of crusts in drainage pipes of non flushing urinals is still the case. It is not possible to remove these by application of high water volumes through the urinal itself; and
- ▶ A very intense odour develops in the drain lines leading away from the non flushing urinals.

b. Dr Steve Cummings - Drainline System Performance Implications for Water Efficient Fixtures

Confirmed the link between non flushing urinals and struvite build up and recommended changes to the drainage installations (and subsequent plumbing code) to facilitate greater flow and prevent struvite build up.

This link is followed by a warning issued by the National Plumbing Regulators Forum, published on the ACTPLA Website.

c. Chartered Institute of Building Services Engineers (CIBSE) - Hydraulics Associations Memorandum

Confirmed the link between non flushing urinals and struvite build up and how cartridge/refill type urinals help eliminate uric salt build-up in the trap. However, the author raised problems with disposal and replacement of cartridges and the on going operational costs of cleaning and maintaining the units.



d. Kai M. Udert, Tove A. Larsen, Will Guyer - Estimating the precipitation potential in urine-collecting systems

Confirmed the link between non flushing urinals and struvite build up, as it states that, '*Precipitation in urine-separating toilets (NoMix toilets) and waterless urinals causes severe maintenance problems and can strongly reduce the content of soluble phosphate.*'

e. Estes, McClure & Assoc Inc Engineering and Consulting - Waterless Urinals: Features, benefits, and applications

The results of two surveys found users generally at least moderately satisfied overall with their non flush urinals. However, a number expressed concerns of one type or another. Reported problems included odours and line encrustations. Many users surveyed observed that there can be a significant learning curve for maintenance and custodial staff to understand proper care of the fixtures.

f. D. Gleiberman, Falcon Waterfree Technologies, J. Watson, Sloan Valve Company - An Assessment of Long-term Performance of Non-Water (Waterfree Urinals) in relation to Drain Line Buildup

'This paper draws three primary conclusions:

- 1. All drain lines supporting any types of urinals can and will clog, even water-flushing urinals can produce some of the worst build-up problems of all plumbing fixtures.*
- 2. Drain line build-up from water-flushing urinals is significantly more costly and problematic to remove than non-water urinals.*
- 3. When installed and maintained properly, non-water urinals will produce less line build-up than water-flushing urinals and can be rinsed clean with water alone².*

3.2.2 Issues linked with corrosion of copper pipe, copper alloy pipe and fittings

Only one paper in the literature search mentioned the link between non flushing urinals and corrosion of copper pipe, copper alloy and fittings. This is possibly because the issue is already covered in the existing Australian Standard.

Tune Up Canberra, ACTPLA a warning on waterless urinals

This is a direct quote from Tune Up Canberra ACTPLA on a warning on waterless urinals.

"Water efficiency measures such as waterless urinals may be recommended by Tune Up reports and building owners may wish to pursue these recommendations as part of Stage 2. Tune Up Canberra will consider providing funding, but it is important that building owners are aware that scale material can build up immediately downstream of waterless urinals causing major blockages when not properly managed. In addition, copper or copper alloy pipe work connected to waterless urinals can be damaged. The AS/NZS 3500.2, Sanitary Plumbing and Drainage, is being amended so certain requirements relating to non-flushing (waterless) urinals are included to prevent issues relating to blockages and pipe damage."³

² f. D. Gleiberman, Falcon Waterfree Technologies, J. Watson, Sloan Valve Company - An Assessment of Long-term Performance of Non-Water (Waterfree Urinals) in relation to Drain Line Buildup

³ Tune Up Canberra, ACTPLA, ACT Environment and Sustainable Development Directorate – accessed 4 June 2012



3.2.3 Other issues

Estes, McClure & Assoc Inc Engineering and Consulting - Waterless Urinals: Features, benefits, and applications

This paper confirmed that waterless, or non flush urinals, may help conserve water and offer other advantages, including lower utility charges, improved restroom hygiene, and decreased fixture maintenance. Some notable caveats include possible lack of acceptance by users, odour control problems, and rejection by code officials.

3.2.4 Testing and Code Requirements

The literature search found that a number of test rigs utilised to measure the performance and efficiencies of non flushing urinals to date have been conducted based on drainage systems which do not conform to current Australian codes, mostly because the tests were conducted overseas. Hence care needs to be taken when trying to adopt the test results of these researches to the installation of non flushing urinals in Australia.

For example, test rigs conducted to address issues associated with non flushing urinals found the following:

- ▶ Flatter drainage pipeline gradient will result in lower velocities and increased time in the pipework to allow precipitates to fall out of the effluent;
- ▶ Lack of adequate venting will result in reduction of air circulating in the pipework to:
 - Enable self-cleaning through drying out the internal surfaces of the pipework; and
 - Aid in the venting of gases produced in the drainage systems.
- ▶ Undersized pipework restricts air flow in the pipework.

However, as the above installations did not comply with current Australian Standards, the recommendations cannot be adopted without changes to the Standards. It should also be noted that the Standards currently do not adequately cover provisions for today's urinals and non flushing urinals, particularly in relations to fixture loading units and pipeline gradient associated with low flow fixtures.

3.3 Issues and Sources Identified by Facility Managers

Survey of the Facility Managers found that out of more than 1,600 non flushing urinals installed in the buildings collectively managed by the respondents, 26% or 416 units are reported to pose problems at some phase after installations. The survey also reveals that approximately:

- ▶ 10% of those experiencing problems, or 142 non flushing urinals, are experiencing regular on going problems, associated with smells, blockages or other issues; and
- ▶ 35% of these, or 145 out of the 416 non flushing urinals having on going problems, are non flushing urinals which have been retrofitted in buildings older than 15 years old.



3.3.1 Issues linked to blockages from struvite build up

Blockages and slow drainage were identified as problems which occur typically on a monthly basis, with nearly 50% of respondents reporting the blockage typically occurring either at the urinals or at the junction between the urinals and the building's drainage pipework. Initial attempts to resolve the blockages are by flushing the units with (hot) water on a daily basis, before maintenance staff or plumbers are called.

Facility Managers understand that intensive cleaning regimes and regular replacement or fill of the cartridges are the key to smooth and efficient operations of the units. However, most have not given their cleaners the appropriate instructions on cleaning the units and more than 60% of respondents do not have clear cleaning instructions shown on the urinal units.

3.3.2 Issues linked with corrosion of copper pipe, copper alloy pipe and fittings

40% of the respondents have non flushing urinals installed in their new buildings, using either PVC or polyethylene piping. 20% of the respondents have only copper piping and 10% have only cast iron piping in their retrofitted non flushing urinals, with no combination of polyethylene (PVC) piping. The remainder of the respondents are unsure of the actual types of piping materials used to support its non flushing urinals system.

Only approximately 10% of respondents were actually aware of the issue of corrosion of copper pipe and copper alloy pipe and fittings. One respondent used to regularly replace the copper sleeves in its system with same, until he was told about the corrosion issue and advised to replace the pipework and associated sleeves with PVC. Others commented on the need to replace more of the existing copper piping in the building risers and associated infrastructure to prevent further problems.

3.3.3 Other issues

Odour/ Smell

20% of the respondents reported problems with odour associated with non flushing urinals. Whilst building users typically did not consider the smell to be a major physical problem which prevent them from using the units, this issue still poses significant concerns to Facility Managers as a perceived health hazard to the building users. One Facility Manager was forced to close the building down temporarily due to extreme odour hazard.

The smell problem typically is resolved primarily by installing cartridges, applying more intensive cleaning and the use of air fresheners. One organisation has accepted the fact that male toilets with non flushing urinals will always carry some odour.

Dumping of chewing gums and similar materials

One respondent reported a problem where cleaners are regularly required to remove chewing gums and other foreign materials from urinals.

General dissatisfaction of non flushing urinals

5% of respondents considered non flushing urinals to be not performing to expectations and too resource intensive, to the extent that they had actually removed the fixtures from their buildings and replaced them



with conventional urinals. This typically occurs in owner occupied buildings, where the Facility Managers have full control and responsibility of the installation, operations and maintenance of the buildings. One organisation with a large number of buildings have made it a policy not to install any more non flushing urinals due to costs and on going problems.

The above issues of blockages and smells are not confined to:

- Any particular make or model of non flushing urinals;
- New or retrofitted installations;
- Any particular type of piping materials;
- any particular type of buildings or usage; and
- Any location in Australia.

3.4 Issues and Sources Identified by members of the Master Plumbers and Hydraulic Services Consultants

3.4.1 Issues linked to blockages from struvite build up

Participants of the teleconference were in agreement that plumbers are regularly called upon to address blockages on non flushing urinals caused by struvite build up, when these could be avoided if recommended cleaning regimes of non flushing urinals were implemented correctly. Participants are also concerned over the practice of regularly flushing litres of hot water into non flushing urinals, as attempts by cleaners, to remove blockages and odours.

The following are comments received on the issue.

Blockages

- ▶ Blockages occur in the first section (600mm) of the pipework through the wall, due to the absence of flushing;
- ▶ Wet fixtures up stream maintain the main drains function but still blockages occur due to the concentration build ups in the outlets of non flushing urinals; and
- ▶ Favourite or first bay urinals located in most convenient locations cause the most issues with struvite and blockages. Is there a way to design out this problem?

Cleaning regimes

- ▶ Issues related to build up of uric acids / salts;
- ▶ In particular, the required daily and programmed cleaning regime done by the cleaners, who may not be adequately trained, or lack supervision;
- ▶ Main problems are associated with cleaners after urinals have been fitted, particularly cleaning with inappropriate materials that degrade the functionality of the urinals;
- ▶ Cleaning agents degrade fixtures;
- ▶ There are products to help breakdown any build up of uric acid;
- ▶ Strong acid used for cleaning destroys rubber seal. Need correct maintenance program for cleaners;



- ▶ Cleaners discharging waste water down urinal to control the smell and uric acid, but defeats the purpose of conserving water;
- ▶ Noted that manufacturers' instructions on cleaning and maintenance are good however they are not effectively communicated to the consumer and cleaners;
- ▶ Found first urinal generally needs cleaning more regularly as it is the most commonly used urinal. Cleaning can happen up to 3 times a day, which means more water is consumed to clean the non flushing urinals;
- ▶ Use power snake to clean urinals at a charge out rate to clients. A power snake should always be used after a cartridge change; and
- ▶ Public hospital – They pour a bucket of hot water down the drain to clear out the smell every 4 hours. This is approximately equivalent to 60L of water every 4 hours. Also, cleaners use a chemical wipe down which defeats the purpose of the non flushing urinal.

Maintenance of non flushing urinals

- ▶ National Plumbing Regulators Forum, CIT and skill centre in Sydney – creating a viewing room in Auburn skill centre to educate apprentices. Construction due in 2013;
- ▶ Cartridge replacement not carried out as per manufacturers' specifications;
- ▶ Noted that the systems with rubber seals and valves seem to be more effective;
- ▶ Increased incidents of sewer blockages due to the reduced quantity of water in the system when compared to the number of occurrence during the period when ongoing flushing system was in place;
- ▶ Debris in urinal - paper, cigarette butts, chewing gum;
- ▶ Disposal of cartridges is not user friendly and pose a potential health issue. Plumber typically needs to put on latex gloves and eyewear, place cartridge in plastic bag, take the cartridge with them and kept it in the van until they can dispose of it where ever they can dump them; and
- ▶ Disposing of disused cartridges. Building users do not want these left onsite because they usually still contain some urine in them, creating a potential health risk to the operators changing cartridges and public if not disposed of correctly. Disposing of the cartridge is not environmentally proactive.

3.4.2 Issues linked with corrosion of copper pipe, copper alloy pipe and fittings

Link between non flushing urinals and corrosion of copper pipe, copper alloy pipe and fittings was also confirmed by participants of the teleconference. They acknowledged the fact that direction outlined in the existing Australian Standard to avoid direct contact between undiluted urine and copper or copper alloy piping and fittings when retrofitting existing installations have not always been adhered to. The reasons for not complying with the Standards are either of the following.

- ▶ Designers failed to include instruction to replace existing copper piping with PVC in the specifications when designing a retrofit; or
- ▶ Plumbers ignored the Standard requirements or the design specifications when installing non flushing urinals in existing buildings; or
- ▶ To save costs, building owners or facility managers ignored plumbers' advice and/or specifications to replace copper piping with PVC during retrofit; or



- ▶ All parties are unaware of the potential corrosion issue.

3.4.3 Other issues

a. Trend to return to flushing urinals

- ▶ The industry noted a trend to replace non flushing urinals with traditional urinals and for them to refuse to install non flushing urinals in the future, despite their Green Star rating. The main reason for this is the costly ongoing maintenance; and
- ▶ Some companies progressively remove non flushing urinals from their property portfolio due to blockages.

b. Odour and ventilations

- ▶ There is a concern across the industry about the odour typically associated with the installation of non flushing urinals causing health hazards to building occupants. The odour issue further highlights misconceptions about non flushing urinals always creating hygiene issues; and
- ▶ The presence of odour in male toilets fitted with non flushing urinals lead to speculations that the ventilation system may not have the appropriate air flow change to remove odour from the toilet block. In turn, this leads to suggestions to review the current code for air ventilation in toilet blocks where non flushing urinals are installed.

c. Upstream fixtures

There are comments indicating the need to install additional fixtures upstream of the non flushing urinals, to assist with flushing the drainage system without having dedicated flushing system for the urinals. This is perceived as a cost effective solution to preventing odours and blockages.

However, the comments also indicate that installation of a wet fixture upstream does not really assist with fixing the problem that occurs at the trap. This arrangement may also pose problems to the system when foreign debris, including vomit is deposited in the basins.

d. Fire insulations for plastic system

The use of a plastic system or PVC system for non flushing urinals, requires additional fire insulations which increase overall installation cost, and in turn is detrimental to the overall cost of the non flushing urinal system.

e. Long term cost benefits of non flushing urinals

- ▶ Non flushing urinals generate a great amount of ongoing maintenance issues with replacement pipes, materials and cartridges for clients who inherit these systems not knowing the true costs of ongoing maintenance;
- ▶ Clients can dictate maintenance periods to save costs and look for cheaper options and inferior brand replacements; and
- ▶ It seems we are saving water with the cost of cartridges and maintenance outweighing the water savings. A cost benefit analysis may fail if the total cost is evaluated over a 10-15 year period with all things considered.



f. Design

Drain design i.e. bend radiuses and entry into other drains has an effect on the ongoing functions. It is suggested that good drainage design principals may assist in preventing odours and blockages associated with non flushing urinals.

g. Urine Concentration at the treatment plant

A question was posed during the teleconference regarding the potential impacts of having concentration of uric acids at the treatment plant. It was suggested that the WA plant is not experiencing any problems with taking the concentrated urine as it means less water for them to treat.

3.5 Issues and Sources Identified by representatives of the Manufacturers and Suppliers

3.5.1 Issues linked to blockages from struvite build up

Manufacturers and suppliers of non flushing urinals are well aware of the fact that struvite build up will cause blockage in non flushing urinals and many have issued cleaning and maintenance instructions on their products to assist cleaning and maintenance teams to correctly look after the installations.

Representatives of the industry consulted during the study also expressed concerns over the practice of flushing buckets of water into non flushing urinals on a daily basis. There is also a concern over poor perceptions about non flushing urinals which also reflect poorly on the designers and manufacturers of these units.

3.5.2 Issues linked with corrosion of copper pipe, copper alloy pipe and fittings

Manufacturers and suppliers are aware of the issue of corrosion in copper pipe, copper alloy pipe and fittings caused by concentrated urine in the system, and conceded that warning about potential corrosions when undiluted urines come in contact with copper piped drainage system is not always adhered to.

3.5.3 The use of cartridges to minimise blockages and smell

Manufacturers of non flushing urinals also produce specially designed cartridges and associated consumables to support the functions of the non flushing urinals and minimise potential blockages and smell. The design of these cartridges and the range of consumables are unique for each type and brand of non flushing urinals.

There are growing concerns over the trend to substitute the cartridges and consumables produced by these manufacturers of non flushing urinals with more generic and less expensive types. As these substitutes have not been designed and manufactured to fit the particular style of non flushing urinals, there are perceptions amongst the manufacturers that these substitutes do not work as effectively, and may generate more blockages and smells to the installations.



4. Findings and Observations

4.1 From the Literature Search

a. Mete Demiriz, - Application of Dry Urinals

The study confirmed that it is not possible to remove urine deposits and fanning of crusts in drainage pipes of non flushing (dry) urinals by application of high water volumes through the urinal itself, and the units need to be maintained and cleaned according to manufacturers' specifications. It also confirmed that this built up of struvite generates a very intense odour in the drain lines leading away from the non flushing urinals.

b. Dr Steve Cummings - Drainline System Performance Implications for Water Efficient Fixtures

In collaboration with the ASFlow Committee, the findings confirmed the above finding by Mete Demiriz and that the deposits can potentially cause complete blockage of the drainline. Test rigs conducted during the research proved the following:

- ▶ Reducing struvite build up in drainlines through the introduction of additional water using fixtures upstream of non flushing urinals;
- ▶ Reducing the transportation of waste from a 4.5L full flush discharge by the 90 degree sweep junction configuration due to the flow characteristics of the hydraulic jump. The hydraulic jump caused the test media to be deposited upstream of the junction; and
- ▶ The use of an alternative 45 degree sweep junction configuration to provide satisfactory waste transportation.

c. Chartered Institute of Building Services Engineers (CIBSE) - Hydraulics Associations Memorandum

The Memorandum confirmed that non flushing urinals provide benefits to the environment, but it questioned the long term cost benefit across its potential operational life.

This Memorandum also confirmed that the use of cartridge/refill type non flushing urinals helped eliminate uric salt build up in traps but raises problems with disposal and replacement of cartridges. The frequency of cartridge replacements or oil/alcohol refills required will be proportional to their usage, and their costs should also be taken into consideration.

d. Kai M. Udert, Tove A. Larsen, Will Guyer - Estimating the precipitation potential in urine-collecting systems

Precipitation in urine-separating toilets (NoMix toilets) and non flushing urinals causes severe maintenance problems and can strongly reduce the content of soluble phosphate.

e. Estes, McClure & Assoc Inc Engineering and Consulting - Waterless Urinals: Features, benefits, and applications

The results of two surveys found users are generally at least moderately satisfied overall with their non flush urinals. However, a number expressed concerns of one type or another. Reported problems included odours and line encrustations. Many users surveyed, observed that there can be a significant benefits by providing training for maintenance and custodial staff to assist with understanding the proper care of the fixtures.



f. S Blume and M Winker - Manuscript - Three years of operation of the urine-diversion system in GTZ headquarters in Germany; user opinions and maintenance challenges

In the main office building of GTZ in Eschborn, Germany a resource-oriented sanitation system containing urine-diversion toilets and waterless urinals is in operation since 2006. After 2.5 years of operating the system, a first overall evaluation of the system and its acceptance amongst users and cleaning staff was conducted.

The overall result is that most of the users appreciate the resource oriented sanitation concept (recycling of nutrients and water savings) but have problems with the technical design. Also, it is difficult to convince the cleaning staff of the necessity of special cleaning routines.

g. M. Clawson, Air Force Civil Engineer Support Agency - Waterless Urinals in Air Force Facilities

Non flushing urinals can be a cost-effective alternative to conventional flush-valve urinals in Air Force facilities, but careful consideration must be given to the custodial, user, and trap replacement issues. Failure to consider these critical factors can cause significant problems and building occupant dissatisfaction with non flushing urinals. To avoid problems with these types of urinals requires that the cleaning staff, maintenance personnel, and users all understand the operation and limitations of non flushing urinals.

4.2 From the Survey and consultations with Facility Managers

Respondents of the survey are typically people who manage the operations, cleaning and maintenance of buildings, for the organisations who occupy the buildings. In select instances, the organisation who occupies the buildings is also the owner. The provision of cleaning and maintenance services to the buildings are generally outsourced through a contract arrangement, and rarely delivered in house.

The survey amongst Facility Managers established the following:

- ▶ There is a link between the installation of non flushing urinals in buildings and issues relating to blockages from struvite (magnesium ammonium phosphate scale) build up;
- ▶ The blockages (and smells) are caused by poor cleaning practices, despite the fact that most manufacturers of non flushing urinals have issued various cleaning and maintenance instructions; and
- ▶ The cost of applying intensive cleaning and maintenance of non flushing urinals is much more than typically expected from sanitary fixtures and is potentially more than the savings achieved through the reduction in water consumption.

A number of respondents considered non flushing urinals to be economically not viable and had actually removed the fixtures from their buildings and replaced them with conventional urinals. However, one respondent also reported that its client, an owner of a large commercial property portfolio, has not only specified the use of non flushing urinals in all retrofits of its buildings, but also insists on a particular brand.

The survey also confirmed the link between non flushing urinals and corrosion of copper pipe, copper alloy pipe and fittings as most Facility Managers reported an improvement in the performance of the system when they replaced all copper piping with PVC. This problem typically occurs when installers (the plumbers and the building owners) do not seek professional advice on material incompatibility which could assist them to avoid installing non flushing urinals to existing copper systems.



Compared to the blockage and smell problems, this incompatibility problem does not appear to cause major concerns to Facility Managers, as the cost of retrofitting and addressing corrosion problems is borne by the building owners. On the other hand, the additional cost of applying intensive cleaning and maintenance of non flushing urinals is borne by tenant organisations, and not the building owner, except in owner occupied buildings.

Whilst non flushing urinals require intensive and specific methods of cleaning, most of the cleaners engaged by respondents of the survey have not been given sufficient instructions on how to clean the non flushing urinals and not all the non flushing urinals have been installed with its care and cleaning instructions affixed to the units

Similarly, many Facility Managers are unsure whether their maintenance service providers have access to the appropriate Operations and Maintenance Manuals for maintaining non flushing urinals.

4.3 From the Plumbing Industry

Participants of the teleconference with representatives of the plumbing industry are typically plumbers who have been involved in the installation, operations, maintenance and disposal of non flushing urinals in various buildings across Australia.

Consultation with representatives of the plumbing industry revealed the following:

- ▶ Untreated urine discharged through non flushing urinals typically causes corrosion to copper pipe, copper alloy pipe and fittings – typically caused by designers and installers who do not follow guidelines to avoid installing non flushing urinals on copper systems, or by building owners who decided not to replace the copper systems during retrofits, primarily due to cost limitations; and
- ▶ The installation of non flushing urinals in buildings has strong linkages to blockages and smells from struvite (magnesium ammonium phosphate scale) build up – problems caused by poor cleaning and maintenance regimes.

The need for more intensive cleaning and maintenance is well observed in the plumbing industry, and there is a frustration that this is not well communicated to the Facility Managers and cleaners of buildings with non flushing urinals through the handing over of the Operations and Maintenance Manuals from the Hydraulic Designers and/or Manufacturers via the Project Manager.

The forum also identifies the following issues in relation to cleaning and maintenance of non flushing urinals:

- ▶ Many cleaners in major buildings, including hospitals, regularly flush litres of water into non flushing urinals as attempts to remove odour and blockages - a practice which exasperates the problem and counter acts the initiative to reduce water consumption;
- ▶ A number of cleaning organisations have substituted the cleaning products or cartridges specific to the non flushing urinals with cheaper brands which often do not work, or create maintenance problems;
- ▶ A potential health issue may arise when transporting cartridges after being removed from the units, as the full cartridge units will remain in the vehicle and travel with staff until they are disposed at destination; and
- ▶ The cleaning and maintenance of non flushing urinals require more resources than the savings achieved through the reduction in water consumption.



There has been a trend to remove non flushing urinals from buildings and replace them with conventional units due to the costs of cleaning and maintaining them, and the challenge of finding reliable cleaners who are able to perform the required cleaning regimes for these units.

4.4 From the Manufacturers

Manufacturers of non flushing urinals confirm the links between these urinals and blockages due to struvite build up, and also with corrosion in copper drainage systems, but found that the causes of both problems are not the non flushing urinals themselves. They agree with the Facility Managers and those in the plumbing industry that the problem of struvite build up is caused by poor cleaning practice, whilst corrosion of copper piping is caused by incorrect installation of non flushing urinals during retrofit of existing systems.

There are concerns amongst manufacturers that they are blamed for designing inefficient or 'smelly' products, despite their efforts of promoting their respective cleaning and maintenance requirements at the time of installation. There are also concerns over the use of substitute and/or less expensive consumables to clean and maintain the non flushing urinals, in place of the products recommended by the manufacturers.

4.5 Observations from Technical Team

This study thus far found the following:

- ▶ Non flushing urinals save considerable volumes of water, which in turn saves building owners of the subsequent costs of annual water rates;
- ▶ Non flushing urinals operate effectively and will not experience blockages due to struvite build up if the units are cleaned and maintained as per manufacturers' recommendations;
- ▶ There is a potential for precipitates to be deposited in sanitary plumbing and drainage systems which may cause corrosions to copper piping and copper alloy pipe and fittings; and
- ▶ Maintenance procedures for non flushing urinals include maintaining a clear sanitary plumbing and drainage pipework.

As identified by the Facility Managers and also by representatives of the plumbing industry, non flushing urinals require higher on going cleaning and maintenance costs than typically expected from other sanitary fixtures. The costs are primarily associated with having cleaners conduct intensive cleaning routines, and use appropriate cleaning consumables and filter cartridges to prevent blockages and smells. Hence building owners and tenant organisations need to be aware that savings achieved through reduction in water consumption may be less than the expenditures incurred through increased cleaning and maintenance regimes.

The Survey also indicates that non flushing urinals pose minimal problems when recommended cleaning and maintenance regimes are applied. This intensive regime is typically followed by managers of single large public building with high number of visitors who are keen to avoid bad press associated with poor amenities in their facilities. They typically can also see the immediate returns on their investment in cleaning and maintaining their toilets through the organisations' profit margins.

On the other hand, managers of a portfolio of buildings of varying age often have difficulties monitoring the diligence and consistency of their cleaning and maintenance service providers across the portfolio.



The challenge is compounded when select buildings are installed with non flushing urinals which require additional attention and resources.

To avoid potential corrosion problems in the future, Building owners contemplating to install non flushing urinals in their existing buildings need to allow for additional costs to replace all existing copper piping and copper alloy pipe and fittings which will be in direct contact with undiluted urines in the system with PVC. If necessary, all copper piping in the risers should also be replaced.

The above findings lead to three distinct typical scenarios:

1. A number of building owners and managers cannot afford the required additional attention and resources associated with non flushing urinals and are returning to conventional flushing urinals, including banning the product from its property portfolio;
2. Building owners and managers accept the fact that non flushing urinals require additional attention and resources, however, where no monetary savings have been made to date, the building owners are not willing to extend the installation of non flushing urinals in their building portfolio until the product/ system improves; and
3. A number of building owners and managers accept the fact that non flushing urinals require additional attention and resources, but they also see the benefits to the environment as well as to their corporation image and consequent profits, and hence are eager to extend the installations across the portfolio.

4.5.1 The World Health Organisation's Liquid Waste Disposal Goals

To protect the health of the community, the primary goal of any sanitary plumbing and drainage system is to have a system capable of operating with minimal maintenance without requiring any intervention that results in human exposure to the internal surfaces on sanitary plumbing and drainage pipework and exposure to sewer gases.

This is summarised in the WHO's Liquid Waste Disposal Goals⁴, where:

Liquid wastes should be disposed of promptly and hygienically

Drainage systems should be of an adequate size and easily cleaned

Drainage systems should be equipped with liquid seal trap

All drains should be adequately vented

Deleterious substances should be excluded from sewers

Backflow of sewage should be prevented.

Consequently, findings of this study thus far, pose some contradictions to parts of the above WHO's Goals in disposing liquid wastes, as non flushing urinals typically require intensive cleaning and maintenance regimes. Failure to undertake appropriate cleaning and maintenance activities may lead to potential health hazards in the form of odour, whilst methods of addressing some of the blockages also involve activities may result in human exposure to the internal surfaces on sanitary plumbing and drainage pipework.

⁴ WHO Health Aspects of Plumbing



The addition of high maintenance products, into a system that has a goal of low maintenance, presents dilemmas in applying WHS principles and in the safe and reliable operation of the system. It is noted that some sanitary plumbing and drainage systems incorporate complexity into the solution with the likes of sewage pumps and vacuum systems. As it is difficult to establish where the line needs to be drawn between what is acceptable complexity and unacceptable complexity, it is likely that any solution will not be agreeable to all industry stakeholders.

Consequently, the primary driver for a solution needs to be focused on the protection of the health and safety of the community.

4.5.2 Drivers for the Installation of Non Flushing Urinals

The primary driver for the installation of non flushing urinals in new and existing buildings has been to implement sustainable water management through water reduction strategies. However, to prevent blockage and smells, the common cleaning practices of non flushing urinals to date include flushing the urinals with litres of water on at least a daily basis.

4.5.3 Current Legislative and Code Environment

The current national Codes and Standards governing the design, manufacture and installation of non flushing urinals and associated systems are legislated by individual State and Territory Acts and Regulations. Currently, none of the codes or the relevant State and Territory Acts mandate provisions to be made for installations of the systems and fixtures and none mandate any obligations to maintain the systems.

Existing product standards generally require operation and maintenance instructions to be attached to the fixture. However, unlike the introduction of the backflow prevention requirements this requirement to attach operations and maintenance instruction to the fixture, and the requirement to clean and maintain non flushing urinals as per manufacturers' instructions, has not been mandated as a public health responsibility. Recent survey work also confirms that only 30% of Facility Managers have operations and maintenance instruction attached to the non flushing urinals.

Similarly, the Plumbing Code of Australia does not detail the maintenance requirements of Sanitary Plumbing and Drainages systems, other than providing a functional guide to provide safe and healthy access to undertake maintenance. This code stipulates that provision is to be made so that "*adequate access for maintenance of mechanical components, operational controls and for clearing blockages.*"⁵ and an Explanatory box with information about "Non-flushing (waterless) urinals".

AS/NZS 3500.2-2003 "*specifies the requirements for the design and installation of sanitary plumbing and drainage from the fixtures to a sewer, common effluent system or an on-site wastewater management system, as appropriate.*"⁶ This standard details where provisions are to be made for maintenance, but does not stipulate the maintenance requirements for the systems.

Currently, AS/NZS 3500.2-2003, in clause 11.24.2.3, provides the following installation instructions: "*Waterless wall-hung urinals with an integral cartridge seal or integral self-sealing mechanical device*

⁵ Australian Government and States and Territories of Australia, 2011, *National Construction Code Series, Volume 3, Plumbing Code of Australia* (PCA:2012), Australian Building Codes Board, Canberra. Clause CP1.1 (d).

⁶ Australian Standards, 2003, *Plumbing and drainage. Part 2: Sanitary plumbing and drainage* (AS/NZS 3500.2:2003), Incorporating Amendment Numbers 1, 2, 3 and 4, Standards Australia, Sydney. Clause 1.1.1.



may be installed without an additional fixture trap or self-sealing mechanical device. Prior to installing a waterless wall-hung urinal to an existing system, the installer shall determine the materials of the pipes in the existing system. The undiluted discharge from the urinal shall not be transported through copper pipework."

Whilst out of date, the above instructions are also quoted in clause 11.2 of ATS 5200.459 and clause 11.2.2 of ATS 5200.469.

As part of the documentation required to be provided by the manufacturers of non flushing urinals, in accordance with ATS 5200.459, clause 11.3, the following operational and maintenance information is required:

"Operating instructions shall be provided, which shall include the following:

- (a) Method of cleaning.*
- (b) Replacement of seals (where necessary).*
- (c) Occupational health instructions, such as safety of equipment.*
- (d) Essential requirements and precautions.*
- (e) Other instructions, as necessary."*

This is similar to ATS 5200.469, however this standard, in clause 11.2.1, further requires that *"Installation instructions shall be provided, which shall give full details of installation procedures for urinal, including the need for special tools or training. Care and maintenance instructions shall be provided and affixed to the urinal."*

(The results of the survey amongst Facility Managers indicate that care and maintenance instructions are not being passed onto facilities management effectively.)

Where existing urinals are to be converted to non flushing type, clause 11.24.3 of AS/NZS 3500.2 requires that *"Urinals shall not be converted into non flushing urinals unless the wall-hung or slab urinal has been authorized for use as a waterless urinal, and the requirements of Clauses 11.24.2.1 and 11.24.2.3 have been satisfied."*

State and Territory legislation mandates that certain plumbing and drainage components are maintained and reports submitted for scrutiny by a local authority. These components include fire systems, on-site wastewater treatment systems and testable backflow prevention devices. Currently there is no legislation that requires other Sanitary Fixtures the maintenance of to be undertaken and/or reported.

4.5.4 Australia's Work Health and Safety Act and the WA and Victorian Occupational Health and Safety Acts

Recently introduced Australia's unified Work Health and Safety and their respective Occupational Health and Safety Acts in WA and Victoria require organisations to apply the highest order of control to ensure works are executed in a safe and healthy manner. This includes the provision of design solutions which facilitate safe and healthy operations, cleaning and maintenance of products and installations.

In terms of the installation and maintenance of non flushing urinals, health and safety hazards are recognised in the process of executing cleaning and maintenance activities to the units. Greater attention needs to be applied to the design and installation of the units to ensure that there is limited human exposure to the internal environment of the plumbing system.



4.6 Other Issues Associated with Non Flushing Urinals

The study also identified a number of other issues associated with non flushing urinals which cannot be categorised the same as above.

- ▶ There is a perceived level of risk to community posed by regular odour emitting from non flushing urinals, regularly raised as health issues to building occupants;
- ▶ The concept of having sanitary fixtures, which do not consume any water, pose some social issues to certain members of the community who are required to use water in ablutions;
- ▶ The use of plastic materials to support the installation of non flushing urinals need to be further supported with the installation of fire insulations; and
- ▶ The impacts and contributions of non flushing urinals to achieving green building targets, and potential changes to Australian Standards to advance the cause of sustainability in buildings.



5. Potential Solutions

This study on the impact of Male Sanitary Systems Non Flushing (Waterless) Urinals on the Plumbing System identifies a number of potential solutions to each of the two issues initially identified in the Brief, as well as to other issues generally associated with non flushing urinals. The solutions are collected progressively during the study either from the literature search or as suggestions from various parties consulted during the study.

To enable us to develop a clear path towards resolving these issues, we have grouped the suggestions into several types as follows:

- ▶ Education Awareness Raising and Education
- ▶ Research Further Research into the topic, which may later provide reasons for changes in Code requirements
- ▶ Modifications Suggestions for minor modifications to the installations of non flushing urinals
- ▶ Design Suggestions for activities during design phase of the installation, which may later lead to changes in Code
- ▶ Code Suggestions for change in Code requirements

5.1 Potential Solutions Identified in the Literature Search

5.1.1 Solutions for built up of struvite which causes blockage in the system

Author	Potential Solutions for built up of struvite which causes blockage in the system	Type of suggestion
Mete Demiriz. ⁷	<ul style="list-style-type: none"> ▶ <i>Dry urinals can be operated hygienically, if they are maintained and cleaned according to manufacturers' specifications.</i> 	Education
	<ul style="list-style-type: none"> ▶ <i>A very intense odour develops in the drain lines leading away from the dry urinals. A larger clearance has to be taken into consideration during the design and positioning of the breather pipes and the air inlet ducts'</i> 	Design
Dr Steve Cummings. ⁸	<p>Recommended the following action and amendments to the plumbing and drainage standards</p> <ul style="list-style-type: none"> ▶ <i>'Waterless urinals - A minimum of two additional fixture units e.g. two hand basins, must be installed upstream of every waterless urinal, excluding cleaner sinks.</i> 	Design

⁷ Mete Demiriz, Gelsenkirchen University of Applied Sciences - Application of Dry Urinals

⁸ Dr Steve Cummings - Drainline System Performance Implications for Water Efficient Fixtures



Author	Potential Solutions for built up of struvite which causes blockage in the system	Type of suggestion
	<ul style="list-style-type: none"> ▶ 90° Junctions - Junctions installed in a vertical plane shall not be used for connection of stacks. Sweep and 45° junctions may be laid in the vertical plane for the connection of a single discharge pipe or a drain. A 45° junction shall only be used for the connection of a water closet pan. 	Design
	<ul style="list-style-type: none"> ▶ Horizontal sweep junctions - At this stage the requirement as specified in the German Standard DIN 1986 appears to be a suitable solution. Following further tests to Australian Standards the adoption of this requirement into the Plumbing Code of Australia may provide a more efficient drainage system 	Code
Chartered Institute of Building Services Engineers (CIBSE) . ⁹	<i>‘The initial cost benefit of non flushing urinals must be viewed across its potential operational life. The frequency of cartridge replacements or oil/alcohol refills required will be proportional to their usage. The design engineer in their final selection will need to evaluate whether a water fed sensor controlled flushing mechanism will ultimately serve an installation better than the installation of waterless urinals with the ongoing costs’</i>	Research Design
M. Clawson, Air Force Civil Engineer Support Agency ¹⁰	Waterless urinals can be a cost-effective alternative to conventional flush-valve urinals in Air Force facilities, but careful consideration must be given to the custodial, user, and trap replacement issues. Failure to consider these critical factors can cause significant problems and building occupant dissatisfaction with waterless urinals. To avoid problems with these types of urinals requires that the cleaning staff, maintenance personnel, and users all understand the operation and limitations of waterless urinals.	Education

⁹ c.Chartered Institute of Building Services Engineers (CIBSE) - Hydraulics Associations Memorandum

¹⁰ Waterless Urinals in Air Force Facilities



5.1.2 Solutions for General Problems associated with non flushing urinals

Author	Potential Solutions for General Problems associated with non flushing urinals	Type of suggestion
Estes, McClure & Assoc Inc Engineering and Consulting ¹¹	<ul style="list-style-type: none"> ▶ 'Before installing waterless urinals throughout a building, campus, or district, a pilot program for evaluation is recommended. This allows owners to become familiar with and gain confidence in the product and properly train their personnel. ▶ Many users surveyed observed that there can be a significant learning curve for maintenance and custodial staffs to understand proper care of the fixtures. 	Education
	<ul style="list-style-type: none"> ▶ Also, a life cycle cost analysis should be done to determine actual cost savings. 	Research
Ralf Otterpohl. ¹²	<p><i>'Open dialogue and exchange of experience are essential in order to bring the matter forward. There are so many technological options, that most social and economic conditions can be met. Creativity is needed to find the appropriate technology and the best way of implementing, operating and financing. Even though many industrialised countries will need decades for conversion due to the long lasting existing infrastructure, these countries are the ones with good resources for research and pilot installations. The pilot installations described above are only a part of worldwide quest for better solutions. A lot more pilot plants and research is needed, preferably projects that do operate without subsidies in typical conditions'</i></p>	Research
Christine Werner, ECOSAN ¹³	<p><i>'Further research and development is urgently required to gain the necessary experience in these more complex areas that would allow ecosan systems to be implemented on a large scale, to show case the technical feasibility and the benefits of this new approach. In addition to this, there are several other challenges which need to be faced before ecological sanitation systems will be widely adopted:</i></p> <ul style="list-style-type: none"> – Awareness of the alternatives offered by ecosan has to be increased and large scale capacity building is required; – Legal frameworks and technical standards need to be revised; – Full cost analysis and comparison of the environmental and health risks of all types of sanitation have to be established; and – Resource reuse needs to be integrated into sanitation planning processes from the very beginning; 	Education Code Research

¹¹ Estes, McClure & Assoc Inc Engineering and Consulting - Waterless Urinals: Features, benefits, and applications

¹² Ralf Otterpohl - Resource efficient wastewater concepts - technical options and initial experience

¹³ Christine Werner, ECOSAN - Closing the loop through ecological sanitation



Author	Potential Solutions for General Problems associated with non flushing urinals	Type of suggestion
	<ul style="list-style-type: none"> – Innovation-friendly investors are required, as well as new financing instruments supporting private households investment. <p><i>However due to its huge potential, these challenges must be overcome and ecological sanitation should be recognised and introduced as the new, promising, holistic and sustainable approach to provide safe and decent sanitation, reduce poverty, contribute to food security, preserve our environment.</i></p>	Research
Kai M. Udert, Tove A. Larsen, Will Guyer	<p><i>‘Several suggestions have been made to remove struvite and HAP scales and prevent their precipitation. Currently, construction of traps, which can easily be exchanged, seems to be the most favourable. However, ongoing research may provide better solutions’¹⁴.</i></p>	Research
S Blume and M Winker - Manuscript ¹⁵	<p>Before non flushing systems can be widely spread, clear cleaning routines and maintenance documentations are required as well as certain technical modification to ease optimise the separation in the toilet bowl as well as the change of spare parts of the toilet.</p>	Education Design

5.2 Potential Solutions Suggested by Survey Participants

To solve blockage and smell problems, participants of the survey across Facility Managers generally recommend improved cleaning and maintenance activities, whilst also installing air fresheners. The following are some of their suggestions.

To remove smells

- ▶ Air fresheners, eg Automatic spray dispenser;
- ▶ Run the toilet exhaust;
- ▶ Additional cleaning;
- ▶ Replace the cartridge;
- ▶ Replace the siphon and with air freshener spray;
- ▶ Top up the liquid seal; and
- ▶ Scrub down urinals.

To remove blockage

- ▶ Check urinal valve flush with water. Replace valve if damaged/ blocked;
- ▶ Fill with water;
- ▶ Flush with 6 litres of water and replace tablets;
- ▶ Flush with water and descale;
- ▶ Flush and clean the urinals;
- ▶ Flush the system with water and possible drain clean out;
- ▶ Have the unit serviced;
- ▶ Reinstate auto flusher to flush on a timer;
- ▶ Scrub out urinal and replace sleeve. Call plumber if blocked; and

¹⁴ Kai M. Udert, Tove A. Larsen, Will Guyer - Biologically induced precipitation in urine-collecting systems

¹⁵ Three years of operation of the urine-diversion system in GTZ headquarters in Germany; user opinions and maintenance challenges



- ▶ Install wash basins upstream from urinals.

For general issues

- ▶ Increase cleaning and maintenance budget and increase the frequency of service; and
- ▶ Remove the Urinals.

5.3 Potential Solutions Suggested by Representatives of the Industry

The following potential solutions have been suggested by Facility Managers, plumbers and hydraulic engineers as well as manufacturers of non flushing urinals consulted during this study.

5.3.1 To control build up of struvite and consequent blockages

- ▶ **Education type of solution**
Improved share of Information and educational process to building users, facility managers, cleaners and cleaning companies, plumbers and maintenance service providers on basic concepts and designs of non flushing urinals, and the importance of applying intensive cleaning and maintenance
- ▶ **Design type of solution**
To increase the air change flow rate and ventilation capacity requirements in male toilets where non flushing urinals are installed

5.3.2 To prevent corrosions of copper pipe, copper alloy pipe and fittings

Education and Information campaign to increase awareness amongst Building Owners, Facility Managers, Design Consultants and Plumbers of the potential risks of corrosions posed by untreated urine entering copper piping and the consequent need to avoid installing non flushing urinals to existing copper piping when undertaking retrofits of male toilets. This may also involve replacing existing copper piping along the stacks and associated drainage lines.

5.4 Potential Solutions suggested by The Innovation Zone

The Innovation Zone is designed for people to quickly and easily contribute to a challenge in the same way you would contribute to a face to face conversation. Therefore the following comments are to be read in that context. The following suggestions are made in response to the issue of blockages caused by built up struvite.

Author	Suggestion	Type of suggestion
GHD Brisbane, QLD	A possible solution would be the installation of a 'counter' on a sensor to flush toilets every 4th person. This method has been used for many years in male toilets and could be easily adapted to the flushless urinals. This would assist in increasing the water flow into the system where the build-ups are usually located. Would a neutralising agent in the urinal work?	Modification



Author	Suggestion	Type of suggestion
	<p>The requirement for additional plumbing could be cost effective in new buildings however currently it is not considered feasible for this type of system to be retrofitted into existing buildings.</p> <p>This is a new and emerging concept that may well revolutionise not only the plumbing systems and output but also the inputs and the habits of individual functions at the point of entry (WC).</p> <p>Refer to Appendix E for further details</p>	
GHD Melbourne, Victoria	<p>It may be more beneficial to program the urinals to flush a certain number of times per day. Once or twice a day - year round should be sufficient, rather than based on the number of times it is used. For example, if there is a conference in the building and 20 people use the urinal in 15 mins, it will flush too often.</p> <p>Or the other way around - if people are working over the holidays - and it only gets used 3 or 4 times in a week or 2, it wont flush often enough, if at all.</p> <p>Flushing the urinal once or twice a day should provide sufficient flow to the system, while maintaining a reduced water usage.</p>	Modification
GHD Townsville, Northern Queensland	<p>I think the issue is one of odour rather than timing - what if there was a sensor that triggered on the odour only? I presume in warm weather there would be more flushes and cold weather less with a timer to ensure a minimum number of flushes per day as a health thing. Even if water usage was cut by 50% it is a significant saving. Like a smoke detector fitted to the urinal!</p>	Modification
GHD Brisbane, QLD	<p>There are automatic sensors available on the market that would be relatively simple to program to activate every fourth visit? Probably not something that could be patented but could be suggested to a supplier if GHD are specifying.</p>	Modification
GHD Cairns, QLD	<p>Suggest that to increase the amount of water in the system without taking from the main water system initiate the recycling of the sink water from hand washing.</p> <p>Distribute the grey water from the wash basin drainage. Although intermittent it should correlate with the frequency of use of the facility.</p> <p>There could be potential issues for disinfection but since it is not drinking water all that may be required is signage .</p>	Design



Author	Suggestion	Type of suggestion
GHD Adelaide, South Australia	<p>In response to the recycling of grey water into the urinals; Recycling grey water is something that is done in Japan in some facilities (and homes). So the toilet (or urinal) is used, and when the user washes hands, the discharge from the sink is used for flushing of the toilet. The sink probably would typically discharge straight to the cistern. There should be a delay in top up from mains water.</p> <p>Overall, a good / practical idea, and something that should be advocated. There is however, likely to be a significant hurdle when it comes to dealing with the Department of Health guidelines for each state, which typically require Class A for toilet flushing. DoH would need to be sounded out for each individual application prior to suggesting to the client.</p>	<p>Design</p> <p>Code</p>
, GHD Adu Dhabi	<p>From my experience with the Middle East (M.E.) countries the non-flushing urinal is not a common practice and generally not recommended in the Islamic communities. This is because the Muslim ritual is for the individual to wash themselves with water after using the toilet or urinal.</p> <p>Instead of urinals it is more common to provide a low flushing WC with a separate faucet with hose attached for rinsing (toilet paper is not used for individual hygiene). The hose is usually ultra-low flow in recent constructions. In some cases if the WC's with flushing are not available, bidets will be provided and used for cleaning. Recently some manufacturers of sanitary fixtures have produced new urinals with ultra low flush rate and most of the M.E. municipalities are going to change the regulations to accommodate them in the design.</p>	Modification
GHD Syracuse, USA	<p>Thank you for including us. I am in the new GHD office in Syracuse NY, USA. We look forward to our future participation.</p> <p>I see your email to Mr Koeller was in regard to drainage systems and possible published data.</p> <p>We have no other data than our experiences. Those are at the user and local level. We still encounter occasional local codes which do not permit the waterless unit. These are often due to plumbing trade pressure to not loose the domestic piping work. We have had user complaints of odors. not from the active part of the unit but from the walls of the unit. Cleaning takes care of this, but this may only be once a day.</p> <p>I hope this in useful to you. This is my feedback from the plumbing (building hydraulic) managers and staff.</p>	Education



Author	Suggestion	Type of suggestion
<p>GHD California, USA</p>	<p>For the Australian report please see the brief news released April 2012 about waterless urinals not being compatible with a building in Sacramento. The entire high rise building housing the California EPA had been retrofitted with waterless urinals, but they were later removed and replaced with 0.5 gpf urinals. The original urinals had been at 1.6 gpf, I believe.</p> <p>CAL/EPA Issues Statement on Waterless Urinals</p> <p>SACRAMENTO, Calif.: Cal/EPA strongly advocates the use of waterless urinal technology in all buildings, new and old, whenever feasible and supported by the building's plumbing systems. This innovative green technology reduces unnecessary water consumption and increases sustainability.</p> <p>The Cal/EPA Headquarters' building was originally equipped with 1.6 gallon-per-flush urinals. In an effort to reduce water consumption, in 2006 the building's management decided to explore the use of waterless urinal technology. This technology was evaluated for a number of years, and it has since been determined that, unfortunately, the building's core plumbing systems are not compatible with that waterless urinal technology. Cal/EPA, as part of its continued effort to save water and promote sustainability, has since installed new 0.5 gallon-per-flush urinals.</p> <p>Cal/EPA strives to spur innovation such as waterless urinals which are a phenomenal technology for saving water. We remain committed to supporting new methods to reduce water consumption, emissions, and waste. The Agency encourages the continued use of waterless urinal technology, and commends these businesses for their technological innovation. The use of waterless urinal technology is an effective way to reduce unnecessary water consumption and promote sustainability.</p> <p>http://www.calepa.ca.gov/pressroom/Releases/2010/April1.pdf</p>	<p>Modification</p> <p>Retrofit</p>



Author	Suggestion	Type of suggestion
GHD Arizona, USA	<p>One option is to deviate from the "pea trap" design, and use a canister type oil trap and tubing (say 1/2 inch diameter). If the tubing is a teflon coated tubing, I don't think the precipitates will form, and if it does, the urinal should be designed to allow removal of the tubing. (1/4 - 1/2 inch teflon tubing are often times used in wastewater samplers....and not many things will stick to it.</p>	Modification
Comment Sydney	<p>Personal feedback from a user; the no flush urinals can create a horrible experience in a washroom sometimes, because of odour. A pretty basic function of any sanitary fixture is that it works and maintains a healthy environment. Always the problem with odour has been with the cleaning regime. It is essential that the cleaners are trained and understand how to maintain and clean the urinals. Adding perfume is addressing the result not the cause. The various manufacturers of waterless and water flushing urinals sing the praises of their own product but all suffer performance if cleaning is not done properly.</p> <p>Generally the introduction of water into the cleaning process is the culprit; as water is the enemy of the waterless urinal on the user side of the fixture. As far as water down drains is concerned, there is general agreement that drains are suffering from reduced water flows and thus moving solids down drains is not happening as efficiently as it used to when larger flushes of water were the norm for soil fixtures. Blindly designing in water saving devices without understanding the effects on hydraulic systems can be a bit dangerous.</p> <p>An Australian manufacturer of water flushing urinals has undertaken a lot of testing of water flushing and waterless urinals (and most of us know of this) to investigate the build up of salts in discharge pipes and the 'solution' has been suggested to design pipework that includes a waste fixture (eg a handbasin) upstream of the urinal. This may or may not be the answer.... but it could help. It's a good idea to design this way if we can and also design drainage so that waste fixtures are installed upstream of WC's to keep solids moving.</p>	<p>Education</p> <p>Design</p>

Summarised suggestion

The most significant solution to arise from the challenge is the reuse of the basin water back into the urinal cistern. This has the effect of increasing the water into the urinal and thus the plumbing system without increase the overall consumption of water for the building.



6. Potential Solutions Suggested by Technical Team

6.1 General solutions

6.1.1 Research Suggestions

- ▶ Conduct further studies on the long term benefits and costs of non flushing urinals, using a whole of life costs analysis, for both new and retrofit installations;
- ▶ Conduct accurate rig tests on the efficiencies and overall performance of non flushing urinals to guide further development of the design and manufacture of non flushing urinals which will either improve its performance and/or maintainability or possibly support any potential changes to current Codes and Standards. This should include tests to establish the most appropriate method of calculation of fixture loading units, establishing the minimum piping slope and various other potential solutions, as identified below; and
- ▶ Conduct further studies on collecting and harvesting urines, as potentially this will assist in preventing built up struvite. Findings of the research may lead to a new Australian Standard to support this.

6.1.2 Change of Code Suggestions

- ▶ To legislate the requirement to undertake intensive cleaning and maintenance of non flushing urinals, by creating an Australian Standard on the maintenance of non flushing urinals, similar to the Standards for maintenance of fire systems and cooling towers in buildings; and
- ▶ To legislate the need to install care and cleaning instructions of non flushing urinals on the units.

6.2 Detailed Technical Suggestions

6.2.1 Calculation of Fixture Loading for non flushing urinal Units

The sizing criteria for sanitary pipework design in Australian Standards are based on fixture units, with urinals and basins having an allocation of 1 fixture unit each. This value has been applied to urinals since 1990¹⁶ for the design of Sanitary Plumbing and Drainage systems. This fixture loading unit is not relevant to today's urinals and non flushing urinals, as explained below.

A Fixture unit, used to determine the hydraulic load on sanitary plumbing and drainage systems, is based on a statistical theory model and was first used by Hunter in 1940 who applied the idea of probability to sanitary appliances.¹⁷ The probability of finding a sanitary appliance at any instant is calculated by:

$$P = \frac{t}{T}$$

Equation 1

Where:

¹⁶ Australian Standards, 1990, *National Plumbing and Drainage Code. Part 2: Sanitary Plumbing and Sanitary Drainage* (AS 3500.2-1990), Standards Australia, Sydney. Section 6.

¹⁷ Wise, A.F.E. Swaffield, J. A. *Water, Sanitary & Waste Services for Buildings*, 2002, 5th Edition, Butterworth, Oxford. Chapter 1.



P = probability.

t is the time in seconds the appliance discharges; and

T is the time in seconds between the operations of the appliance or the interval between uses.

T values are often given in texts as

- ▶ 1,200 sec Intermittent use;
- ▶ 600 sec Frequent use;
- ▶ 300 sec Congested use.

A further variable in determining a fixture unit rating for an appliance is the average flow, q , from the appliance during the time of appliance discharge, t .

AS/NZS 3500.2:2003, Table 6.1 details that non flushing urinals, along with all other urinals be given a fixture unit rating of “1”. This is an over estimation of the loading that non flushing urinals and ultra-low flushing urinals have on the systems even with congested frequency of use.

The single fixture rating applies equally to urinals with flush volumes of 2.5 L per flush and those urinals which are waterless or are ultra-low flush.

The t , T and q values for a 2.5 L flush urinal are estimated to be:

t : 5 sec
 T : 300 sec
 p : 0.0167
 q : 0.6 L/s

That is; a probability of 0.0167 of 0.6 L/s at any instance.

The t , T and q values for a non-flush urinal are estimated to be (assuming a micturition point of 250 mL):

t : 12 sec
 T : 300 sec
 p : 0.04
 q : 0.0208 L/s

That is; a probability of 0.04 of 0.0208 L/s at any instance.

On the above basis, and assuming a 2.5 L flush urinal is given a fixture unit loading of 1, using Hunter’s approach, the fixture unit loading for a non flushing urinal would be approximately 0.15.

Consequently, it would be beneficial to apply fixture loading units developed specifically for non flushing urinals and ultra-low flush urinals. However, it should be noted that this will significantly change design solutions and may force more appropriate pipe sizing and pipe gradients suitable for low water use plumbing and drainage systems.

6.2.2 Minimum Pipe Slope

A tenet of drainage design is the concept of a flushing velocity, which generally accepted as being 0.6 m/s.

Figure 1 details calculated velocities in a PVC pipe with an internal diameter based on Manning's Equation along with depth of flow at various pipe gradients. Two scenarios have been shown, one and four non flushing urinals discharging into a single pipe, based on the fixture unit developed earlier in 6.2.1.

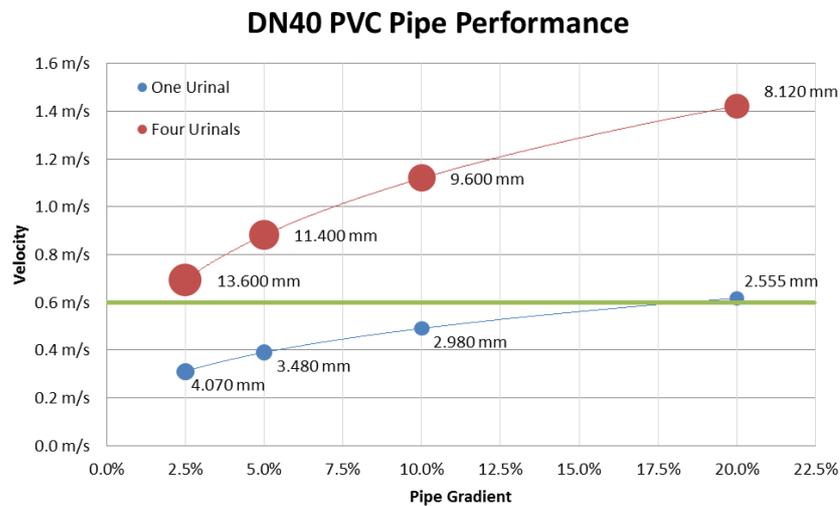


Figure 1 DN40 Drains

Where a single urinal is connected to the pipe detailed in Figure 1, the flushing velocity is reached when the pipe gradient is approximately 20% (1:5) with a 2.555 mm depth of flow. Where four urinals are discharging into a single pipe, the probable simultaneous flow achieves the flushing velocity at the AS/NZS 3500.2 flattest permitted gradient, 2.5% (1:40), for DN40 drains¹⁸.

Test rigs mentioned in a couple of the researches, indicate that steep graded pipes resist the build-up of urine precipitates. It may be critical now to conduct controlled physical tests in Australia to determine the minimum threshold gradient, if any, which would be resistant to the build-up of urine precipitates.

6.2.3 Maintenance Access

Maintenance access to individual non flushing urinals could be provided similar to the pipework arrangement shown in Figure 2. A new range of fittings may need to be manufactured to accommodate increased gradients in pipework.

¹⁸ Australian Standards, 2006, *Plumbing and drainage. Part 2: Sanitary plumbing and drainage (AS/NZS 3500.2:2006)*, Incorporating Amendment Numbers 1, 2 and 3, Standards Australia, Sydney. Tables 6.3 and 7.1.

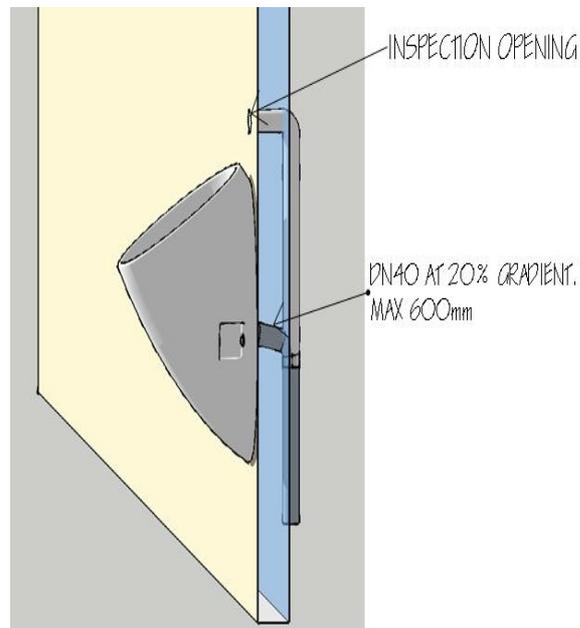


Figure 2 Urinal Inspection Outlet

6.2.4 Urinal Pipework

Similar to Figure 8.7 in AS/NZS 3500.2:2003, the pipework directly out of the non flushing urinal could be specified to have a steeper gradient and a shorter pipe length as shown in Figure 2.

6.2.5 Single Stack Fixture Range

Changes to Urinal Fixture Ranges on Single Stack systems would have to be included to embed self-maintaining sanitary plumbing systems as shown in Figure 3.

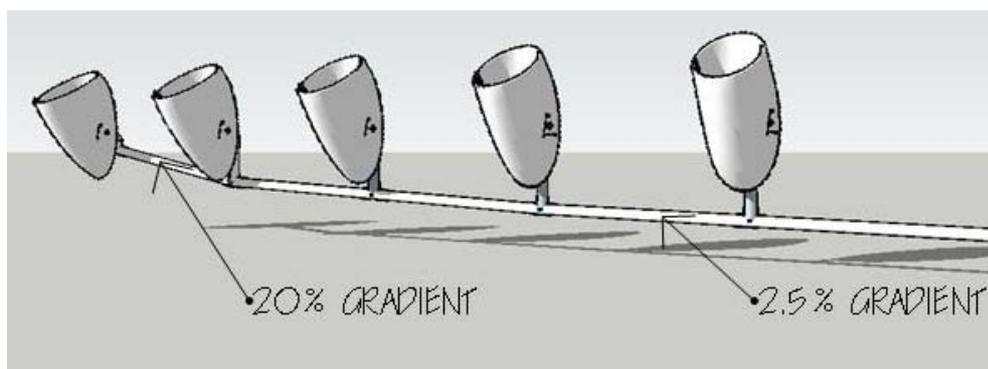


Figure 3 Fixture Range

Further automated maintenance strategies may need to be included in Urinal fixture ranges and instances where a number of non flushing urinals are on a single branch drain. A tundish and a device like an automated priming device could be incorporated as shown in Figure 4.

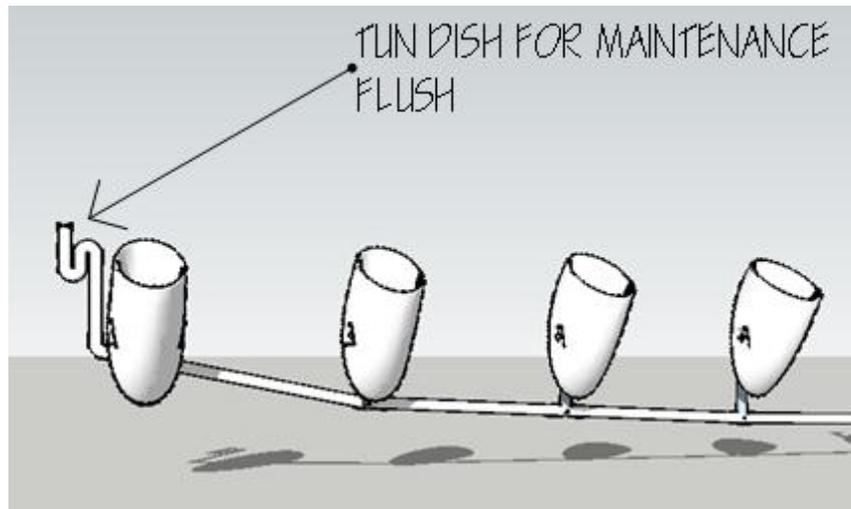


Figure 4 Fixture Range Tundish



7. Conclusion and Recommendations

7.1 General Conclusions

7.1.1 In relation to blockages due to struvite build up

The study confirmed that blockages and smell due to struvite build up that occur in non flushing urinals can be prevented if the units are cleaned and maintained as per manufacturers' recommendations. This includes maintaining a clear sanitary plumbing and drainage pipework.

Poor cleaning and maintenance practices of non flushing urinals are primarily caused by lack of training and information about the operations and maintenance of non flushing urinals by building cleaners, maintenance service technicians and building/ facility managers. This is due to the fact that traditionally sanitary fixtures require only basic cleaning and maintenance regimes and do not require specific consumables to manage untreated urine in the system.

High incidents of blockage and smells associated with non flushing urinals and the higher operations and maintenance costs have led many building managers and owners to return to conventional flushing urinals. This is further supported by the fact that, despite the additional expenses, building owners and managers frequently cannot be assured that appropriate cleaning and maintenance regimes are applied to the non flushing urinals and no blockages and smells will occur.

7.1.2 In relation to corrosion of copper piping

The study confirmed that corruptions to copper piping, and copper alloy pipe and fittings associated with non flushing urinals are caused by precipitates being deposited in sanitary plumbing and drainage systems.

The issue is widely known amongst the plumbing industry, although specifications from building owners and their designers typically fail to provide instructions to prevent non flushing urinals being installed upon existing copper pipe system. This is potentially caused by:

- ▶ Lack of awareness about the need to verify material compatibility prior to proceeding with the retrofit; and
- ▶ Lack of funds to cover the additional costs associated with replacing the existing copper piping system during retrofit.



7.2 Summary of Recommendations

The following is a summary of recommendation to the Australian Building Code Board and relevant building industry. It does not include suggestions which may be applied when designing or planning to install non flushing urinals.



Table 3 List of Recommendations

Type of Recommendation	Recommendations	Time Frame	Estimated Cost To ABCB	Party responsible for actions
Education	Public awareness raising sessions and publications to the general public, cleaners, facility managers, building users etc on the concepts behind non flushing urinals, its methods of operations, cleaning and maintenance as well as its hygiene, health, environmental, social, and religious consequences	12 months	\$ 250,000	Water authorities, plumbing industry and urinal manufacturers
	Education on how to retrofit non flushing urinals in existing buildings and avoid corrosions of the existing pipework.	12 months	\$ 250,000	Plumbing industry and design consultants
Research	Conduct rigorous testing of non flushing urinals on a number of aspects and suggestions identified by GHD Study Team	2 – 5 years	\$ 2,000,000	Water authorities, manufacturers and plumbing industry in collaboration with the ABCB
	Research and tests to review the option and implications of reusing the basin water back into the urinal cistern, effectively increasing the water into the urinal and thus the	2 – 3 years	\$ 250,000	Water authorities, manufacturers and plumbing industry in
	Establish the required air flow change required for male toilets with non flushing urinals installed,	12 months	\$100,000	CIBSI and the building industry, in collaboration with ABCB
	Investigate the potentials of using vacuum systems in urinals and the future of enzyme type non flushing urinals in Australia,	2 – 5 years	\$ 500,000	Water authorities, manufacturers and plumbing industry
	Investigate the viability of separating, collecting and harvesting urines in Australia,	2 – 5 years	\$ 500,000	Water authorities, manufacturers and plumbing industry
Modifications	Nil			



Design	For manufacturers to conduct technical modification to the design of the units to ease optimise the separation in the toilet bowl as well as the change of spare parts of the toilet.	1 - 2 years	\$ 200,000	manufacturers and plumbing industry
Code	Dr Stephen Cummings proposal for a change in existing plumbing Code associate with the use of Horizontal sweep junctions	2 – 3 years	\$ 500,000	Dr Cummings, manufacturers , the plumbing industry in collaboration with ABCB

7.3 Details of the Recommendations

7.3.1 Education

It is anticipated that the following education will significantly assist in addressing issues reported on non flushing urinals, with minimum costs to the building owners and their tenant organisations.

1. Public awareness raising sessions and publications on the concepts behind non flushing urinals, its methods of operations, cleaning and maintenance as well as its hygiene, health, environmental, social, and religious consequences. This can be delivered jointly by local water authorities, the plumbing industry as well as manufacturers of urinals;
2. Focused information sessions to building users, managers and owners when planning to install non flushing urinals in buildings, followed by further training and information sessions after installations to guide users, cleaners and facility managers to use, operate and clean the units;
3. Education on the importance of cleaning and maintenance of non flushing urinals to the cleaning industry, maintenance service providers, building/ facility managers and building owners. This can be in the form of public seminars and publications, as well as in service trainings, delivered by representatives of the plumbing industry, hydraulic engineers/ designers as well as manufacturers of non flushing urinals; and
4. Education on how to retrofit non flushing urinals in existing buildings and avoid corrossions of the existing pipework. To be delivered to representatives of the plumbing industry, maintenance service providers, building/ facility managers and building owners, in the form of public seminars and publications, delivered by representatives of the plumbing industry and hydraulic engineers/ designers.

7.3.2 Research

The following research activities are recommended to assist the industry in addressing current problems and promoting the use of non flushing urinals into the future:

1. Conduct testing of non flushing urinals using test rigs based on Australian Standards compliant drainage systems, to gain accurate measures of efficiency of systems etc which will be relevant to AS environment. The purpose of the tests can include the following:



- Apply fixture loading units developed specifically for non flushing urinals and ultra-low flush urinals as outlined in 6.2.1, which may significantly change design solutions and force more appropriate pipe sizing and pipe gradients suitable for low water use plumbing and drainage systems;
 - Specify minimum flows in pipes using urinals, based on calculations shown on Figure 1;
 - Specify a steeper gradient and a shorter pipe length as shown in Figure 1;
 - Provide maintenance access to individual non flushing urinals, similar to the pipework arrangement shown in Figure 2; and
 - Introduce changes to Urinal Fixture Ranges on Single Stack systems as shown in Figure 3.
2. Research and supporting tests to review the option and implications of reusing the basin water back into the urinal cistern, effectively increasing the water into the urinal and thus the plumbing system without increase the overall consumption of water for the building;
 3. Further research and investigations on various methods to remove struvite and HAP scales and prevent their precipitation, other than the currently favourable suggestion for construction of traps which can easily be exchanged;
 4. Manufacturers to conduct whole of life costs of their products, including the actual water consumption, and the estimated cleaning and maintenance services and consumables that their customers can expect to pay when installing non flushing urinals. This information should be made available whenever customers request the information as part of their decision making process;
 5. Establish the air flow change required for male toilets with non flushing urinals installed, to control the spread of odour;
 6. Investigate the potentials of using vacuum systems in urinals and the future of enzyme type non flushing urinals in Australia, particularly its benefit cost to the environment as well as to building users, managers and owners; and
 7. Investigate the viability of separating, collecting and harvesting urines in Australia, including follow up of current trial in Victoria on the separation of urine from solids to be collected in a central location and used for fertiliser. Refer to Appendix F for further details.

It is anticipated that findings of the research will guide:

- ▶ Manufacturers to modify the design of non flushing urinals to decrease the level of cleaning and maintenance regimes currently required; and
- ▶ Legislators to modify existing codes and standards requirements to facilitate a drainage system which will assist in decreasing the level of cleaning and maintenance regimes, as well as decreasing the frequency of blockage and smells after installations.

7.3.3 Modifications

The following are suggestions for minor modifications or additions that building owners and facility managers may consider to improve the effectiveness of the non flushing urinals in their buildings.

1. The installation of a 'counter' on a sensor to flush toilets every 4th person, which would save 75% of flushing water and minimise the issues with the build-up salts leading to blockages;
2. Additional logic added to ensure minimum flushes are applied during long periods of no use;



3. Program the urinals to flush a certain number of times per day. Once or twice a day - year round;
4. Install a sensor that triggered on the odour or temperature only; and
5. Initiate the recycling of the sink water from hand washing so that, when the user washes their hands, the discharge from the sink is used for flushing of the toilet.

7.3.4 Design

a. For designers and installers

The following suggestions can be adopted by designers when planning to install non flushing urinals, although its application should be considered on a case by case basis.

1. To design a larger clearance and positioning of the breather pipes and the air inlet ducts to eliminate the likelihood of odour developing in the drain lines leading away from the dry urinals;
2. Junctions installed in a vertical plane should not be used for connection of stacks. Sweep and 45° junctions may be laid in the vertical plane for the connection of a single discharge pipe or a drain. A 45° junction to be used for the connection of a water closet pan; and
3. To review the initial cost benefit of non flushing urinals across their potential operational life, particularly as the frequency of cartridge replacements or oil/alcohol refills required will be proportional to their usage. The design engineer in their final selection will need to evaluate whether a water fed, sensor controlled flushing mechanism, will ultimately serve an installation better than the installation of waterless urinals with the ongoing costs.

b. For manufacturers and designers of non flushing urinals

For manufacturers to conduct technical modification to the design of the units to optimise the separation in the toilet bowl as well as the change of spare parts of the toilet.

7.3.5 Code

Dr Stephen Cummings proposed a change in existing plumbing Code associated with the use of Horizontal sweep junctions – This was based on the German Standard DIN 1986 and appears to be a suitable solution. However further tests to Australian Standards needs to be conducted to verify this research and potential solutions.



Appendix A
Bibliography



Bibliography of the literature search and reference material:

ACTPLA website - NPRF ADVISORY NOTE on Waterless Urinals, issued 2nd November 2009
http://www.actpla.act.gov.au/_data/assets/pdf_file/0019/15940/Urinal_flyer_DRAFT_ver_3.pdf
(accessed 4 June 2012)

S Blume and M. Winker, 2010. Manuscript - Three years of operation of the urine-diversion system in GTZ headquarters in Germany; user opinions and maintenance challenges
http://www2.susana.org/docs_ccbk/susana_download/2-893-en-iwa-acceptance-building-1-gtz-2010.pdf
(accessed 25-January-2012).

Chartered Institute of Building Services Engineers (CIBSE), 30-July-1988. Hydraulics Associations Memorandum. Technical papers extract from Chartered Institute of Building Services Engineers (CIBSE) information portal. <http://www.cibse.org> (accessed 19-January-2012).

M. Clawson, Air Force Civil Engineer Support Agency, 2009. Non flushing urinals in Air Force Facilities. <http://thegreencartridge.blogspot.com.au/2009/11/waterless-urinals-in-air-force.html> (accessed 12 March 2012).

Dr S. Cummings, unknown. Drainline System Performance Implications for Water Efficient Fixtures. No URL identified (accessed 12-January-2012).

Dr S. Cummings, unknown. Outcomes from an Industry and Regulator Research Collaboration into Reduced Flows on Building Drainline Systems in Australia
No URL identified (accessed 12-January-2012).

Dr S. Cummings, unknown. Operational Performance Boundaries in Drainage Systems
<http://www.plumbingregulators.org/resources/Cummings.pdf> (accessed 07-February-2012).

Department of Commerce, Plumbers Licensing Board, July 2011. Technical Note, Non flushing urinals. http://www.plumbers.wa.gov.au/PDF/Technical_Notes/Waterless_Urinals_Te.pdf, (accessed 9 March 2012).

M. Demiriz, Gelsenkirchen University of Applied Sciences, unknown. Application of Dry Urinals. <http://www.cuwcc.org/assets/0/28/1264/1288/AF9E5998-5CCF-4AD2-866E-085E85C74653.pdf>
(accessed 12-January-2012).

Estes, McClure & Assoc Inc Engineering and Consulting, 17-May-2004. Non flushing urinals: Features, benefits, and applications. <http://repository.tamu.edu/bitstream/handle/1969.1/4626/ESL-HH-04-05-26.pdf?sequence=4> (accessed 25-January-2012).

Prf. C. Gerba, University of Arizona, August 2003. Sanitation and Public Health Issues of Flush Type Urinals vs Waterfree Urinals
http://falcon-media.unitedfuture.com.s3.amazonaws.com/university_Arizona_letter.pdf (accessed 9 March 2012).

D. Gleiberman, Falcon Waterfree Technologies, J. Watson, Sloan Valve Company, 2008. An Assessment of Long-term Performance of Non-Water (Waterfree Urinals) in relation to Drain Line Buildup.
<http://www.map-testing.com/assets/files/Non%20Water%20Urinal%20Report%20FINAL.pdf> (accessed 12 March 2012).



J. Koeller - California Urban Water Conservation Council, 2005. High Efficiency Plumbing Fixtures - toilets and urinals.

<http://ufdc.ufl.edu/?b=WC04992219> (accessed 25-January-2012).

J.Koeller, Koeller and Company, 2005. Evaluation of Potential Best Management Practices - High Efficiency Plumbing Fixtures - Toilets and Urinals.

<http://www.map-testing.com/assets/files/FINAL-HET-HEU-2010-10-15.pdf> (accessed 12 March 2012).

McAlpine, 12-August-2010. United States Patent Application Publication

<http://www.google.com.au/patents?hl=en&lr=&vid=USPATAPP12679755&id=7nPTAAAEBAJ&oi=fnd&dq=United+States+Patent+Application+Publication+%22waterless+urinal%22+McAlpine&printsec=abstract#v=onepage&q=United%20States%20Patent%20Application%20Publication%20%22waterless%20urinal%22%20McAlpine&f=false> (accessed 25-January-2012).

V.Marshall, 2008. Non flushing urinals Fact and Fiction, November 2008.

http://www.terrylove.com/waterless_urinals_fact_fiction.htm (accessed 12 March 2012).

J. Martin, James Heaney - University of Florida" 26-March-2008, Water Use by Urinals.

<http://library.conservefloridawater.org/publications/15512825.pdf> (accessed 25 January-2012).

R. Otterpohl, Technical University of Hamburg-Harburg, unknown. Resource efficient wastewater concepts - technical options and initial experience.

<http://www2.gtz.de/Dokumente/oe44/ecosan/en-resource-efficient-wastewater-concepts-2002.pdf> (accessed 25-January-2012).

K. A Owens - University of Twente, Netherlands", 16-August-2006. Practical Problems with Dry Toilet Technologies: The Case of the Green Building Renovation Project in Charleston SC USA

<http://www2.gtz.de/Dokumente/oe44/ecosan/en-practical-problems-with-dry-toilet-technologies-2006.pdf> (accessed 25-January-2012).

Tune Up Canberra – Warning on Waterless Urinals -

http://www.actpla.act.gov.au/topics/design_build/regulation2/tune_up_canberra/tune_up_canberra_faq_and_information (accessed 4 June 2012)

K. M. Udert, T. A. Larsen, W. Guyer - Swiss Federal Institute for Environmental Science and Technology, 17-January-2003. Estimating the precipitation potential in urine-collecting systems

<http://www.sciencedirect.com/science/article/pii/S004313540300071X> (accessed 25-January-2012).



Appendix B

Summary of select relevant research material





Table 4 Summary of literature search

Title	Author	Summary	Link
<p>NPRF ADVISORY NOTE on Waterless Urinals Issued 2nd November 2009</p>	<p>National Plumbing Regulators Forum</p>	<p>The purpose of this Advisory Note is to provide guidance to the Australian and New Zealand plumbing industry and consumers regarding the installation and maintenance of waterless urinals.</p> <p>The NPRF through its Technical Advisory Committee has facilitated an amendment to the Plumbing and Drainage Standards AS/NZS 3500.2: 2003 Part 2: Sanitary plumbing and drainage to manage the build-up of Struvite in sanitary plumbing and drainage systems. The amendment will provide provisions to minimise the risk of blockages by requiring a minimum of 2 fixture units e.g. 2 hand basins to be installed upstream of each waterless urinal. While this requirement will assist in preventing blockages of main drain lines the trials demonstrated it will not prevent build up of Struvite in the discharge pipe from the waterless urinal to the main drain line as discussed earlier.</p> <p>At this stage it is recommended that facility owners and managers arrange for waterless urinals be inspected and cleaned at periods of no less than 6 months, until a more appropriate maintenance interval can be established for each facility. The maintenance interval will be dependent on a number of factors such as usage patterns, waterless urinal type, drainage design and other factors.</p>	<p>http://www.actpla.act.gov.au/customer_information/industry/industry_groups/plumbers_and_drainers_information</p>



Title	Author	Summary	Link
Application of Dry Urinals	Mete Demiriz, Gelsenkirchen University of Applied Sciences	<ul style="list-style-type: none">• Dry urinals can be operated hygienically, if they are maintained and cleaned according to manufacturers' specifications.• The optimization of existing dry urinals, and new techniques in recent years have increased the life-span and the maintenance intervals, which made it possible to operate them cost-efficiently.• Despite some statements- as in Sanitarbau 2003[5]- urine deposits and fanning of crusts in drainage pipes of dry urinals is still the case. It is not possible to remove these by application of high water volumes through the urinal itself.• A very intense odour develops in the drain lines leading away from the dry urinals. A larger clearance has to be taken into consideration during the design and positioning of the breather pipes and the air inlet ducts.	Papers\20120112 Application of Dry Urinals.pdf



Title	Author	Summary	Link
Drainline System Performance Implications for Water Efficient Fixtures	Dr Steve Cummings	<p>Based on the key findings of the study, the ASFlow committee recommended the following action and amendments to the plumbing and drainage standards</p> <ul style="list-style-type: none">- Waterless urinals - A minimum of two additional fixture units e.g. two hand basins, must be installed upstream of every waterless urinal, excluding cleaner sinks.- 90° Junctions - Junctions installed in a vertical plane shall not be used for connection of stacks. Sweep and 45° junctions may be laid in the vertical plane for the connection of a single discharge pipe or a drain, provided:<ul style="list-style-type: none">a) A 45° junction shall only be used for the connection of a water closet pan.- Horizontal sweep junctions - Based on test results it is reasonable to conclude that the junction configuration was the main cause of the blockage in the Western Australia installation. The committee is currently exploring potential solutions. At this stage the requirement as specified in DIN 1986 and tested in configuration C4 appears to be a suitable solution. The adoption of this requirement into AS/NZS 3500.2 will provide a more efficient drainage system and will avoid performance problems as experienced in the Western Australian installation. <p>Further studies of the influence of horizontal junction configurations involving reduced WC flush volumes are proceeding. Initial results indicate that WC flush volume directly affects waste drainline carrying performance. These results match similar studies that have shown that at ultra-low flush volumes, small reductions in water volume dramatically reduces drainline carry performance (Swaffield, 2009) (Gauley, 2005) (Drinkwater, 2008) (Barnard, 2009)</p>	Papers\20120112 Drainline System Performance Implications.pdf



Title	Author	Summary	Link
		<p>CONCLUSION</p> <p>Outcomes from the research approach taken by ASFlow and discussed in this paper have already led to proposed changes to AS/NZS 3500.2 that will avoid installation failures within building drainage networks. As rectification of system failure is significant this work is critical for industry and the Australian community to ensure that drainage designs installed in accordance with AS/NZS 3500.2 will operate effectively.</p> <p>Currently work is proceeding at CIT to evaluate the effect on drainline systems of ultra-low flush discharges. This research together with the work already completed will provide the installation criteria for the effective performance and compatibility with future ultra-low WC fixtures.</p>	
Outcomes from an Industry and Regulator Research Collaboration into Reduced Flows on Building Drainline Systems in Australia	Dr Steve Cummings	<p>The research approach taken by the ASFlow committee has shown that there are performance incompatibility issues with reduced fixture flows in building drainlines and cuJTent plumbing requirements in AS/NZS 3500.2. The incompatibility problems have been addressed with proposed amendments to standards providing a performance platform for further reductions in fixture flows.</p> <p>Research conducted by the ASFlow committee has highlighted the critical need for extensive drainline research to be conducted before the introduction of further reductions in fixture discharges and flows within buildings. This work has also shown that universal test criteria needs to be established which includes realistic solids and paper test media to represent actual usage conditions.</p>	Papers\20120112 Outcomes from an Industry and Regulator Research.pdf



Title	Author	Summary	Link
Hydraulics Associations Memorandum	Chartered Institute of Building Services Engineers (CIBSE)	<p>Water free urinal/s provide cost benefits at installation whilst demonstrating a positive conversation ethic to the community at large. However, the initial cost benefit must be viewed across its potential operational life. The frequency of cartridge replacements or oil/alcohol refills required will be proportional to their usage.</p> <p>Conclusion:</p> <p>The design engineer in their final selection will need to evaluate whether a water fed sensor controlled flushing mechanism will ultimately serve an installation better than the installation of waterless urinals with the ongoing costs. Regardless whether urinals are water flushed or waterless they all require a maintenance regime to be in place. The concept of the waterless urinal arose out of the need to conserve urinal flushing water and benefits this could provide. At the end of the day, use of cartridge/refill type urinals help eliminate uric salt buildup in trap (a source of most blockages in urinal waste pipes) but raises problems with disposal and replacement of cartridges.</p>	Papers\20120119 Hydraulics Associations_a.pdf



Title	Author	Summary	Link
Estimating the precipitation potential in urine-collecting systems	Kai M. Udert, Tove A. Larsen, Will Guyer - Swiss Federal Institute for Environmental Science and Technology	<p>Precipitation in urine-separating toilets (NoMix toilets) and waterless urinals causes severe maintenance problems and can strongly reduce the content of soluble phosphate.</p> <p>Conclusion:</p> <p>Modelling the precipitation potential (PP) is a promising approach for predicting precipitation effects in urine-collecting systems. PP predicts both the mineral composition and the expected mass concentration of precipitates. However, it does not consider further effects, which govern the occurrence of blockages, such as precipitation kinetics, attachment of minerals on pipe walls or foreign solids. Calculating PP is particularly applicable for old precipitates, since they are supposed to be in equilibrium with the solutes in the aqueous phase. Younger precipitates may deviate in their composition and mass concentration.</p> <p>We compared simulation results with field measurements and found good agreement for low and very high diluted urine. Only in the NoMix trap simulation results and measurements did not agree sufficiently. Varying urine dilutions are probably responsible for the deviation. However, well-controlled experiments are necessary for a further model validation.</p> <p>Simulation results showed that the composition of the precipitates changes with dilution. Struvite precipitates only at low dilution while HAP occurs over a wide range of dilution factors. HAP is the sole calcium phosphate mineral, although several other calcium phosphate minerals are saturated before precipitation. The third compound of the precipitate—calcite—is only found in urine highly diluted with tapwater, but not in urine diluted with rainwater.</p>	Papers\20120125 estimating-precipitation-potential-urine-collecting-systems-2003.pdf



Title	Author	Summary	Link
		<p>In low diluted urine, only little urea has to be hydrolysed for reaching 95% of the maximum PP. Since urease is known to hydrolyse urea very efficiently, we conclude that substantial precipitation can occur in traps and pipes where urine retention is usually short.</p> <p>Flushing water characteristics affect the composition and amount of precipitates. Rainwater flushing reduces the PP more effectively than tapwater flushing. Therefore, we recommend rainwater flushing as one measure against blockages by precipitates. Since phosphate fixation is high in urine diluted with tapwater, tapwater flushing may facilitate the extraction of struvite and HAP, which both may be recycled as slow-release fertilisers [2].</p>	
Waterless Urinals: Features, benefits, and applications	Estes, McClure & Assoc Inc Engineering and Consulting	<p>ABSTRACT</p> <p>Billions of gallons of water are used annually to flush toilets in the United States. Consequences of this usage include consumption of natural resources and construction of new infrastructure to treat and transmit potable water and wastewater. Waterless, or no-flush urinals, may help mitigate these effects and offer other advantages, including lower utility charges, improved restroom hygiene, and decreased fixture maintenance. Some notable caveats include possible lack of acceptance by users, odor control problems, and rejection by code officials.</p> <p>SUMMARY</p> <p>Waterless urinals can offer a viable alternative to the conventional flush-type. Potential advantages include odor control and improved restroom cleanliness, water savings, reduced maintenance, and environmental friendliness.</p>	Papers\20120125 waterless urinals features, benefits and applications.pdf



Title	Author	Summary	Link
		<p>The results of two surveys cited, while not scientific, found users generally at least moderately satisfied overall with their no-flush urinals. However, a number expressed concerns of one type or another. Reported problems included odors and line encrustations.</p> <p>Before installing waterless urinals throughout a building, campus, or district, a pilot program for evaluation is recommended. This allows owners to become familiar with and gain confidence in the product and properly train their personnel. Many users surveyed observed that there can be a significant learning curve for maintenance and custodial staffs to understand proper care of the fixtures. Also, a life cycle cost analysis should be done to determine actual cost savings. Finally, contact building officials early in the process to find out if the use of waterless urinals is allowed by local codes.</p> <p>Widespread use of waterless urinals can produce a domino effect of conservation. Since no water is required, water utilities will not need to treat and pump as much water. Also, the absence of flushing means that less wastewater is generated requiring treatment. Smaller quantities of water pumped leads to energy savings. Therefore, water is conserved as are resources needed to generate electricity.</p>	



Title	Author	Summary	Link
Urea hydrolysis and precipitation dynamics in a urine-collecting system	Kai M. Udert, Tove A. Larsen, Martin Biebow, Will Guyer - Swiss Federal Institute for Environmental Science and Technology	<p>Blockages caused by inorganic precipitates are a major problem of urine collecting systems. The trigger of precipitation is the hydrolysis of urea by bacterial urease.</p> <p>Conclusion</p> <p>In this study, we investigated ureolysis and precipitation in a urine collecting system. We proved that ureolysis triggers precipitation. High urease activity in the pipes and in the collection tank causes fast precipitation of calcium and magnesium phosphates. For complete urea hydrolysis in the collection tank, urine retention times of only few days are necessary.</p> <p>We found that urease active bacteria primarily grow in the pipes. Long pipes may therefore enhance ureolysis. In the collection tank, lysis of urease active bacteria sets urease free. About 20% of the urease activity is due to free urease.</p> <p>Precipitation could be simulated with a dynamic computer model based on the surface dislocation approach. The simulations resulted in struvite and octacalcium phosphate (OCP) as precipitating phases, which accords with literature. Since hydroxyapatite (HAP) is the calcium phosphate phase at solid-solute phase equilibrium, OCP transforms later into HAP.</p> <p>In undiluted urine, maximum mass concentrations of precipitates can be reached in few hours. Struvite precipitates earlier than OCP. Soon after the solubility product has been exceeded, strong struvite precipitation sets in, while OCP needs high supersaturation for substantial precipitation.</p>	Papers\20120125 urea-hydrolysis-precipitation-dynamics-urine-collecting-system-2003.pdf
Water Use by Urinals	Jacqueline Martin, James Heaney - University of Florida	<p>Urinals are found in men's bathrooms of the commercial, industrial, and institutional (CII) sectors of society. If men's restrooms account for a significant portion of a facility's water budget and the urinals are older, a urinal retrofit may provide significant water savings for the facility. The types of urinals and their water use characteristics are described in this report. Information on the expected prevalence of these urinals is also presented along with information on urinal retrofit programs.</p>	Papers\20120125 Water use by urinals 15512825.pdf



Title	Author	Summary	Link
Resource efficient wastewater concepts - technical options and initial experience	Ralf Otterpohl, Technical University of Hamburg-Harburg	<p>Abstract:</p> <p>Technology for future houses especially in water scarce regions may well include water recycling units that makes tap water while people drink bottled water of high quality . There may be toilets that produce just a bag of dry fertiliser per year, hopefully without fossile energy. Rainwater infiltration is increasingly replacing storm sewers anyway. Many urban areas of the future could simply be without sewerage systems. Technical feasibility is given even today and economic feasibility is coming closer by advances in membrane technology. However, there are more likely scenarios than this. One person produces about 500 litres of urine and 50 litres of faeces per year (=blackwater). The same person, produces in a range of 20.000 to over 100.000 litres of wastewater. Black- and greywater (wastewater without toilet) do have very different characteristics. If blackwater is collected separately with low dilution it can be converted to safe natural fertiliser, replacing synthetic products and preventing spread out of pathogens and other pollutants to receiving waters.</p>	Papers\20120125 resource-efficient-wastewater-concepts-2002.pdf



Title	Author	Summary	Link
		<p>Risks, obstacles and restrictions</p> <p>The first objective for sanitation must be minimising hygienic risks. New systems should be better than the conventional sanitation systems that have a good hygienic standard for inside the houses but in most cases not for the receiving waters.</p> <p>Conclusions</p> <p>Pilot projects of new types of sanitation systems are built in different places around the world. The examples indicate that new technologies are feasible not only concerning technology but also economics.</p> <p>Many of the new systems will require stormwater infiltration or surface transport via trenches or channels.</p> <p>It is quite a challenge to participate in the development of emerging new technology. Professional skills and open-minded search for solutions are needed to find better ways for future sanitation. Open dialogue and exchange of experience are essential in order to bring the matter forward. There are so many technological options, that most social and economic conditions can be met. Creativity is needed to find the appropriate technology and the best way of implementing, operating and financing. Even though many industrialised countries will need decades for conversion due to the long lasting existing infrastructure, these countries are the ones with good resources for research and pilot installations. The pilot installations described above are only a part of worldwide quest for better solutions. A lot more pilot plants and research is needed, preferably projects that do operate without subsidies in typical conditions.</p>	
		<p>The tremendous investment into wastewater infrastructure should be done based on evaluation of the options that we have, not just on working the same way as before. It could be shown that there are many different solutions that can be appropriate in different socio-economic and geographical situations</p>	



Title	Author	Summary	Link
Closing the loop through ecological sanitation	Christine Werner, ECOSAN	<p>The problems raised by the decreasing quality and quantity of fresh water resources around the world are becoming increasingly serious. All indicators show that the situation is getting worse, and that we now face a serious world water crisis that will affect us all. The poor in developing and emerging market economy countries are already feeling the effects of this crisis, suffering most from a decrease in availability of fresh water resources, from sanitation related diseases and a damaged environment, and will suffer further as the competition for resources becomes ever more intense.</p> <p>THE CHALLENGES FACING ECOSAN</p> <p>In recent years many successful ecosan programmes have been implemented in different countries in rural and sparsely settled urban areas. A great deal of experience has been made in these areas and a variety of solutions exists that can be recommended for wide-spread large-scale use in accordance with local physical, cultural and socio-economic conditions. Although initial experiences with ecosan systems are available from densely populated urban areas, further research and development is urgently required to gain the necessary experience in these more complex areas that would allow ecosan systems to be implemented on a large scale, to show case the technical feasibility and the benefits of this new approach. In addition to this, there are several other challenges which need to be faced before ecological sanitation systems will be widely adopted:</p>	Papers\2012\0125 ecosan-closing-the-loop-2006.pdf



Title	Author	Summary	Link
		<ul style="list-style-type: none">- Awareness of the alternatives offered by ecosan has to be increased and large scale capacity building is required- Resource reuse needs to be integrated into sanitation planning processes from the very beginning- Legal frameworks and technical standards need to be revised- Full cost analysis and comparison of the environmental and health risks of all types of sanitation have to be established- Innovation-friendly investors are required, as well as new financing instruments supporting private households investment <p>However due to its huge potential, these challenges must be overcome and ecological sanitation should be recognised and introduced as the new, promising, holistic and sustainable approach to provide safe and decent sanitation, reduce poverty, contribute to food security, preserve our environment</p>	
Biologically induced precipitation in urine-collecting systems	Kai M. Udert, Tove A. Larsen, Will Guyer - Swiss Federal Institute for Environmental Science and Technology	<p>Abstract Precipitation in urine-separating toilets (NoMix toilets), waterless urinals, and conventional urinals causes severe maintenance problems</p> <p>Conclusions</p> <p>Precipitation occurs in waterless urinals, NoMix systems, and conventional urinals. By blocking traps and pipes, precipitates diminish the functionality and comfort of toilets. Additionally, soluble phosphate becomes fixed in solids.</p>	Papers\20120125 biologically-induced-precipitation-urine-collecting-system-2003.pdf



Title	Author	Summary	Link
		<p>The precipitates investigated consisted of struvite, HAP, and calcite. Microbial ureolysis is the main cause for precipitation with rising pH and release of ammonia and carbonate. Ureolysis is catalysed by the enzyme urease. Since urease-positive bacteria are ubiquitous their colonising of toilets is nearly inevitable</p> <p>Dilution with tap water affects the composition of precipitates. While struvite occurs in less diluted urine, calcite is found in systems with high urine dilution. HAP precipitates over a wide range of dilution factors but is more frequent in less diluted urine. While only a minor part of ammonia is incorporated into precipitates, i.e. struvite, a large fraction of soluble phosphate may be eliminated through struvite and HAP precipitation.</p> <p>The elimination of soluble phosphate is limited by the amount of magnesium and calcium ions available for precipitation. Therefore, the fraction of eliminated phosphate increases when urine is diluted with tap water. Whether phosphate fixation impedes the later treatment and use of source-separated urine, depends on the availability of phosphate from struvite and HAP.</p> <p>Several suggestions have been made to remove struvite and HAP scales and prevent their precipitation. Currently, construction of traps, which can easily be exchanged, seems to be the most favourable. However, ongoing research may provide better solutions</p>	



Title	Author	Summary	Link
<p>Practical Problems with Dry Toilet Technologies: The Case of the Green Building Renovation Project in Charleston SC USA</p>	<p>Katherine A Owens - University of Twente, Netherlands</p>	<p>This paper details the experiences of a student-faculty research team in managing waterless urinals as part of a campus sustainability project, the Green Building Renovation. Based on our experiences to date, we recommend that when installing toilets or any other significant green change, a team comprised of a student coordinator and a faculty coordinator should be in place to guarantee proper functioning and long term satisfaction. The faculty coordinator should be aware of the long-term advising role required (even if other efforts are made to keep the project student led), and the students involved should make every effort to document their experiences so new individuals involved can be efficient in their approaches to management of the building and outreach. As founding Green Team members, we should have emphasized these issues more as each student took over. Another active solution would be to host an open house and workshop regarding all building technology every year, when new students join the project team. Finally, incorporating a male contact for urinal problems will remove any barriers in communication resulting from the, to date, all female project contacts.</p>	<p>Papers\20120125 practical-problems-with-dry-toilet-technologies-2006.pdf</p>
		<p>In retrospect, the problems with the urinals should have been addressed immediately, with team members prioritizing active problem solving. Implementing several changes in current team structure have the potential to create an effective network capable of solving any problems with green building maintenance, including urinal difficulties. The best strategy to ensure change on campus and benefit the most from the technology demonstrated in the green building is to incorporate the lessons learned; specifically, appointment of a paid student coordinator, backing by the institution and the student group with urinal maintenance instructions and volunteerism in its by-laws, continuation of education efforts to campus faculty and staff, and continued data collection and journal records passed between students with each graduating year. A cooperative effort between Falcon, the College of Charleston, and continuing patience of the campus community will ultimately produce an effective model of resource conservation.</p>	



Title	Author	Summary	Link
Manuscript - Three years of operation of the urine-diversion system in GTZ headquarters in Germany; user opinions and maintenance challenges	S Blume and M Winker	<p>In the main office building of GTZ in Eschborn, Germany a resource-oriented sanitation system containing urine-diversion toilets and waterless urinals is in operation since 2006. After 2.5 years of operating the system, a first overall evaluation of the system and its acceptance amongst users and cleaning staff was conducted. The overall result is that most of the users appreciate the resource oriented sanitation concept (recycling of nutrients and water savings) but have problems with the technical design. Also, it is difficult to convince the cleaning staff of the necessity of special cleaning routines. Hence, before such systems can be widely spread, clear cleaning routines and maintenance documentations are required as well as certain technical modification to ease optimise the separation in the toilet bowl as well as the change of spare parts of the toilet.</p>	Papers\20120125 Manuscript iwa-acceptance-building-1-gtz-2010.pdf
		<p>CONCLUSIONS</p> <p>The overall result from the user surveys is that the users appreciate the resource oriented sanitation concept (recycling of nutrients and water savings) but are unhappy with the inconveniences caused by the technical design of the UD flush toilets. Furthermore, it was shown that a crucial point for users is perceived or actual toilet hygiene: People's willingness to sit down on the toilet could be raised significantly if disinfection devices were available.</p> <p>For a wider acceptance, further technical development of the UD flush toilets would be necessary. A high turn-over in cleaning staff and different cultural/lingual backgrounds makes it difficult to communicate the necessary cleaning routines which take a little bit more extra time and are new for the cleaning staff. Hence, before such urine-diversion flush toilets can be widely spread, clear cleaning and maintenance routines are required.</p> <p>On a positive note, this demonstration and research project has attracted wide attention for the ecosan approach within GTZ (implementing development cooperation projects worldwide) and outside of GTZ. Each year, many international delegations and student groups take part in guided tours of the installations, which raises their awareness about resource oriented sanitation systems.</p>	



Title	Author	Summary	Link
United States Patent Application Publication	McAlpine	Describes and apparatus for waterless urinals. Details the background of the invention	Papers\20120125 US patent application 20100199412[1].pdf
	Tune Up Canberra, ACTPLA, ACT Environment and Sustainable Development Directorate	<p>Direct quote from ACT PLA a warning on waterless urinals:</p> <p>"Water efficiency measures such as waterless urinals may be recommended by Tune Up reports and building owners may wish to pursue these recommendations as part of Stage 2. Tune Up Canberra will consider providing funding, but it is important that building owners are aware that scale material can build up immediately downstream of waterless urinals causing major blockages when not properly managed. In addition, copper or copper alloy pipe work connected to waterless urinals can be damaged. The AS/NZS 3500.2, Sanitary Plumbing and Drainage, is being amended so certain requirements relating to non-flushing (waterless) urinals are included to prevent issues relating to blockages and pipe damage."</p>	http://www.actpla.act.gov.au/topics/design_build/regulation2/tune_up_canberra/tune_up_canberra_faqs_and_information
High Efficiency Plumbing Fixtures - toilets and urinals	J. Koeller - California Urban Water Conservation Council	<p>Background Advent of Low-Flow Fixtures</p> <p>Beginning in 1992, a new water-efficiency standard for toilets and urinals became the law in California. The maximum flush volume for each of these fixtures was lowered to 1.6 gallons and 1.0 gallons, respectively.</p> <p>The products that resulted from this process were given the various labels of ultra-low-flow, ultra-low-flush, low-flow, and similar. Although most early versions of the toilet fixtures flushed at 1.6 gallons or less, they did not necessarily perform well and, thus, did not always result in satisfied customers and users. To this day, the reputation of some early "low flow" toilet fixtures still exists and influences water conservation programs³. As a result of early problems, the plumbing industry embarked upon fresh product development to improve performance and thereby restore customer confidence and satisfaction. By 1997, fixture performance had improved significantly.</p>	Papers\20120125 High-efficiency plumbing fixtures - toilets and urinals.pdf



Title	Author	Summary	Link
Operational Performance Boundaries in Drainage Systems	Dr Steve Cummings	<p>Waterless urinals Key Findings –</p> <ul style="list-style-type: none">– Struvite build-up over time and use will occur in drainline systems connected to waterless urinals that can potentially cause complete blockage of the drainline.– Struvite build-up in drainlines can be significantly reduced through the introduction of additional water using fixtures upstream of waterless urinals. Each waterless urinal shall be installed only where at least 2 fixture units, are connected upstream of the connection of the waterless urinal to the discharge pipe.– Transportation of waste significantly reduced by the 90° sweep junction configuration - hydraulic jump.– The alternative 45° junction configuration provided satisfactory waste transportation. Horizontal Sweep Junctions– Waste transportation performance of horizontal sweep junctions is adversely affected by waste water back flow.– Horizontal sweep junctions configurations – probable cause of drainline blockage in Western Australia.– Alternative junction design provided a significant improvement in drainline transportation.– German DIN standard 1986 requirements should to be considered for adoption into AS/NZS 3500.2.	Papers\20120207 Waterless Urinal Study Cummings.pdf



Title	Author	Summary	Link
Sanitation and Public Health Issues of Flush Type Urinals vs Waterfree Urinals	Prof C. Gerba	<p>Letter to Falcon Waterfree Technologies assessing the potential for the transmission of disease by Waterfree Urinals vs conventional flush urinals.</p> <p>In my professional opinion, I believe that the use of Waterfree urinals would result in a significant improvement in public restroom hygiene. Flush type urinals are far more likely to be colonized by bacteria because of the greater presence of moisture, to serve as reservoirs of disease causing microorganisms, and to cause the widespread dissemination of microorganisms in a restroom because of the generation of aerosols during flushing. Flush type urinals are much more likely to harbor disease-causing microorganisms and spread them throughout the environment in the restroom where the public will come into contact with them. The surfaces inside flush type urinals are kept moist by its continual flushing. This moisture encourages the growth and survival of bacteria.</p> <p>In summary, I believe Waterfree urinals could greatly improve the hygiene of public restrooms, and that here is no significant risk from infectious microorganisms by the disposal of spent cartridges from the Waterfree urinals in landfills.</p>	http://falcon-media.unitedfuture.com.s3.amazonaws.com/university_Arizona_letter.pdf
Waterfree Urinal Research Project, Final Report	University of California	<p>Summary of Urinal Testing</p> <p>In September of 2000, FWT delivered to UCLA a prototype of the non-flushing, waterfree urinal they intend to market in the U.S. The urinal was installed on September 15, 2000 in Boelter Hall on the UCLA campus in the men's restroom located on the fifth floor, room 5754 and has been in continuous service since that date.</p> <p>Urinal usage was monitored carefully over a period of six weeks. The waterfree urinal averaged 116.24 uses per day, or 813.68 uses per week. Based on the actual urinal usage recorded at UCLA, the AllSeal™ solution and SealTrap™ cartridges have operated properly and without problems. The manufacturer's design duty life of 7,000 uses before clogging of the SealTrap™ cartridge was actually exceeded both times the cartridge has been replaced. In the original installation, the SealTrap™ cartridge lasted for over 7,300 individual users. The second cartridge has lasted over 7,500 individual users, and has required only normal maintenance (cleaning and removal of trash, etc.) and has never clogged.</p>	http://falcon-media.unitedfuture.com.s3.amazonaws.com/13209675-03-UCLA-FullReport.pdf



Title	Author	Summary	Link
Waterless Urinals in Air Force Facilities	M. Clawson, Air Force Civil Engineer Support Agency	<p>SYNOPSIS</p> <p>Waterless urinals, sometimes called “no-flush,” “touch-less,” or “waterfree” urinals, have had mixed success in Air Force facilities. This fact sheet provides some lessons learned that designers and facility managers must address when waterless urinals are being considered. When compared to conventional urinals, waterless urinals save about one gallon of water each time they are used. For high-use facilities, this can add up to savings of over 20,000 gallons per year per urinal. Use of any trade names in this fact sheet is not an endorsement of any product.</p> <p>CONCLUSION</p> <p>Waterless urinals can be a cost-effective alternative to conventional flush-valve urinals in Air Force facilities, but careful consideration must be given to the custodial, user, and trap replacement issues. Failure to consider these critical factors can cause significant problems and building occupant dissatisfaction with waterless urinals. To avoid problems with these types of urinals requires that the cleaning staff, maintenance personnel, and users all understand the operation and limitations of waterless urinals.</p>	http://thegreencartledge.blogspot.com.au/2009/11/waterless-urinals-in-air-force.html
Waterless Urinals Fact and Fiction, November 2008	V.Marshall	<p>This technical bulletin is designed to answer questions and provide guidance regarding the viability of various types of waterless and low flow urinals currently on the market.</p> <p>In the summer of 2006, Naval Station Norfolk Public Works Officer (PWO) Cdr. Chuck Smith Ret. requested a study of waterless urinals to determine if these products should be mandated on future NavFac construction projects. Waterless urinals qualify for LEED points and can help meet US Green Building certification criteria. Three different manufacturers were invited to install their products at no cost to the Navy for an extended evaluation. These are the results of that two year study.</p>	http://www.terrylove.com/waterless_urinals_fact_fiction.htm



Title	Author	Summary	Link
An Assessment of Long-term Performance of Non-Water (Waterfree Urinals) in relation to Drain Line Build up	D. Gleiberman, Falcon Waterfree Technologies, J. Watson, Sloan Valve Company	<p>A current initiative in the United States Environmental Protection Agency (EPA) WaterSense program is to develop a specification for high-efficiency urinals (HEU), which includes non-water (waterfree) urinals. The EPA has requested information and data from manufacturers of non-water urinals to better understand concerns about drain line clogging as it relates to the use of non-water urinals. This paper provides the EPA with technical information as to what occurs in drain lines for non-water urinals in comparison to drain lines for water-flushing urinals.</p> <p>This report provides the EPA and others with important background information on plumbing fixtures and plumbing design as they relate to drain line issues. A detailed explanation of the differences in physical and chemical composition between the deposits from water-flushing urinals (calcite) and non-water urinals (struvite) has been provided.</p>	http://www.map-testing.com/assets/files/Non%20Water%20Urinal%20Report%20FINAL.pdf
		<p>The examples of water-flushing urinal installations provided that show hard calcite deposits range from 21 months to over ten years in use. Information from plumbers who routinely work on these types of clogged drains from water-flushing urinals as well as numerous commercial products available to alleviate these problems has also been provided.</p> <p>As a result, this paper draws three primary conclusions:</p> <ol style="list-style-type: none">1. All drain lines can and will clog, and water-flushing urinals produce some of the worst build-up problems of all plumbing fixtures.2. Drain line build-up from water-flushing urinals is significantly more costly and problematic to remove than non-water urinals.3. When installed and maintained properly, non-water urinals will produce less line build-up than water-flushing urinals and can be rinsed clean with water alone.	



Appendix C

Questionnaires and Results of Survey of Facility Managers



Survey Questionnaires

FMA Australia is supporting GHD in its work with the Australian Building Code Board (ABCB) to conduct a study on the installation, operation, cleaning and maintenance of non-flushing urinals. The study aims to quantify and substantiate the extent and scope of the problems reported to date, associated with the installation of non-flushing urinals both in new and renovated buildings. It is anticipated that findings of this study may lead to recommendations to change the Plumbing Code of Australia.

Please submit your responses to the following questionnaires by 15 February 2012.

GENERAL

Question	Respond
Total number of buildings managed	_____
Percentage of buildings installed with non-flushing urinals	<input type="checkbox"/> 0-10% <input type="checkbox"/> 11-20% <input type="checkbox"/> 21-30% <input type="checkbox"/> 31-40% <input type="checkbox"/> 41-50% <input type="checkbox"/> 51-60% <input type="checkbox"/> 61-70% <input type="checkbox"/> 71-80% <input type="checkbox"/> 81-90% <input type="checkbox"/> 91-100%
Estimated number of non-flushing urinals installed	_____
Percentage of non-flushing urinals which regularly pose problems	<input type="checkbox"/> 0-10% <input type="checkbox"/> 11-20% <input type="checkbox"/> 21-30% <input type="checkbox"/> 31-40% <input type="checkbox"/> 41-50% <input type="checkbox"/> 51-60% <input type="checkbox"/> 61-70% <input type="checkbox"/> 71-80% <input type="checkbox"/> 81-90% <input type="checkbox"/> 91-100%
Comments	

Please complete the following for the building where you have the most issues with the non-flushing urinals installed.

Question	Respond
Building Details	
Postcode	_____
Percentage of non-flushing urinals in the building which regularly pose problems	<input type="checkbox"/> 0-10% <input type="checkbox"/> 11-20% <input type="checkbox"/> 21-30% <input type="checkbox"/> 31-40% <input type="checkbox"/> 41-50% <input type="checkbox"/> <input type="checkbox"/> 51-60% <input type="checkbox"/> 61-70% <input type="checkbox"/> 71-80% <input type="checkbox"/> 81-90% <input type="checkbox"/> 91-100%
Age of building	<input type="checkbox"/> <5 yrs <input type="checkbox"/> 5-10 yrs <input type="checkbox"/> 10-15 yrs <input type="checkbox"/> >15 yrs



Question	Respond	
Building Classification	Aged Care Assembly Carpark Education Factory Healthcare Hotel/Motel – 3 stars and less Hotel/Motel – 4 Stars Hotel/Motel – 5 Star Laboratory	Office – A Grade Office – B Grade Office – C Grade Office – D Grade and less Office – Premium Grade Public Residential Retail Warehouse
Number of floors	_____	
Average percentage of men on each floor	<input type="checkbox"/> 0-20% <input type="checkbox"/> 21-40% <input type="checkbox"/> 41-60% <input type="checkbox"/> 61-80% <input type="checkbox"/> 81-100%	
Number of tenant organisations	<input type="checkbox"/> < 5 <input type="checkbox"/> 5-10 <input type="checkbox"/> >10	
Other relevant information about the building:		
Installation Date	<input type="checkbox"/> pre 2000 <input type="checkbox"/> 2000 – 2005 <input type="checkbox"/> 2005 – 2010	
Were the non-flushing urinals installed as part of a retrofit program of an existing building?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Other	
If known, type of sanitary drainage pipework materials	<input type="checkbox"/> cast iron <input type="checkbox"/> brass <input type="checkbox"/> copper <input type="checkbox"/> PVC <input type="checkbox"/> Polyethylene <input type="checkbox"/> Other plastic	
Do the non-flushing urinals have any rubber valves?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure	



Question	Respond
Typical problems reported by the cleaners and their frequency:	<input type="checkbox"/> Blockage <input type="checkbox"/> Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Slow Drainage <input type="checkbox"/> Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Smell <input type="checkbox"/> Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Other
Any other relevant details about the installation?	
Cleaning Regime	
Cleaning services arrangement	<input type="checkbox"/> In-house <input type="checkbox"/> Contracted <input type="checkbox"/> Other
Did you receive any specific instructions from the manufacturer about cleaning the non flushing urinals?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure
Did you provide the cleaning instructions to your cleaning service provider?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure
Is the specified cleaning regime displayed in a prominent position near the non-flushing urinals?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure
Frequency of cleaning	<input type="checkbox"/> Daily <input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Other
Frequency of cartridge replacement (if applicable)	<input type="checkbox"/> Weekly <input type="checkbox"/> Monthly <input type="checkbox"/> Yearly <input type="checkbox"/> Other
Any other comments associated with cleaning the non-flushing urinals	
Maintenance Regime	
Maintenance services arrangement	<input type="checkbox"/> In-house <input type="checkbox"/> Contracted <input type="checkbox"/> Other
Do you have any Operations and Maintenance Manual for the non-flushing urinals?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure
Where is this Manual kept?	<input type="checkbox"/> by the urinals <input type="checkbox"/> in the cleaning/ maintenance cupboard <input type="checkbox"/> in the Facilities Office <input type="checkbox"/> Unsure <input type="checkbox"/> Other



Question	Respond
Do the people carrying out maintenance tasks have access to this Manual?	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Unsure
Where typically in the drainage and non-flushing urinals system are the blockages found?	<input type="checkbox"/> At the urinal <input type="checkbox"/> At the junction between the urinal and the building drainage pipe work <input type="checkbox"/> At the junction between the building pipework and the town sewer system <input type="checkbox"/> Other
What is the average cost of attending each blockage?	<input type="checkbox"/> <\$1000 <input type="checkbox"/> \$1001-\$2000 <input type="checkbox"/> \$2001-\$3000 <input type="checkbox"/> \$3001-\$4000 <input type="checkbox"/> \$4001-\$5000 <input type="checkbox"/> >\$5000 <input type="checkbox"/> Other
If you are experiencing smell problems, how severe is the smell problem?	<input type="checkbox"/> mild, only noticeable in the toilet area and can be addressed with the use of air freshers <input type="checkbox"/> strong enough that it is noticeable outside the toilet areas and generate complains <input type="checkbox"/> So strong that the building has to be evacuated <input type="checkbox"/> Other comments _____
How do you typically rectify the smell problem?	
Any other comments associated with maintenance of non-flushing urinals	

OPTIONAL DETAILS

Details	
Name	
Title	
Organisation	
Qualifications	
Nomination as a sample building:	No
Would you like your building to be nominated as a sample in the study?	Yes – my contact details are as follows:



Table 5 Survey Results

Survey Results											
General											
No of responses	The responses came from Facility Managers from small organisations with only a single building to look after to those representing university or large national company who manage anything up to 500 buildings.										
	<table border="0"> <tr> <td>5 from Sydney CBD;</td> <td>4 from Brisbane CBD;</td> </tr> <tr> <td>5 from NSW region;</td> <td>1 from Queensland region;</td> </tr> <tr> <td>8 from the ACT;</td> <td>2 from Adelaide CBD;</td> </tr> <tr> <td>6 from Melbourne CBD;</td> <td>6 from Perth CBD; and</td> </tr> <tr> <td>8 from Victoria region;</td> <td>4 from WA Region.</td> </tr> </table>	5 from Sydney CBD;	4 from Brisbane CBD;	5 from NSW region;	1 from Queensland region;	8 from the ACT;	2 from Adelaide CBD;	6 from Melbourne CBD;	6 from Perth CBD; and	8 from Victoria region;	4 from WA Region.
5 from Sydney CBD;	4 from Brisbane CBD;										
5 from NSW region;	1 from Queensland region;										
8 from the ACT;	2 from Adelaide CBD;										
6 from Melbourne CBD;	6 from Perth CBD; and										
8 from Victoria region;	4 from WA Region.										
Total number of buildings managed by Fmrs participating in the survey	2,202										
Total number of buildings installed with non flushing urinals	319 or 15% of buildings managed										
Total number of urinals installed in these buildings	9,324										
Total number of non flushing urinals installed	1,640 or 18% of total urinals installed										
No of non flushing urinals posing problems	431 or 26% of total non flushing urinals installed										
Building Details											
Age of the buildings	10 buildings which are less than 5 years old; 10 buildings which are between 5-10 years old; 4 buildings which are between 10-15 years old; and 25 buildings which are older than 15 years old										



Survey Results													
% of non flushing urinals which pose problems	Approx 10% on average are posing problems, with higher percentage (around 35%) are posed by non- flushing urinals retrofitted in buildings older than 15 years old												
Type of buildings in the survey	<table border="0"> <tr> <td>2 assembly buildings;</td> <td>5 Premier Grade office buildings;</td> </tr> <tr> <td>1 carpark building;</td> <td>16 A Grade office buildings;</td> </tr> <tr> <td>7 educational facilities;</td> <td>7 B Grade office building;</td> </tr> <tr> <td>1 hospital;</td> <td>2 C Grade office buildings;</td> </tr> <tr> <td>1 hotel/ motel;</td> <td>1 D Grade office building; and</td> </tr> <tr> <td>2 laboratories;</td> <td>4 public buildings (courthouse, exhibition hall etc).</td> </tr> </table>	2 assembly buildings;	5 Premier Grade office buildings;	1 carpark building;	16 A Grade office buildings;	7 educational facilities;	7 B Grade office building;	1 hospital;	2 C Grade office buildings;	1 hotel/ motel;	1 D Grade office building; and	2 laboratories;	4 public buildings (courthouse, exhibition hall etc).
2 assembly buildings;	5 Premier Grade office buildings;												
1 carpark building;	16 A Grade office buildings;												
7 educational facilities;	7 B Grade office building;												
1 hospital;	2 C Grade office buildings;												
1 hotel/ motel;	1 D Grade office building; and												
2 laboratories;	4 public buildings (courthouse, exhibition hall etc).												
No of tenancy	The majority of the buildings are occupied by less than 5 tenant organisations with 8 of them having more than 10 tenant organisations and 5 of them have between 5-10 tenant organisations.												
% of men occupying the buildings	Most buildings are occupied by between 41-60% men, with 8 buildings occupied by 61-80% men and 3 buildings occupied solely by men.												
Other comments	<ul style="list-style-type: none"> ▶ 20,000m² with half occupied in 1996 and other half (with non-flushing) occupied in 2007; ▶ 5 star green rated; ▶ A large building about 1 city block in size. Equivalent to a 50 story building; ▶ Administration building and function centre for school events and performances; ▶ Building is a teaching facility for apprentices; ▶ conference and exhibition location up to 20000 people per day; ▶ Convention and Exhibition Centre so the occupancy varies greatly by event; ▶ Courthouse; ▶ Event venue; 												



Survey Results

- ▶ It is a theatre with regular performances. The problems existed because the urinals were not installed correctly. The cartridges were not installed, therefore the drain was exposed to the public bathroom. This created a horrendous stench and unhygienic bathroom. It was closed down due to this. Since we've been looking after it everything is going well;
- ▶ Local Government Administration building;
- ▶ Not leased - Owner Occupied - 1200-1300 staff on site;
- ▶ School building, boys school and the urinals are found in both student and staff areas;
- ▶ Transport Depot;
- ▶ We have a mix of buildings ranging from warehouse to Ex offices, all seem to work well bar the warehouse loading dock as there hundreds of contractors and deliveries;
- ▶ We have over 200 bldgs across SA, NT & WA.

Installation Age	1 had the urinals installed prior to 2000, 9 had theirs installed between 2000-2005, 30 had them installed between 2005-2010 and 7 had theirs installed after 2010.
Retrofit or Not	28 out of 49 respondents had their urinals installed as retrofit of older buildings
Pipe Materials	4 had cast iron; 2 had combination of cast iron and copper; 2 had combination of cast iron and PVC; 10 have copper piping; 2 have combination of copper and PVC piping; 3 have polyethylene piping; and 18 have PVC piping.
Blockage Problem	20 reported blockage as a monthly problem, with 4 reporting blockage as a weekly problem
Slow Drainage Problem	1 reported slow drainage as a daily problem, 7 reported it as a weekly problem and 20 reported it as a monthly problem
Smell Problem	9 reported it as a daily problem, 10 reported it as weekly problem and 16 reported it as a monthly problem



Survey Results	
Physical Damage Problem	5 reported as a monthly problem, 1 reported it as a weekly problem
Other Problems	2 reported it as a monthly problem and another reported it as weekly problem.
Comments about the Urinals	<ul style="list-style-type: none"> ▶ GBH Waterless Urinal; ▶ I did also replace all associated copper pipes with PVC PRIOR to the retro fit. But they should always be charged by a hand basin or similar! ▶ Installed on copper waste pipes and were not changed to PVC this causes the copper on the waste bend to erode. During clearing blockages this breaks and the whole line is replaced with PVC which is very costly due to the nature of the installation; ▶ Good cleaning is imperative
	<p>If the cartridges are replaced be it an oil, valve or siphon design on a regular maintenance program there are few problems. There must be money in the property managers' budget for this maintenance service. It is usually done by a specific Service Technician due to it's intense/grubby nature. Many non flushing urinals are left for years without service!! This is due to important servicing information not being passed down from architect, developer, builder, plumber to property manager. Then they say they have no budget for it;</p>
	<ul style="list-style-type: none"> ▶ Scale build up if not flashed with water monthly; ▶ Really need to be flushed regular, build up in pipes mud like; ▶ Some form of flushing is required to prevent chemical build up; ▶ These were installed across a variety of sites. We only had minimal issues with the cube system mainly due to cleaners not following the correct cleaning methods; ▶ This has been run as a trial and we have only received positive feedback;
	<p>We did redo the pipework to PVC as original pipework was brass/copper; and</p> <p>We rely on the Landlord to keep stock of the filters and install them when needed.</p>
Cleaning Regimes	
Cleaning Service Arrangement	<p>Most have engaged outsourced cleaning service providers, with 8 being delivered in house and 1 have a combination of both in house and outsourced.</p> <p>1 respondent have the non flushing urinals serviced by a company qualified to provide the manufacturers' recommended maintenance requirements.</p>
Receipt of manufacturers instructions	3 respondents did not receive any instructions from manufacturers on cleaning regime, and 6 were unsure.
Cleaners received instructions on non flushing urinals	5 did not pass on the cleaning instructions to their cleaners with 3 unsure.



Survey Results	
display of the cleaning instructions	32 do not display the cleaning instructions by the urinals, 3 are unsure
frequency of cleaning	Most have the urinals cleaned on a daily basis, 1 respondent has them cleaned weekly and another has them cleaned monthly
Frequency of cartridge being replaced	<p>4 have them replaced weekly,</p> <p>8 have them replaced monthly,</p> <p>2 have them replaced 3 monthly,</p> <p>2 have them replaced 6 monthly,</p> <p>3 have them replaced yearly,</p> <p>others as required, depending on usage</p>
Comments on the cleaning regime	<ul style="list-style-type: none"> ▶ Cleaning procedures need to be followed and staff require regular training. Supply of service cartridges has been slow ▶ If urinals are cleaned properly we would have no issues - it is being addressed with excellent results; ▶ Added cost to cleaning contract; ▶ Cleaners have doubled the strength of the spray on solution and it has remarkable results. Cleaners are being drilled on how to clean the urinals properly and ensure they pour at least 4 litres of boiling water down the drain each night. We (the men) are very happy with the urinals although it did take awhile for them to get use to it. It has saved a lot of water consumption for the organisation; ▶ Contract plumber for recharging oil in units; ▶ Each cartridge requires a different maintenance service. The oil ones take the most time and are the most unpleasant to change, then siphon design are next and lastly the valve design are the best and easiest to change over. This has a big impact on having someone to do the service. It also can cost a lot for the oil to be replaced. This cost is usually covered by the savings in water usage;
	<ul style="list-style-type: none"> ▶ Getting cleaning staff to follow cleaning regime is difficult; ▶ Have improved with greater use of the chemical. The chemical cannot be mixed with normal cleaning product - even separate mops and buckets to be used; ▶ Refer to this link for a current discussion on dry urinals: http://www.linkedin.com/groupAnswers?viewQuestionAndAnswers=&discussionID=92066034&gid=82437&commentID=67953155&trk=view_disc&ut=1ArzWgR7bGY541



Survey Results

- ▶ The intensity of urine and the associated smell guides us towards water-based urinals;
- ▶ The urinals are fine but require much more maintenance and servicing to ensure they do not smell. This costs more than the actual savings in water consumption costs; and
- ▶ We had our supplier instruct the cleaners direct, issues only raised when cleaners changed and new starter did not know the cleaning requirements.

Maintenance Regimes

Maintenance service arrangements	Most respondents have the urinals maintained by an outsourced service providers, 8 respondents have the urinals maintained by in house resources, and 2 have a combination of both in house and outsourced maintenance service providers.
Availability of O&M Manuals	10 respondents do not have any Operations and Maintenance Manuals for the non flushing urinals, and 7 are unsure if they have the Manuals or not.
Where the Manual is kept	1 respondent keeps the Manual by the urinals, 10 stores them in the cleaning/ maintenance cupboard, 11 have them stored in the Facilities Office, 9 store them both in the maintenance/cleaning cupboard as well as in the Facilities Office, 4 are unsure where they keep the Manuals.
Maintenance staff access to Manual	6 respondents confirm that maintenance staff do not have access to the Manual, 8 indicated that they are not sure if maintenance staff have access to the Manual or not.
Location of blockage	2 respondents indicated blockage to occur at the junction between the building pipework and the town sewer system, 20 respondents indicated problems to occur at the junction between the urinal and the building drainage pipework, 24 respondents reported problems to occur at the urinal units.
Cost of attending blockage	Most blockage can be repaired for less than \$1,000 although 3 respondents reported blockage problems which cost between \$1-2,000.
Extent of smell problems	28 respondents reported that the smell is typically only mild and can be masked by air fresheners, 17 respondents have the smell strong enough and can be noticed outside the toilet areas. One respondent were forced to close the building down.



Survey Results

Methods of addressing the smell problem

- ▶ Additional cleaning;
- ▶ Air fresheners;
- ▶ Air fresheners were not needed, cleaning regime was reinstated and issue reduced to negligible;
- ▶ Air freshers , run the toilet exhaust beyond when there are no tenants;
- ▶ Automatic spray dispenser;
- ▶ Check urinal valve flush with water if still operational replace valve if damaged/ blocked;
- ▶ Check when the last maintenance regime was carried out. Contact the Landlord to investigate the issue. If the temperatures have been on the high side they may require changing at intervals less than the 6-weekly schedule i.e. monthly;
- ▶ Cleaning treatment performed next cleaning day, full clean and flush with 6 litres of water tablets replaced.
- ▶ Deodoriser spray;
- ▶ Exhaust air fans and air deodorant systems;
- ▶ Fill with water;
- ▶ Flash with water and descale;
- ▶ Flush and clean the urinals;
- ▶ flush the system with water and possible drain clean out;
- ▶ Have the unit serviced;
- ▶ I find there is always a slight smell;
- ▶ If there is a smell, I know the cleaning wasn't done properly and at this stage after the contract has run 2 years, I get them back in to clean it properly at no cost to the organisation. This is now very rare;
- ▶ Increase (\$\$\$) the frequency of service;
- ▶ It normally indicates a maintenance issue;
- ▶ pour water into urinal trough; have reinstated auto flusher to flush once a day;
- ▶ Remove the Urinals;
- ▶ replace the cartridge;
- ▶ Replace the siphon and with air freshener spray;
- ▶ Scrub down urinals;
- ▶ Srub out urinal and replace sleeve. Call plumber if blocked;



Survey Results

	<ul style="list-style-type: none"> ▶ The floor needs to be cleaned with a microbial spray cleaner and scrubbed. The urinals may require a maintenance service. If there is uric scale built up on the front of the urinals once cleaned off, the smell disappears; ▶ Top up the liquid seal; and ▶ With consent cleaning and air fresheners.
<p>Comments on maintenance regimes</p>	<ul style="list-style-type: none"> ▶ As long as maintenance regimes are followed they more than pay for them selves; ▶ if you keep up the maintenance you do not have many issues but they are costly and expensive to maintain and once in you do not have much choice; ▶ It has become somewhat of an accepted problem, in that our complaints have slowed but the odours are still detectable; ▶ Need the correct degree of flow from the urinal or will back up; ▶ One of my concerns is how the oil from the maintenance regime disposed of is. Is it environmentally managed?
<p>Plumbers need to understand how to install the waterless fixtures with the cartridges and set them up ready for usage. Often the non flushing urinals are used by the sparkies, tilers, general blow in's and they stink by the time the tenant moves in. They haven't been cleaned and have no cartridge in them!! It's been thrown away. This is the recipe for a 'bad start'. I've spoken to manufacture's and they hang their head low acknowledging the maintenance information is not pushed. Yes, it is available online, or if tenants scream loud enough. We have relationships with all manufacturers' and service all urinal makes and models;</p>	
	<ul style="list-style-type: none"> ▶ Proper cleaning is the key; ▶ The replacement cartridges are not cheap sometimes I think it would be better to flash. Scale would not build up at the urinal and in the pipe work close to the urinal we would not have the maintenance cost; ▶ Unsure about some information as we have a contract with a service provider; ▶ We had to put signs up to ask men not to spit their chewing gum into the urinal. Cleaners had to remove gum on a daily basis which helps but is not ideal; and ▶ With the system we used it is necessary to flush the line every evening with clean water. I f this is not regularly done then we tended to have build up in the S bend areas.
	<ul style="list-style-type: none"> ▶



GHD

16 Marcus Clarke St Canberra ACT 2601
PO Box 1877 Canberra ACT 2601 Australia
T: 61 2 6113 3200 F: 61 2 6113 3299 E: cbrmail@ghd.com.au

© GHD 2012

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	D Boynton	A Sudjiman		H Badger		
2	A Sudjiman	H Badger				