

Urban greywater reuse at the D'LUX Development

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Abstract

The Inkerman D'LUX Development (formerly Inkerman Oasis Development) comprises 236 new apartments in Inkerman Street, St Kilda (Melbourne). Occupancy of the first apartments occurred in mid-2003. The development includes a novel water recycling scheme based on supply of treated greywater to toilets and a below-ground garden irrigation system. Stormwater from the site is also treated and recycled for these purposes. The key components of the water recycling scheme include a subsurface flow wetland for stormwater storage, a lint trap for greywater pre-treatment, a membrane bioreactor for treatment of both stormwater and greywater and a UV disinfection system. The objective of the treatment train is to produce effluent classified as "Class A" according to the Victorian EPA Reclaimed Water Guidelines. A contracting company specialising in novel water management systems in urban developments provided the treatment system to the site developer. South East Water has provided financial support to the contractor and operates and maintains the system under a contract with the body corporate. The treatment system was commissioned in mid-2004 and underwent verification testing prior to supplying water for the intended uses. The key components of the water recycling system and outlines of the basic contractual arrangements are described, and details of the key issues, including protection of public health, are provided.

Keywords: Greywater; Recycling; Urban; On-site TP; Public health

1. Description of the D'LUX project

The Inkerman D'LUX Housing Development is a joint undertaking between the City of Port Phillip and Inkerman Developments Pty Ltd. The project is an infill development on Inkerman Street, St Kilda, ultimately comprising 236 residential apartments, constructed in two stages. The

first stage of the development is complete and comprises 107 apartments.

A key feature of the development is incorporation of initiatives designed to conserve energy and water. The water conservation features include recycling of greywater and stormwater collected from the site.

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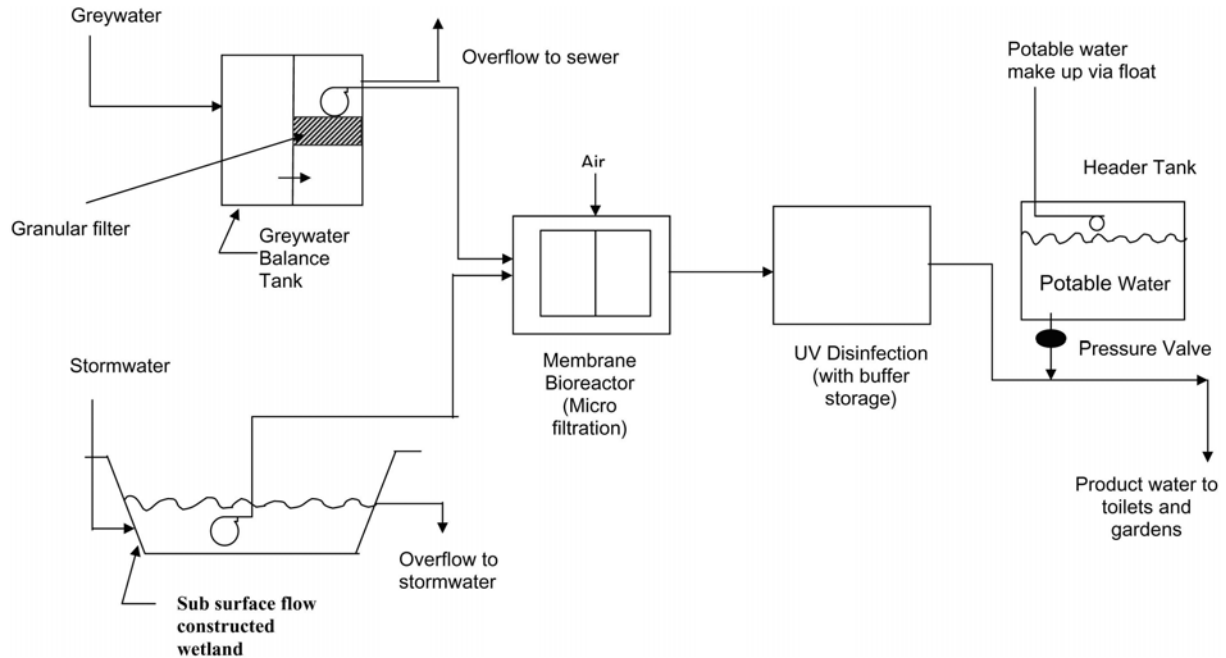


Fig. 1. Schematic of treatment plant process.

A process schematic of the water recycling system is presented in Fig. 1. The key features of the system include:

- Greywater is collected from bathrooms in about 100 of the apartments and stored in a balance tank, which normally overflows to the sewer. This tank is designed to allow sludge to settle in the base and includes a granular filter medium intended to trap lint.
- A subsurface flow constructed wetland which collects stormwater from the site and normally overflows to the local drainage system.
- Both the greywater balance tank and the wetland can be discharged by pumping to a membrane bioreactor, equipped with Kubota membranes with a nominal pore size of 0.4μ .
- The discharge from the bioreactor is disinfected with UV light and pumped to a header tank which feeds a ring main connected to toilets within the apartments and a below-ground garden irrigation system. The header

tank is provided with a back-up potable water supply.

2. Significance of the D'LUX project

The Government announced the following two water conservation targets for the water industry for April 2003:

- reduce per capita drinking water use in Melbourne by 15% by 2010 and
- recycle 20% of Melbourne's "waste" water by 2010.

There are three possible approaches to achieving a reduction in per capita water use: demand management (i.e., reducing customer usage by means such as education and restrictions), non-revenue water (i.e., reducing the water industry's use of water and reducing leaks from the water supply network) and potable substitution (i.e., substitution of potable water for some purposes

such as toilet flushing and garden watering with water from other sources such as groundwater or treated sewage).

The water industry has a history of promoting demand management and pursuing reductions in non-revenue water. However, further significant gains are unlikely to be achieved if only these two approaches are adopted. Thus, achievement of the Government target on per capita water use requires significant potable substitution. D'LUX is one of the first projects of this type in Victoria and is therefore an important test bed for the industry.

3. Commercial arrangements

3.1. Construction

The development was constructed on a surplus municipal depot site owned by the City of Port Phillip. The agreement between the City of Port Phillip and the developer includes a requirement that ownership of some of the apartments is vested in the city for community housing purposes. The developer, Inkerman Developments Pty Ltd, is a joint venture created for the purposes of the project. The members of the joint venture include the developer, Riverside Melbourne and the builder, Contract Control Constructions. The recycled water system was designed and supplied by Integrated Eco-Villages as a sub-contractor to the builder.

3.2. Operation and maintenance of the recycled water system

South East Water has been involved with the Inkerman D'LUX project since early 2003; however, the formal operation and maintenance of the recycled water system by South East Water only commenced in October 2004. The principal phases of the operation and maintenance period include performance verification and subsequent on-going operation and maintenance services.

The treatment plant commenced operation in August 2004, with the recycled water being discharge to sewers, which will continue to occur until South East Water has successfully verified the performance of the plant. This was expected to take 2–3 months and commenced in June 2005 with a review role by the Environmental Health Unit in the Department of Human Services (DHS). It was expected that the performance verification phase includes inoculation of the treatment plant with microorganisms.

Agreements were developed and executed and are detailed below.

3.2.1. System operation and maintenance

South East Water provides operation and maintenance services to the Body Corporate, who owns the water recycling system. These services will include:

- regular site and equipment inspections according to an agreed schedule;
- provision of a continuous response service to alarms forwarded by telemetry to South East Water's control centre;
- sampling and analysis of liquid and soil samples according to an agreed schedule. The sampling frequency for aqueous samples and the range of analytes varies once performance verification has been achieved;
- other services such as maintenance according to a schedule prepared by Integrated Eco Villages and preparation of reports to the Body Corporate.

The period of this agreement is 6 years and the Body Corporate makes an annual lump sum payment for the services.

3.2.2. Provision of consultant services

Integrated Eco Villages provides consultant services to South East Water for the first 12 months of the 6-year operation and maintenance period. These services include:

- as-constructed details;

- operation and maintenance manuals;
- performance requirements for the water recycling system;
- no payment to Integrated Eco Villages for these services.

3.2.3. Sponsorship

South East Water sponsored the project, making separate lump sum payments to both the developer, Inkerman Developments Pty Ltd, and the supplier of the water recycling system, Integrated Eco Villages. South East Water adopted this approach in order to ensure the completion of the water recycling project. This allowed for the evaluation of the technology as a means of recycling water in an urban environment.

4. Key issues

The D'LUX Development revealed a number of key issues for the water industry if further development or urban recycled water systems are to be encouraged.

4.1. Regulatory arrangements

The D'LUX Development preceded development of a regulatory framework and associated practices applicable to recycling greywater and stormwater. Typical difficulties encountered by the council, the developer and Integrated Eco Villages included confusion over whether:

- there was a requirement for a Works Approval and/or a Licence from the EPA. This confusion arose because the recycled water system has no waste discharge to the environment.
- the EPA guidelines for "Use of Reclaimed Water" applied to the project. This circumstance arose partly because the scope of the guidelines indicates that they apply "primarily ... to the use of reclaimed water from sewage treatment plants".

The difficulties associated with this lack of clarity were exacerbated by the fact that the designer/supplier of the water recycling system, Integrated Eco Villages, is based in Canberra and therefore found it difficult to gain a good understanding of the Victorian regulatory framework. This lack of clarity and poor awareness of the regulatory framework resulted in the project being well into the construction phase before any constructive discussions with regulators occurred. In practice, there was a real possibility that the project could have become fully operational without any regulatory scrutiny. This would have been a very unsatisfactory position for the proponents of the development, particularly if there were a subsequent public health or environmental contamination event.

This difficulty was addressed by the EPA and DHS agreeing to use the Environment Improvement Plan (EIP) process described in the guidelines for "Use of Reclaimed Water" to assess proposed risk management arrangements at the site. South East Water prepared an EIP on behalf of the Body Corporate and submitted this to the EPA and DHS. This received endorsement from the two regulators supporting the adequacy of the water recycling system, even though regulatory approval was not required.

4.2. Risks to public health

The system designed to manage the risk to public health at the site needs to include a number of features.

4.2.1. Verification of performance

Verification of the performance of the treatment plant was undertaken by South East Water prior to supplying recycled water for the first time. This was expected to commence in mid-2005 over 2–3 months. The regulators in Victoria (EPA and DHS) have advised that the preference for undertaking the verification process is to conduct some form of *in situ* spiking test with

target or surrogate organisms to confirm the theoretical log removal and achievement of Class A quality effluent. However, they are prepared to consider alternate surrogate tests, such as turbidity or other physical/chemical indicators in the event that the theoretical log removal of the treatment system readily achieved the requirements for Class A with a reasonable safety margin and track record. The reasonable safety margin has yet to be defined, but it is expected to be at least 2 log.

The regulators have indicated that they will have greater confidence in the theoretical log removal of treatment processes comprising membrane filtration combined with ultraviolet disinfection and a chlorine residual. At this stage they have less confidence in the performance of multimedia filters to consistently produce Class A quality effluent.

4.2.2. Plumber awareness

The education of plumbers is the responsibility of the Plumbing Industry Commission in Victoria. However, the plumber awareness programme proposed is the responsibility of the Body Corporate with significant assistance from South East Water. The main objective is to make sure that plumbers that come on site are aware that there is a dual-reticulation system. Some responsibility is passed on to customers to ensure that if they engage a plumber to undertake plumbing works inside their apartment, they inform the plumber that there is a dual-reticulation system.

Plumber awareness is also achieved through clear identification of above- and below-ground pipework and erection of signage both internal and external to the apartment buildings. It is anticipated that signage will be displayed within each apartment; however, this requires further deliberation.

4.2.3. Cross connection testing

Testing to identify cross connections between

the potable water reticulation system and the recycled water reticulation system occur both internal and external to the apartments. The Body Corporate has the overall responsibility for the cross-connection testing; however, South East Water gives significant assistance. Any positive cross-connection test results will trigger investigations to establish the point of cross connection, how it occurred and preventive measures for the future.

The details of the cross connection testing are being developed at present; the expected details are as follows:

1. Frequency:

- Cross connection testing occurs prior to the supply of recycled water into the ring main for the first time.
- Testing external to the apartments occurs every 3 years.
- Testing internal to the apartments occurs every 3 years or at a change of occupancy in an apartment, whichever occurs first.

2. Method:

- The methods to check for cross connection being considered include pressure testing, dye testing and draining the potable water line.
- The use of a dye test is most convenient when undertaking cross connection testing on a large scale, and is the preferred method of the Body Corporate as it is less intrusive on customers.
- For change of occupancy it is anticipated that a pressure test or draining of the potable supply line within the apartment is most suitable.

The occurrence of cross connection testing is audited annually as part of the overall auditing process. The draft agreements for the water recycling system envisage that the responsibility for development and implementation of the plumbing management system and the communication management program lie with the Body

Corporate. However, it is the expectation and requirement of both the EPA and DHS that South East Water supply significant assistance to develop and implement these. It is not clear that the Body Corporate will wish to retain this responsibility in the longer term, nor is it yet clear whether EPA and DHS will continue to be satisfied with the current arrangements.

4.3. On-going viability of the recycled water system

The current arrangements envisage that ownership of the recycled water system is vested in the Body Corporate. South East Water has structured the proposed payments by the Body Corporate for operation and maintenance services to be broadly consistent with the anticipated savings in potable water and sewerage charges. This approach was designed to encourage continuing use of the system. However, it is quite possible that the Body Corporate will choose to shut the system down if unanticipated costs arise (e.g., equipment replacement). This is clearly an unsatisfactory outcome if potable water substitution is a key component of the water industry's approach to reducing per capita water consumption.

5. Conclusions

The Inkerman D'Lux Development in Melbourne is the first domestic recycling scheme based on either greywater or sewage in Mel-

bourne to be operated by a water authority. Commissioning is imminent and the key messages arising from the project to date are:

1. Uncertainty about whether greywater recycling projects in Victoria which do not discharge to the environment need approval by regulatory authorities such as the EPA and DHS. There is evidence that the development industry is therefore prepared to implement such projects without obtaining the support of regulators. This is an unsatisfactory position and the consequences there should be subsequent public health issue are likely to be extensive.

2. Key public health management issues yet to be fully resolved at Inkerman D'Lux include the process verification program, the plumbing management program and the customer education program.

3. SE Water is responsible for developing and undertaking the process verification program as part of the contract to operate and maintain the greywater recycling system. The Body Corporate is responsible for the plumbing management and customer education programs; however, it is the expectation of regulators and a requirement of SE Water to have a key involvement. The willingness of the Body Corporate to accept the potential liabilities associated with their role may change in the future as the project is implemented.

4. Ownership of the recycling scheme is vested in the Body Corporate. This clearly raises the possibility that the equipment will be shut down in the future if costs become unacceptable. Should this occur, the value of the project as a means of conserving drinking water will be lost.