



**FACILITY FOR ADVANCING WATER BIOFILTRATION, FAWB**

**ANNUAL REPORT 2006-2007**

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## WHAT IS WATER BIOFILTRATION?

Water biofiltration is the process of improving water (stormwater and wastewater) quality by filtering the water through biologically influenced media.

Stormwater biofiltration systems include:

- Bioretention systems
- Constructed surface-flow wetlands
- Constructed sub-surface-flow wetlands

The application of water biofiltration technologies to mitigate the impacts of catchment development on the health of urban waterways is becoming widespread - even though the technology is continually evolving both in its effectiveness and efficacy in water cleansing, and in its implementation in the urban landscape at a range of scales.

There have been a number of successful applications of biofiltration, but also many poor outcomes owing to inappropriate utilisation of the technology, poor construction, operation and maintenance practices. There has also been insufficient understanding and dissemination of guidance on biofiltration borne out of successful applications, and research and development.

When used appropriately, biofiltration systems have been found to be viable and sustainable as a water treatment measure. Biofiltration systems also add to the quality of the landscape through the integration of these vegetated systems.



**Wolseley Parade, Victoria Park, Sydney – an existing biofilter**

## **BACKGROUND, MISSION AND MAIN AIMS**

### **Background**

The Facility for Advancing Water Biofiltration, FAWB, is an unincorporated joint venture between Ecological Engineering (now a Practice Area of EDAW) and Monash University, and was formed in mid-2005 following a successful application in the Victorian State Government's Strategic Innovation Initiative.

The following industry collaborators are also involved:

- Manningham City Council (Vic)
- Melbourne Water (Vic)
- VicRoads (Vic)
- Landcom (NSW)
- Brisbane City Council (Qld)
- Adelaide and Mount Lofty Ranges Natural Resources Management Board (SA)

(The Auckland Regional Council, New Zealand, participated as a collaborator to 30 June 2006.)

FAWB is primarily funded through the Victorian State Government's Science, Technology and Innovation (STI) grant (\$1.46 million), industry cash contributions (\$0.5 million) and a direct cash contribution from Monash University (\$0.35 million). The total value of the activities within FAWB, including both cash and in-kind contributions, is \$4.3 million over three years.

As part of the STI Grant Application, FAWB developed a comprehensive Business Plan. This plan incorporates detailed research and marketing plans, with the opportunity to update the Plan on an annual basis.

### **Mission**

The mission of the Facility for Advancing Water Biofiltration, FAWB, is to provide proof of concept, by developing and field-testing a range of biofilter systems that can be applied to specific market-based needs, and to facilitate industry-wide adoption and implementation of the technology through effective industry engagement and delivering industry capacity guidance and other adoption tools.

### **Main Aims**

The main aims of FAWB are to:

- Provide scientific "proof of concept" for the application of stormwater biofilter technologies
- Facilitate industry-wide adoption and implementation of the technology

The specific outcomes of FAWB's work will be innovative stormwater biofilter technologies underpinned by:

- New scientific knowledge about the key physical, chemical, and biological performances which underpin the effectiveness of stormwater biofilters
- Design specifications for biofilters that form the basis for written technical design, construction and maintenance guidelines to accompany legislation/regulation
- Algorithms that assist the design of biofilters for a wide range of applications
- Prototypes of modular units for specific applications (e.g. devices for stormwater treatment and re-use at the level of an individual household or a single commercial site)

## PROJECT HIGHLIGHTS

### *Project 1: Technology*

#### **Laboratory Experiments - Optimising & demonstrating biofiltration technology**

Laboratory studies of bioretention systems are being undertaken to determine the optimum design configuration (vegetation, media, outlet specifications) and operating conditions for achieving long-term, sustainable pollutant removal.

The laboratory experiments involve 800 experimental-scale bioretention columns, which are being subjected to a range of test conditions.

#### **Choosing the best plant species...**

Which species can best accommodate the wetting and drying pattern in a bioretention system? Which species will support the best long-term removal of pollutants?

FAWB is testing 20 different species (including grasses, sedges, reeds, shrubs and trees) to find out, by dosing vegetated bioretention "columns" with stormwater, and measuring the growth rate and pollutant uptake of each species.

The pollutant concentration in the filter media, and the stormwater effluent is also being measured.



**Testing plants species suitable for bioretention systems**

## **Influence of design and operating**

### **- Test set up**

150 large (375mm diameter) bioretention columns have been constructed, to test the:

- Optimal filter media type (e.g. sandy loam, sandy loam with vermiculite/perlite, low pH sandy loam, activated carbon, etc)
- Optimal filter depth (up to 700mm, plus 'transition layer')
- Benefit and configuration of an anaerobic zone for promoting denitrification, for sustainable nitrogen removal
- Influence of plants (using 5 species chosen from the subset of 20 (above) on bioretention effectiveness in pollution reduction
- Influence on bioretention operation and effectiveness of climate, pollutant concentration and storm size

### **- Water quality monitoring**

Each column is dosed with stormwater, and the outflow rate and pollutant (sediment, nitrogen, phosphorus, heavy metals, hydrocarbons, etc) concentration monitored.

### **- Health aspects**

Each column is tested for its ability to produce water suitable for stormwater reuse. Testing is undertaken for pathogens, viruses and other contaminants.



**Advanced bioretention columns for testing the performance anaerobic zones.**

## Long-term sustainability

Bioretention systems need to perform effectively over long periods.

- FAWB is conducting experiments to: Test designs and specifications of filter media and vegetation that maintain the permeability of the soil filter media
- Measure the long-term efficacy of different filter media types (ie. their pollutant adsorption capacity)

## Key messages from Project 1: Technology

1. All biofilters configurations tested (both vegetated and unvegetated) remove more than 90% of heavy metals (both particulate and dissolved).
2. Without vegetation, most soils will naturally leach some nitrogen. Biofilters therefore rely strongly on vegetation and its symbioses with bacteria and fungi, for the removal of nutrients from stormwater.
3. Of the species tested extensively so far (*Carex appressa*, *Dianella revoluta*, *Microleana stipoides*, *Leucophyta brownii* and *Melaleuca ericifolia*), *Carex appressa* is the best for nutrient removal (this is anticipated to be because of rapid spreading of roots throughout the soil media, and the role of symbiotic fungi around the root rhizosphere). Biofilters planted with shallow-rooted plants (e.g. *Microleana stipoides*) will be ineffective in nutrient removal.
4. The addition of vermiculite and perlite (around 5% each by volume) to the soil media helps to maintain hydraulic conductivity, making the biofilter more robust to slight deviations from the specified soil media characteristics. It is also known to enhance the (already high) heavy metal adsorption capacity of biofilters.
5. Biofilter soil media placed 'uncompacted' will show an initially very high hydraulic conductivity, which will settle back to the design value within a few months.
6. It is important that testing of biofilter soil media for hydraulic conductivity use the method of McIntyre and Jakobsen (published in *Practical drainage for golf, sportsturf and horticulture* (2000), Ann Arbor Press), which takes into account the effect of compaction of the soil media.
7. Some degree of leaching of fine sediment and nutrients from the soil media will usually occur during the establishment phase, until the soil has stabilised, and plant roots have occupied the soil volume (this will typically take 2-6 months).
8. The presence of an anaerobic zone (made of sand or gravel with around 5% carbon source, such as woodchips) will improve nitrogen removal, by promoting denitrification, and will also enhance plant survival during drought periods.

## Project 2: Policy and Risks

### Mapping Industry Capacity for WSUD

FAWB's research aims to assess the institutional factors that influence the opportunities and constraints within organisations for the implementation of Water Sensitive Urban Design (WSUD) technologies, of which biofilters are one.

The strength and relative importance of the relationships and inter-linkages between these factors differ between organisational types. These factors are investigated and mapped for industry sectors to determine the current institutional capacity trends for WSUD technologies.

### Key Research Objectives

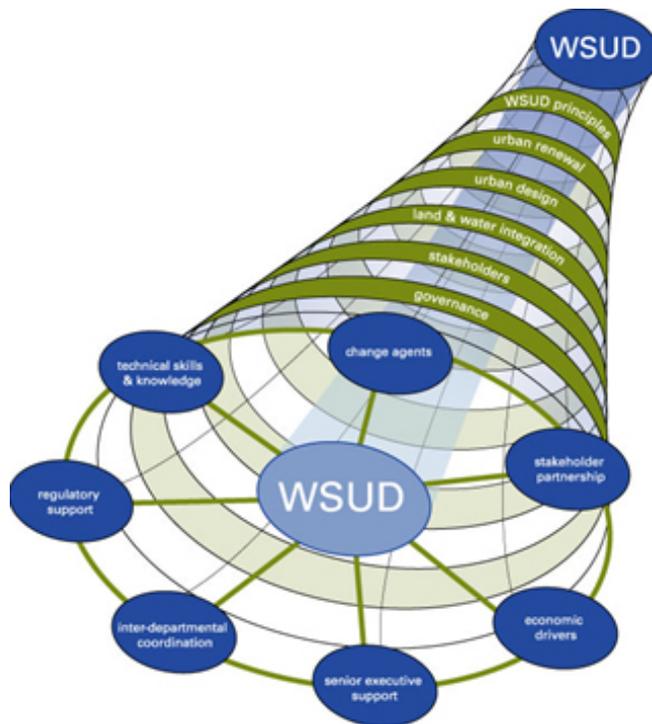
- Key objectives are to: Assess how current administrative frameworks both constrain and enable the uptake of biofilter technologies
- Identify the necessary 'institutional qualities' that will effectively expedite the adoption of biofilter technologies in practice
- Determine how to adapt existing reform processes and ideas to best advance the change needed
- Deliver practical guidance to urban water managers and policy makers



Project leader Dr Rebekah Brown addressing seminar to launch report on Transition to WSUD

### Mapping Industry Capacity

This research aims to assess the institutional factors that influence the opportunities and constraints within organisations for the implementation of Water Sensitive Urban Design (WSUD) technologies, of which biofilters are one. The strength and relative importance of the relationships and inter-linkages between these factors differ between organisational types. These factors are investigated and mapped for industry sectors to determine the current institutional capacity trends for WSUD technologies.



### Barriers and drivers to 'Sustainable Urban Water Management'

In complementary research involving the FAWB Project 2 team, the National Urban Water Governance Program conducted an on-line survey in November 2006. The questionnaire focused on perceived 'barriers' and 'drivers' to advancing sustainable urban water management in three case study regions: Melbourne, Brisbane and Perth.

The questionnaire was aimed at range of stakeholders, but specifically urban water professionals. The questionnaire response was overwhelming with over 300 respondents in Perth and Brisbane, and over 420 in Melbourne (a total of 1041).



CEO Dr Tony Wong speaking at seminar on Transition to WSUD

### Key Messages from Project 2: Policy and Risk

1. The WSUD approach is yet to be mainstreamed anywhere, and the mainstreaming of WSUD will require a more complex multi-sectoral governance approach that is dedicated, proactive and strategic in its pursuit of WSUD. This is because there is currently an absence of an overriding and galvanising socio-political driver or 'crisis' to drive the necessary change.
2. There is a need to provide guidance to urban water strategists and others on how to enable effective institutional change that will lead to the mainstreaming of the WSUD approach across modern cities.
3. The retrospective social research analysis of the key factors over the last 40 years that has enabled the successful institutionalisation of 'urban stormwater quality management' across Metropolitan Melbourne reveals: how the 'value' of environmental protection of waterways has been institutionalised towards a relatively advanced stage of increasing importance, within the broader set of well established institutional values of flood protection, public health protection, water supply security and economic efficiency within current decision and policy-making processes.
4. While the historical case study research revealed a range of interconnected activities and initiatives that on the surface seem to represent an organic development pathway, there has been a critical, and in many ways opportunistic, interplay between industry champions and important context variables that has provided the structure and catalyst for the transition so far.
5. Eight key context variables are identified as instrumental when considered as a 'package' to advancing institutional change.

No.	Key Variables	Description
1	<b>Socio-Political Capital</b>	Aligned community, media and political concern for improved waterway health, amenity and recreation.
2	<b>Bridging Organisation</b>	Dedicated organising space that facilitates collaboration across science and policy, agencies and professions, and knowledge brokers and industry.
3	<b>Trusted &amp; Reliable Science</b>	Accessible scientific expertise, innovating reliable and effective solutions to local problems.
4	<b>Binding Targets</b>	A measurable and effective target that binds the change activity of scientists, policy makers and developers.
5	<b>Accountability</b>	A formal organisational responsibility to the improvement of waterway health, and a mandate for influencing practices that lead to such an outcome.
6	<b>Strategic Funding</b>	Additional resources dedicated to the change effort.
7	<b>Demonstration Projects &amp; Training</b>	Accessible and reliable demonstration of new thinking and technologies in practice, accompanied by knowledge diffusion initiatives.
8	<b>Market Receptivity</b>	A well articulated business case for the change activity.

6. The insights from the Melbourne case study provide an important basis for other cities, and other sectors of activity, to learn from.
7. While the institutional dynamics of the WSUD approach may be more complex than those for the urban stormwater quality management (USQM) approach, the Melbourne case study provides a solid platform of evidence for how institutional change can successfully occur and identifies key factors that underpin such change.

## ***Project 3: Adoption Tools***

### **Building Industry Capacity for Biofilters: Adoption of Technologies**

A central aim of FAWB is to promote the widespread adoption of biofilter technologies. Australia is in the early stages of a transition away from the traditional water servicing approach and towards more sustainable urban water management.

For this transition to become stable, with technologies such as biofilters being adopted as mainstream practice, industry capacity needs to be improved.

With technologies such as biofilters being adopted as mainstream practice, industry capacity needs to be improved. FAWB aims to build industry capacity for biofilter technologies by delivering a number of products and services to industry.



**Biofilter application, Coomera Waters**

### **Modelling Tools**

- Algorithms for improved prediction of the performance of biofilters including bioretention systems and constructed wetlands

The two main outputs have been anticipated:

- A simple, but robust, design model of biofilter performance
- Biofilter design methodology for a number of possible situations (e.g. residential sites, retrofit, rain gardens, highway runoff treatment, re-use, etc)

### **Adoption Guidelines**

- Design recommendations for multi-functional biofilter systems
- Design and construction guidelines for biofilter systems

Key outputs for adoption tools are:

- A set of design recommendations outlining the principal design considerations needed for effective operation of biofilters for water quality improvement.
- Production of guidelines  
The guidelines should assist industry to adapt biofilter technologies into urban design for multiple functions. Typical examples could include urban design amenities, and treatment for stormwater reuse. Other novel designs may arise during the research

### **Commercialisation**

- The involvement and commitment of FAWB and its key staff to international conferences continued at a substantial level, raising awareness of biofiltration technologies. In particular, FAWB staff and postgraduates presented twelve papers at Novatech 2007, the 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007
- As part of Project 2, Policy and Risk, the FAWB working document 'Transition to Water Sensitive Urban Design: The Melbourne Story' was launched in Melbourne on 15 February 2007 and a seminar held for participants from industry, research and government.
- The Parliamentary Secretary for Innovation, and Industry, Mr Tony Lupton led a parliamentary delegation on a tour of the FAWB carpark biofilter and vegetation trials at Monash on 26 February 2007.
- In association with Clearwater, the Victorian-based urban water management training and resource agency, and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" in August and September 2006.
- Five postgraduates, including two postgraduates from European universities, worked on PhD studies associated with FAWB and its staff.
- Postgraduates Dale Browne, Belinda Hatt, Sébastien Le Coustumer and Yaron Zinger were lead authors of papers which they presented at the Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, held in Lyon, France, June 25-28, 2007.  
Godecke Blecken was the lead author of a paper presented at the Lyon conference by a co-author.

## ***Project 4: Demonstration and Testing***

### **Field Trials- Optimising & demonstrating biofiltration technology**

A key aim of FAWB's research is to develop biofiltration technologies that provide effective and sustainable treatment of stormwater. Bioretention systems are a form of biofilter that are becoming widely used owing to their efficiency and adaptability to urban landscape design.

FAWB is using a combination of laboratory experiments and field trials of bioretention systems to test the influence of design configurations and operating conditions, and to demonstrate their full-scale applications. The field trials are being documented to provide guidance on construction, operation and maintenance of biofiltration systems, and for achieving long-term performance and sustainability.

#### **Aims of Field Trials**

A number of field trials of bioretention systems in Melbourne, Sydney and Brisbane are being undertaken to:

- Validate laboratory studies and address site specific issues
- Provide demonstrations of bioretention systems in a range of urban environments (streetscapes, greenfields, inner-city retrofits, etc)
- Provide the basis for monitoring of long-term robustness under real operating conditions
- Document construction procedures, for use in guidelines and standard drawings

#### **Bioretention for stormwater harvesting (Melbourne)**

A bioretention system has been constructed to treat stormwater runoff from a car park, prior to its harvest for reuse.

This system has been designed as three separate cells allowing field-scale trials of biofilter media (including additives) and hydraulic loadings.



Mixing trial filter media for field comparisons

**Bioretention system in sodic soil environment (Sydney)**

The application of bioretention systems in sodic soil environments requires particular attention to preventing any increases in discharge to groundwater and leaching of saline water into receiving waters. (A sodic soil is defined as a non-saline soil containing sufficient exchangeable sodium (Na) to adversely affect plant or vegetation production and soil structure under most conditions of soil and plant type.)

Field trials are undertaken to investigate if special construction techniques need to be adopted in constructing bioretention systems in sodic soil environments.

**Large-scale bioretention system (Brisbane)**

This regional-scale bioretention system treats stormwater runoff from an 87ha residential catchment. Specifically, this trial will examine the effectiveness of an anaerobic zone for removal of nitrogen from urban stormwater.

The system is designed with three hydraulically separate filtration cells, each with a different sub-surface drainage configuration and vegetation specification thus providing a unique monitoring



Wakerley bioretention system: regional scale trial for nitrogen removal

## Key Messages from Project 4: Demonstration and Testing

1. In field applications, biofilters may demonstrate high variations in hydraulic performance due to different specifications of filter media characteristics, and poor construction and maintenance practices (43% of tested existing systems have field infiltration capacity below 50 mm/hour).
2. There will be leaching of silt and some pollutants over the establishing phase. The flushing of solids should cease within 3-6 months in most cases (dependent on the amount of rainfall during this period).
3. Bioretention systems constructed in sodic soil without impermeable lining are not at risk of exporting salt from insitu soil into local streams.
4. To ensure reliable operation of bioretention systems, filter media specifications must be adhered to in terms of both composition and hydraulic conductivity. FAWB has produced such specifications that will be updated as required to reflect new and relevant research insights. Dispersive clay and silt from the Western Sydney area are generally unsuitable material for creating bioretention filter media owing to their unreliability in maintaining media hydraulic conductivity. Furthermore, it is important to tests soils prior their installation (see Project 1, Key Message 6).
5. Effective communication between designers and construction contractors is essential, throughout all stages of the project. It is imperative that quality control issues are addressed in planning and design, construction and maintenance throughout the life of the bioretention system, and that the design intent is communicated to the contractors, at a pre-construction briefing.
6. Maintenance requirements could be high during the establishment phase; frequent weed removal is required and the juvenile vegetation should be watered during extended dry periods. However the need for this level of maintenance reduces significantly as the vegetation matures. The development of mosses on the surface should be discouraged, as these can reduce the hydraulic capacity of the system. Dense planting of the preferred plants at the time of construction will help to minimise the extent of weed invasion, and minimise any moss growth.

## STRUCTURE AND MANAGEMENT

The Facility for Advancing Water Biofiltration, FAWB, a joint venture research facility between Ecological Engineering Holdings Pty Ltd (now a Practice Area of EDAW) and Monash University under the auspices of the Victorian Government's Science Technology and Innovation Initiative, operates in cooperation with industry collaborators and stakeholders.

FAWB commenced in July 2005 under the Grant Agreement between the State of Victoria and Monash University, the Joint Venture Agreement between Monash University and Ecological Engineering Holdings Pty Ltd, and Collaboration Agreements between Monash University and each of the following industry collaborators.



**Launch of FAWB and Opening of Monash Carpark Biofilter 17 October 2006  
by Mr Matt Viney, MP, Parliamentary Secretary for Industry and Innovation,  
pictured with FAWB CEO Dr Tony Wong**

### *Industry Collaborators*

Adelaide and Mount Lofty Ranges Natural Resources Management Board, SA  
Auckland Regional Council, New Zealand (to 30 June 2006)  
Brisbane City Council, Qld  
Landcom, NSW  
Manningham City Council, Vic  
Melbourne Water Corporation, Vic  
VicRoads, Vic

## Organisation Structure

### **Board of Management**

#### *Independent Chairperson*

Prof Russell Mein, RG Mein and Associates

#### *Collaborator Representatives*

Mr Claude Cullino, Manningham City Council, Collaborator Representative  
(Alternate, Mr Graham Rooney, Melbourne Water)  
Ms Armineh Mardirossian, Landcom – NSW, Collaborator Representative (to April 2007)  
(Alternate, Ms Marianne Robertson, VicRoads)

#### *Ecological Engineering/EDAW Representatives*

Dr Peter Breen  
Mr Malcolm Eadie

#### *Monash University Representatives*

Dr Tim Fletcher  
Prof Bill Young

## Board Meetings

FAWB Board Meetings for 2006-2007 were held on:

7 September 2006  
23 November 2006  
16 February 2007  
24 May 2007



**FAWB Board Members and participants, September 2006**

### **FAWB Management**

#### *Chief Executive Officer*

Dr Tony Wong, Ecological Engineering/EDAW

#### *Research Manager*

Assoc Prof Ana Deletic, Monash University

#### *Project Leaders*

Dr Rebekah Brown, Monash University (Project 2)

Assoc Prof Ana Deletic, Monash University (Project 3) (Succeeded by Ms Belinda Hatt from 25 July 2007)

Dr Tim Fletcher, Monash University (Project 1)

Mr Justin Lewis, Monash University (Project 4)

#### *Business Manager*

Mr John Molloy, Monash University

### **Research Program - Projects**

Project 1: Technology

Project 2: Policy and Risk

Project 3: Adoption Tools

Project 4: Demonstration and Testing

### **Research Advisory Panel**

A FAWB Research Advisory Panel was formed under the arrangements in the FAWB Joint Venture Agreement, the purpose of the Panel being to provide independent peer review and to advise the FAWB Board (through the Research Manager) on the scientific merit and rigour of the research program.

Panel members for 2006-2007 included:

- Professor Simon Beecham  
(School of Natural and Built Environment, University of South Australia)
- Professor Jenny Dixon  
(School of Architecture and Planning, The University of Auckland)
- Mr Earl Shaver (at the time with Auckland Regional Council).

The Research Advisory Panel conducted a two-day review of the research activities of FAWB on 25 and 26 September 2006.



**FAWB Research Advisory Committee (L to R): Mr Earl Shaver, Prof Simon Beecham, and Prof Jenny Dixon**



**FAWB Research Review in session**

### **Stakeholders Committee**

The FAWB Joint Venture Agreement provides for, as a central item, a Stakeholders Committee. The Stakeholders Committee advises the Board of Management (through the CEO) on Collaborator and end-user perspectives of the FAWB research program.

Stakeholder /Collaborator Representatives for 2006-2007 were:

- Mr Claude Cullino, Manningham City Council (Alternate Mr Jeff Young)
- Mr Keith Downard, Adelaide and Mount Lofty Ranges Natural Resources Management Board
- Ms Armineh Mardirossian, Landcom - NSW (Alternate, Mr Stuart McCowan)
- Ms Marianne Robertson, VicRoads
- Mr Graham Rooney, Melbourne Water
- Ms Anne Simi, Brisbane City Council (Alternate Mr Stuart Hovermann)

Meetings of the Stakeholders Committee were held on:  
18 August 2006  
20 April 2007

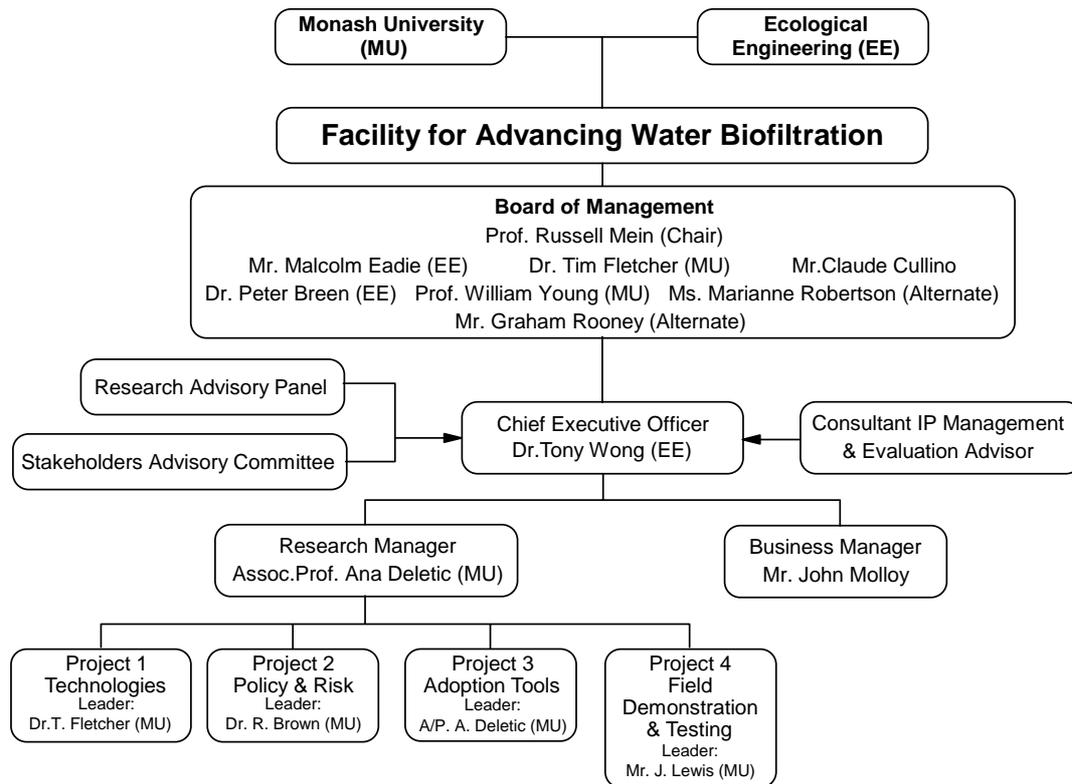


**FAWB Stakeholders Meeting, August 2006**



**Anne Simi (BCC), Jeff Young (Manningham CC) and Marianne Robertson (VicRoads)  
at FAWB Stakeholders Meeting, April 2007**

## FAWB Governance Structure



### FAWB Office

The FAWB Office is located at:  
 Monash University, Department of Civil Engineering  
 Building 60, Clayton Campus  
 MONASH UNIVERSITY, VIC 3800, Australia  
 phone +61 3 9905 4957  
 fax +61 3 9905 5033  
[fawb@eng.monash.edu.au](mailto:fawb@eng.monash.edu.au)

## COOPERATIVE LINKAGES

### Local links

#### *Participants and Collaborators*

FAWB linkages between its Joint Venture Participants, Ecological Engineering and Monash University, were strengthened during the year.

All Collaborators:

- Adelaide and Mount Lofty Ranges Natural Resources Management Board, SA
- Auckland Regional Council, New Zealand (to 30 June 2006)
- Brisbane City Council, Qld
- Landcom, NSW
- Manningham City Council, Vic
- Melbourne Water Corporation, Vic
- VicRoads, Vic

completed FAWB Collaboration Agreements with Monash. The Auckland Regional Council (New Zealand) agreement applies to 30 June 2006.

FAWB linkages with stakeholders continue to be fostered. The major Australian urban water management agencies, Brisbane City Council and Melbourne Water continue to be key participants.

Significant linkages and interaction with Landcom–NSW have been established and maintained, including a major demonstration site at Second Ponds Creek being provided by Landcom.

#### *Joint activity - Research Planning Workshop*

A one-day research-planning workshop was held on 25 September 2006. This workshop provided the forum for all four projects of the research program to be discussed amongst the R&D participants, to plan activities for the year ahead and to facilitate integration of these activities across the program.



FAWB team at Research Planning Workshop

### International collaborative links

#### *Lulea University of Technology (Lulea, Sweden)*

A PhD student from the Lulea University of Technology (Lulea, Sweden), Godecke Blecken, has been working with FAWB at Monash. A joint paper with researchers from FAWB at Monash University, and the Lulea University of Technology, was presented at the Novatech 2007 Conference at Lyon, France.

The FAWB Research Manager, Assoc Prof Ana Deletic and Project Leader Dr Tim Fletcher had a planning meeting in June 2007 with Prof Maria Viklander of Lulea University of Technology on future collaborative project opportunities.

*INSA de Lyon (Lyon France)*

FAWB linkages with INSA (Institut National des Sciences Appliquées) Lyon, France were strengthened through the involvement of students Katia Bratières and Lucie Acazar. Katia Bratières, an undergraduate from INSA spent six months with FAWB. Lucie Alcazar has been collaborating with FAWB at Monash on pathogen aspects of biofiltration. She will also spend six months with FAWB.

Postgraduate scholar, Sébastien Le Coustumer, returned to INSA Lyon. Sébastien has continued with testing the hydraulic performance of standard biofilter vegetation columns under joint supervisors in Lyon and at Monash.

Further links were made through the visit of FAWB Project Leaders and postgraduates to Lyon before and during the Novatech 2007 Conference. Tim Fletcher has been requested by INSA Lyon to be an "External Expert" to a proposed multiple-partner biofiltration research project in France.

*Technological University, Delft, The Netherlands*

Dr Rebekah Brown, Project 2 Leader, gave a seminar in Delft in June 2007 on the nature and findings of her study with Jodi Clarke on 'The Transition to Water Sensitive Urban Design, The Story of Melbourne.' The seminar strengthened the collaboration with the Delft institution with FAWB and Dr Brown's team. Her findings were an eye-opener for the Delft social scientists who had been pioneers in the development of 'transition' theory for the take up of new technology.

*Dutch Ministry of Water Resources, Delft, The Netherlands*

CEO Dr Tony Wong gave a presentation on the 'Water Sensitive City' to the Dutch Ministry of Water Resources in June 2007. Useful linkages were established and considerable interest was shown in the FAWB activities in view of the increased awareness in the Netherlands of the potential impacts of climate change on water resources management.

*York University, United Kingdom*

FAWB invited Prof Malcolm Cresser, from York University, UK, (who is a world renowned expert on the nitrogen N cycle in plant/soil systems) to come and work with FAWB over two weeks in April 2007.

Prof Cresser arrived on 12 April 2007 for his collaborative visit to FAWB at Monash. A highly successful internal workshop was arranged from which the main findings were summarized and knowledge gaps identified.

The collaboration with Prof Cresser and York University continued with further discussions between the Research Manager, Assoc Prof Ana Deletic and Prof Cresser in the UK in June 2007.



**FAWB workshop with Prof Malcolm Cresser, April 2007**

*Pennine Water Group, University of Sheffield and University of Bradford*

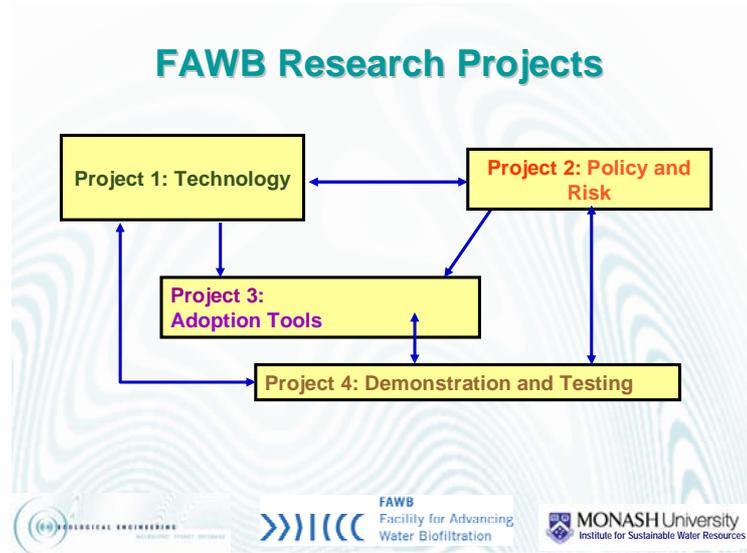
Assoc Prof Ana Deletic FAWB Research Manager, had discussions in June 2007 on cooperative future projects with Professor Richard Ashley, Managing Director of the Pennine Water Group, a centre dedicated to research into water and wastewater. It is based at the Universities of Sheffield and Bradford. Assoc Prof Deletic also presented seminars at Sheffield and Bradford Universities.

*Singapore Department of Water Resources*

Cooperative links were furthered with the Singapore Department of Water Resources through a presentation in June 2007 by FAWB CEO Dr Tony Wong on the nature of FAWB, its joint research/industry collaboration, and its work and findings on biofiltration to date. The Singapore Government has invited Dr Wong to participate in and assist with the planning and arrangements for a collaborative research and industry group on water sensitive urban design to be established in Singapore, along the lines of the FAWB venture.

## RESEARCH

### Research Structure



### Projects

#### *Project 1: Technology*

##### **Project Aims**

The aim of Project 1 is to develop and test biofilter technologies that will be capable of treating stormwater runoff in a range of urban situations, and to overcome technical barriers to the utilisation of biofiltration technology.

The specific aims are to:

- Develop new biofilter designs to optimise performance and ensure long-term sustainability;
- Determine design configurations that optimise treatment performance, and reduce the risk of soil media clogging;
- Develop new filter media types for targeted pollutants (such as heavy metals, nutrients and pathogens);
- Determine sustainable pollution loadings, in order to make predictions about effective lifespan; and
- Determine the performance and risk of using stormwater biofilters as a treatment device for stormwater reuse.

Based on these aims, three Project Activities have been developed, within Project 1:

- Project Activity 1.01 Vegetation trials
- Project Activity 1.02 Laboratory biofilter column experiments
- Project Activity 1.03 Biofilter optimisation for stormwater reuse

##### **Project Leader**

Dr Tim Fletcher, Monash University

##### **Project highlights 2006-2007**

###### *Key messages from Project 1: Technology*

1. All biofilter configurations tested (both vegetated and unvegetated) remove more than 90% of heavy metals (both particulate and dissolved).
2. Without vegetation, most soils will naturally leach some nitrogen. Biofilters therefore rely strongly on vegetation and its symbioses with bacteria and fungi, for the removal of nutrients from stormwater.
3. Of the species tested extensively so far (*Carex appressa*, *Dianella revoluta*, *Microleana stipoides*, *Leucophyta brownii* and *Melaleuca ericifolia*), *Carex appressa* is the most effective for nutrient removal (this is anticipated to be because of rapid spreading of roots throughout the soil media, and the role of symbiotic fungi around the root rhizosphere). Biofilters planted with shallow-rooted plants (e.g. *Microleana stipoides*) will be ineffective in nutrient removal.

4. The addition of vermiculite and perlite (around 5% each by volume) to the soil media helps to maintain hydraulic conductivity, making the biofilter more robust to slight deviations from the specified soil media characteristics. It is also known to enhance the (already high) heavy metal adsorption capacity of biofilters.
5. Biofilter soil media placed 'uncompacted' will show an initially very high hydraulic conductivity, which will settle back to the design value within a few months.
6. It is important that testing of biofilter soil media for hydraulic conductivity use the method of McIntyre and Jakobsen (published in *Practical drainage for golf, sportsturf and horticulture* (2000), Ann Arbor Press), which takes into account the effect of compaction of the soil media.
7. Some degree of leaching of fine sediment and nutrients from the soil media will usually occur during the establishment phase, until the soil has stabilised, and plant roots have occupied the soil volume (this will typically take 2-6 months).
8. The presence of an anaerobic zone (made of sand or gravel with around 5% carbon source, such as woodchips) will improve nitrogen removal, by promoting denitrification, and will also enhance plant survival during drought periods.

The biofiltration vegetation columns were re-deployed to a further stage of the experimentation. The main activity has been on pathogen testing. Preliminary results show that the biofilter designs are capable of producing significant reductions in pathogen numbers.



Laboratory columns

### Activity 1.01 Vegetation trials

#### Aim

To undertake pot trials to:

- Measure growth rates under controlled watering regimes
- Measure nutrient uptake

with harvesting and assays (plant and soil) to determine mass balance .

### **Achievements 2006-2007**

The laboratory testing of the pollutant removal performance of 20 different plant species was completed. All laboratory data was collected.

The key finding is that some plants are excellent for N removal, but others are not. For example, while *Carex fascicularis* and two indigenous species of *Juncus* were doing an excellent job, some other plants, such as *Lomandra longifolia* and *Microlaena stipoides* were not able to prevent leaching of total nitrogen, TN (i.e. more TN left columns than was applied in stormwater).



**Plant species trials**

### **Activity 1.02 Laboratory biofilter column experiments**

#### **Aim**

To develop a standard experimental system for biofilter columns and:

- undertake basic mechanistic experiments - mass balance
- quantify variation in performance with different design elements
- test major design variations

#### **Achievements 2006-2007**

The results from the four rounds of sampling of standard columns are very consistent in regard to the removal of pollutants: Total suspended solids TSS, total phosphorus TP and heavy metals are effectively removed by almost all the system designs tested.

The systems planted with *Carex* are able to reliably remove TN (consistently around 50% for all sampling rounds). Unfortunately, there is leaching of TN, in particular NO<sub>x</sub>, from all other designs (even columns planted with 4 other species). We are making an effort to solve this problem, and will test some new design features in the near future.

PhD student Yaron Zinger has finished his first study on the effectiveness of the anoxic zone (created at the biofilter bottom), as well as carbon source additions. His results are showing that even high nitrogen oxides removal is possible if biofilters are designed in certain way.

In his second round of experiments; Yaron Zinger is testing the effects of drying/wetting cycles on the performance of biofilters planted with *Carex*. The preliminary results suggest that the prolonged dry periods will have negative effects on nutrient removal. However, an anoxic zone implemented at the bottom of the filters will remove these effects and assure persistently high performance.

Belinda Hatt (also a FAWB PhD student) showed that the duration of dry periods plays an important role on nutrient behaviour in non-vegetated systems. Two of her papers are now in press in *Water Science and Technology*, one is under review in *Water Research*, and she is writing a fourth journal paper.

PhD student from Technical University Lulea (Sweden), Godecke Blecken, arrived to work with us for six months. He and Yaron Zinger have been analysing the data on the impacts of temperature on biofilter performance.

Postgraduate scholar, Sébastien Le Coustumer, PhD student from Lyon, France, has been testing the hydraulic performance of standard columns. He has been gaining more evidence that the infiltration capacity over time is reaching an asymptotic and satisfactory value (on average around 180-200 mm/hour). This is highly encouraging, but the monitoring must continue to further prove this useful finding.



Columns for anoxic zone studies

### Activity 1.03 Biofilter optimisation for stormwater reuse

#### Aim

To:

- - Develop new biofilter designs to optimise performance and ensure long-term sustainability;
- - Determine design configurations that optimise treatment performance, and reduce the risk of soil media clogging.

#### Achievements 2006-2007

A large laboratory set-up was established to optimise biofilter design. It consists of 140 standard and 18 advanced columns, representing different biofilter designs (with five replicates of each design). Regular dosing of the columns and monitoring of their treatment performance has commenced.

Preliminary results are showing a high removal rate for all key stormwater pollutants, including 50% removal of total nitrogen.

## Project 2: Policy and Risks

### Project Aims

This Project contributes to the broader Program aim of advancing the effective implementation of water biofiltration technologies, by concentrating on developing guidance strategies related to institutional change. The other project areas focus on addressing the current technical knowledge limitations to advancing widespread practice, and this project provides complementary insight into addressing significant institutional knowledge gaps. These relate to the design and administration of 'enabling' policy and regulatory frameworks, and addressing 'risk perception' related to previously identified issues such as liability and poor organisational capacities.

Therefore, Project 2 aims to develop a methodology to address institutional and social barriers to the widespread adoption of biofiltration technologies, which is focussed through two activities:

- Activity 2.01: Developing regulatory, policy and strategic guidance; and
- Activity 2.02: Addressing risk perception, liability and opportunities.

Key objectives of Project 2 are to:

- Construct a transition map of biofilter technology adoption across Metropolitan Melbourne (i.e. institutional, policy, niches etc);
- Assess industry 'risk perception' to the widespread implementation of biofilters;
- Determine the incentives and disincentives to improve industry receptivity; and
- Provide policy and governance advice for advancing the WSUD transition, with a particular focus on biofilter technology.

### Project Leader

Dr Rebekah Brown, Monash University

### Project highlights 2006-2007

#### Key Messages from Project 2: Policy and Risk

1. The WSUD approach is yet to be mainstreamed anywhere, and the mainstreaming of WSUD will require a more complex multi-sectoral governance approach that is dedicated, proactive and strategic in its pursuit of WSUD. This is because there is currently an absence of an overriding and galvanising socio-political driver or 'crisis' to drive the necessary change.
2. There is a need to provide guidance to urban water strategists and others on how to enable effective institutional change that will lead to the mainstreaming of the WSUD approach across modern cities.
3. The retrospective social research analysis of the key factors over the last 40 years that has enabled the successful institutionalisation of 'urban stormwater quality management' across Metropolitan Melbourne reveals: how the 'value' of environmental protection of waterways has been institutionalised towards a relatively advanced stage of increasing importance, within the broader set of well established institutional values of flood protection, public health protection, water supply security and economic efficiency within current decision and policy-making processes.
4. While the historical case study research revealed a range of interconnected activities and initiatives that on the surface seem to represent an organic development pathway, there has been a critical, and in many ways opportunistic, interplay between industry champions and important context variables that has provided the structure and catalyst for the transition so far.
5. Eight key context variables are identified as instrumental when considered as a 'package' to advancing institutional change.

No.	Key Variables	Description
1	<b>Socio-Political Capital</b>	Aligned community, media and political concern for improved waterway health, amenity and recreation.
2	<b>Bridging Organisation</b>	Dedicated organising space that facilitates collaboration across science and policy, agencies and professions, and knowledge brokers and industry.
3	<b>Trusted &amp; Reliable Science</b>	Accessible scientific expertise, innovating reliable and effective solutions to local problems.
4	<b>Binding Targets</b>	A measurable and effective target that binds the change activity of scientists, policy makers and developers.
5	<b>Accountability</b>	A formal organisational responsibility to the improvement of waterway health, and a mandate for influencing practices that lead to such an outcome.
6	<b>Strategic Funding</b>	Additional resources dedicated to the change effort.
7	<b>Demonstration Projects &amp; Training</b>	Accessible and reliable demonstration of new thinking and technologies in practice, accompanied by knowledge diffusion initiatives.
8	<b>Market Receptivity</b>	A well articulated business case for the change activity.

6 The insights from the Melbourne case study provide an important basis for other cities, and other sectors of activity, to learn from.

7 While the institutional dynamics of the WSUD approach may be more complex than those for the urban stormwater quality management (USQM) approach, the Melbourne case study provides a solid platform of evidence for how institutional change can successfully occur and identifies key factors that underpin such change.

#### *Transition to WSUD*

The final version of the report: 'Transition to WSUD the Melbourne Story' has been printed.

Twenty-eight formal submissions were received on the WSUD working document launched at the 15 February 2007 workshop. State, local government staff and consultants provided their comments.

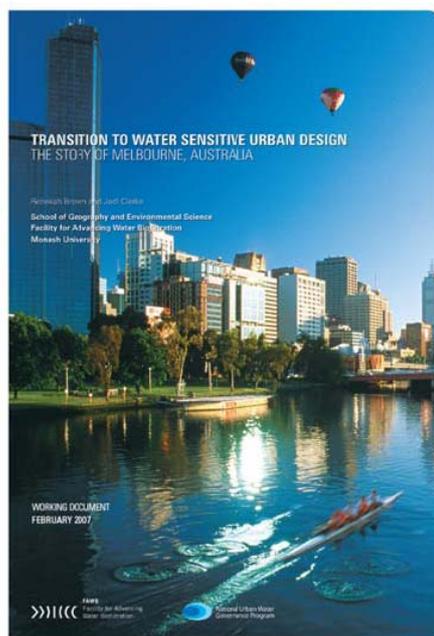
Good feedback, on historical details particularly, was obtained. Participants at the workshop and other reviewers regarded technology champions as important. Individual champions were seen as influential by some commentators, others saw the interplay of champions with other organisations as pivotal.

#### *Barriers and drivers to 'Sustainable Urban Water Management'*

Responses from the questionnaire and on-line survey on perceived 'barriers' and 'drivers' to advancing sustainable urban water management are being processed and analysed. Three case study regions: Melbourne, Brisbane and Perth, were used.

Issues concerning the acquisition of new technology and infrastructure were seen as critical, with timing of the acquisition being a particular concern.. Generally, the expected acquisition period was around 6-15 years, say 10 years. The team was trying to get a sense of urban development rates and the associated infrastructure.

The strong need for and demand by local government and other groups for training on WSUD in regional Victoria was recognised.



Working Document on WSUD transition, February 2007

## **Activity 2.01 Policy - Regulatory, policy and strategic guidance**

### **Aim**

To undertake a comprehensive review of current Victorian legislative and policy drivers for improving urban stormwater quality, building on work already carried out by FAWB partner organisations.

### **Achievements 2006-2007**

FAWB presented a successful seminar and workshop to launch the report "Transition to WSUD: The Story of Melbourne, Australia" as a working document on 15 February 2007.

The final report was published in June 2007, prior to a launch and seminar on the report held in July 2007.

## **Activity 2.02 Risk - Risk perception, liability and opportunities**

### **Aim**

To identify and categorise current industry and community perceptions of potential risks connected with the incorporation of biofilter technologies into public and private infrastructure.

### **Achievements 2006-2007**

Project Leader, Dr Rebekah Brown and Researcher Jodi Clarke completed their on-line survey of practitioners of opportunities and barriers to the adoption of water sensitive urban design technologies.

They also travelled to Perth and Brisbane conducting individual and focus group interviews on the same subject. Key people in politics, industry, and research were interviewed on the adoption of water sensitive urban design, including biofiltration technologies.

The study team has been undertaking a detailed analysis of the data, aiming to reveal the main risks in adoption of our biofilter technology. The preliminary stage of survey analysis has been completed revealing some key risks in adoption of our biofilter technology.

Communication of scientific results, as well as the trust that industry has for scientific results, are some key issues identified for adoption of WSUD technologies.

### **Project 3: Adoption Tools**

#### **Project Aims**

The main challenge for Project 3: Adoption Tools is to develop a practical road map of activities to inform the production of biofilter adoption guidelines. The aim of Project 3 is to develop biofilter adoption tools for practitioners.

There are two specific objectives currently proposed:

- To develop the design algorithms of stormwater biofilters for a variety of possible applications; and
- To develop adoption guidelines/recommendations for biofilters.

The project is scheduled to start in 2007, however the research plans were scheduled to be developed mid-2006. This planning was carried out in conjunction with the stakeholders (during a stakeholder meeting held in August 2006 focusing on this), and is presented in this report.

#### **Project Leader**

Dr Ana Deletic, Monash University, succeeded by Belinda Hatt (from 25 July 2007)

#### **Project Output**

A comprehensive set of design recommendations that outline key design considerations that are necessary to preserve the effective operational processes of biofilters as water quality improvement measures.

This document will include case studies derived from Project 2 to demonstrate how the fundamental technical specifications of biofilters can be adapted into urban design.

#### **Project highlights 2005-2006**

The FAWB Board approved the appointment of Belinda Hatt as Project Leader, commencing July 2007.

Further scoping work for Project 3 has been proposed after Belinda Hatt commences as Project Leader. A workshop is planned to facilitate the scoping.

It was felt important to include insights from the FAWB work which could be applied to building algorithms and models for Project 3. There was also a need for the findings from Project 2, including the survey outcomes, to be incorporated in Project 3.

### **Activity 3.01 Design Algorithm**

#### **Aim**

To develop a simple, but robust, design methodology for biofilter design .

#### **Achievements 2006-2007**

Belinda Hatt was appointed as Project Leader

As noted above, the research proposals for Project 3 are to be reviewed and further scoped.

### **Activity 3.02 Design guidelines for multi-functional biofilters**

#### **Aim**

To develop a comprehensive set of design recommendations that outlines key design considerations that are necessary to preserve the effective operational processes of biofilters as water quality improvement measures.

#### **Achievements 2006-2007**

Following the registration process set up in December 2006 for FAWB's first product, the soil media specifications (placed on FAWB web page), 56 users have registered to download the guideline document.

Activity 3.02 will be subject to further scoping.

## **Project 4: Demonstration and Testing**

### **Project Aims**

Project 4 aims to complete a number of field trials of bioretention systems in Melbourne, Brisbane and Sydney, in order to:

- Validate laboratory studies and address site specific issues;
- Provide the basis for monitoring of long term robustness under real operating conditions;
- Provide demonstrations of bioretention systems in a range of urban environments (streetscapes, greenfield, inner-city retrofits, etc); and
- Document construction procedures, for use in guidelines and standard drawings.

The focus of Project 4 is on testing the novel systems constructed in consultation with FAWB, as well as on testing a number of existing bioretention systems.

The current activities include:

Activity 4.01 Bioretention System in Western Sydney  
Activity 4.02 Monash University Car Park Bioretention System  
Activity 4.03 Wakerley Bioretention System, Brisbane  
Activity 4.04 Testing Existing Bioretention Systems  
Activity 4.05 Testing Brisbane Bio-pods

### **Project Leader**

Justin Lewis

### **Project highlights 2006-2007**

#### *Key Messages from Project 4*

- 1 In field application, biofilters may demonstrate high variations in hydraulic performance due to different specifications of filter media characteristics, and poor construction and maintenance practices (43% of tested existing systems have field infiltration capacity below 50 mm/hour).
- 2 There will be leaching of silt and some pollutants over the establishing phase. The flushing of solids should cease within 3-6 months in most cases (dependent on the amount of rainfall during this period).
- 3 Bioretention systems constructed in sodic soil without impermeable lining are not at risk of exporting salt from insitu soil into local streams.
- 4 To ensure reliable operation of bioretention systems, filter media specifications must be adhered to in terms of both composition and hydraulic conductivity. FAWB has produced such specifications that will be updated as required to reflect new and relevant research insights. Dispersive clay and silt from the Western Sydney area are generally unsuitable material for creating bioretention filter media owing to their unreliability in maintaining media hydraulic conductivity. Furthermore, it is important to tests soils prior their installation (see Project 1, Key Message 6).
- 5 Effective communication between designers and construction contractors is essential, throughout all stages of the project. It is imperative that quality control issues are addressed in planning and design, construction and maintenance throughout the life of the bioretention system, and that the design intent is communicated to the contractors, at a pre-construction briefing.
- 6 Maintenance requirements could be high during the establishment phase; frequent weed removal is required and the juvenile vegetation should be watered during extended dry periods. However the need for this level of maintenance reduces significantly as the vegetation matures. The development of mosses on the surface should be discouraged, as these can reduce the hydraulic capacity of the system. Dense planting of the preferred plants at the time of construction will help to minimise the extent of weed invasion, and minimise any moss growth.



**Monash University Car Park Bioretention System**

*Monash University Car Park Bioretention System, Melbourne*

The inflow from the sedimentation or pretreatment tanks at Clayton was an issue. It was relatively free of pollutants.

In other words, the pretreatment tanks were effective in removing sediment and heavy metals. As a result, gauging the effectiveness of the biofilter in removing those pollutants was a challenge. By-passing of the pre-treatment tanks was an option.

Nitrogen and phosphorus levels were also an issue. Nitrogen was being leached into the effluent. The carpark biofilter vegetation had been fertilised at the start. The filter media was another aspect under investigation.

*Wakerley Bioretention, Brisbane*

Another round of experiments on the biopods at Brisbane had been completed.

Testing was similar to that used at Cremorne St, Brisbane. The biofilter had been replanted with Carex and improved performance is hoped for.

**Activity 4.01 Bioretention System in Western Sydney**

**Aim**

To provide insight into sodic soil interaction with the bioretention filter media and the significance of trench lining on the hydrologic performance of bioretention swales in Second Ponds Creek and to document design and construction procedures for bioretention systems in sodic soil environments.

**Achievements 2006-2007**

A preliminary report on the laboratory study into performance of biofilters built in sodic soils has been produced and sent to Landcom. The results show that the leaching of salt does not appear to be a major problem even for an unlined bioretention system built in sodic soils.. The study also showed that FAWB's improved soil specification should be stable over time. Based on this study, Landcom has ordered the same filter material for a number of systems that will soon be built in Western Sydney. The experiments are to continue, looking into the impacts of drying on salt leaching.

The laboratory study into the performance of biofilters built in sodic soils was completed. The final data analyses have continued, and the final report is scheduled for 2007-2008.



**Second Ponds Creek Bioretention System**

## Activity 4.02 Monash University Car Park Bioretention System

### Aim

To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

### Achievements 2006-2007

The system is now fully equipped. In addition to being a focus in the FAWB launch and opening of October 2006, it was also the first system that FAWB is able to monitor during natural storms. Belinda Hatt is leading this work.

Several storms have been monitored, and researchers are waiting for the results from chemical analyses. The results are expected to present the first data on the performance of biofilters during real events that have been obtained in Australia and elsewhere.



Monash Carpark Biofilter

## Activity 4.03 Wakerley Bioretention, Brisbane

### Aim

To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

### Achievements 2006-2007

Justin Lewis, Dr Tim Fletcher, Sally Taylor (from Brisbane Ecological Engineering office) and Dr Ana Deletic spent almost a full day in a workshop with several Brisbane City Council representatives, planning the monitoring of this system. It is an impressive system with some unique features (e.g. an anoxic zone), and FAWB will provide on-going technical assistance to FAWB's Collaborator, BCC to set up the monitoring program early next year. See photo of Wakerley Bioretention site shown below.

FAWB is has been assisting its BCC partners to design the monitoring program that should start in mid 2007



**Construction of the Wakerley site (October 2006).**

#### **Activity 4.04 Testing existing biofilter systems**

##### **Aim**

To provide knowledge about the operation and treatment efficiency of the bioretention system in removing typical urban stormwater pollutants and to complement laboratory experiments on different biofilter configurations and soil media.

##### **Achievements 2006-2007**

This new activity is already yielding some very interesting results. Data has been gathered on the hydraulic performance and accumulation of metals in over 20 biofilters of different designs and age (in Sydney, Melbourne and Brisbane).

Testing existing bioretention systems – Sébastien Le Coustumer has effectively completed the field work required (over 40 biofilters have been tested for hydraulic conductivity and accumulation of metals). He is currently compiling the data, and aiming to produce summary sheets for each biofilter that was tested.



**An existing biofilter tested in Activity 4.04**



**Leyland Grove, Victoria Park, Sydney - an existing system tested**

#### **Activity 4.05 Testing Brisbane Bio-pods**

##### **Aim**

To assist in the design, construction and testing of bio-pods, (small and functional biofiltration systems that have been retro-fitted into the urban landscape in Brisbane) to achieve effective biofilter performance.

##### **Achievements 2006-2007**

FAWB has been involved in helping BCC to build and test bio-pods. The design (which used FAWB filter media guidelines) and implementation of these systems has been outlined in a paper by Smith and others for the International Public Works Conference, Cairns, Qld, August 2007.

The hydraulic and treatment performance of one of the systems has been tested in two separate experiments. The system was replanted with FAWB recommended plants between the two experiments. A preliminary assessment of the results from the first sampling event indicates that the infiltration capacity of the system is unchanged, while the pollutant removal performance, in particular for nutrient removal, has improved as the vegetation has matured.



**Brisbane City Council existing biofilter 'pod'**

## COMMERCIALISATION, PUBLIC RELATIONS AND COMMUNICATIONS

### Commercialisation

The involvement and commitment of FAWB and its key staff to international conferences continued at a substantial level, raising awareness of biofiltration technologies. In particular, FAWB staff and postgraduates presented twelve papers at Novatech 2007, the 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007.

Postgraduates Dale Browne, Belinda Hatt, Sébastien Le Coustumer and Yaron Zinger were lead authors of papers which they presented at the Novatech 2007. Godecke Blecken, also a FAWB postgraduate, was the lead author of a paper presented at the Lyon conference by a co-author.

As part of the activities of Project 2, Policy and Risk, the FAWB working document 'Transition to Water Sensitive Urban Design: The Melbourne Story' was launched in Melbourne on 15 February 2007 and a seminar held for participants from industry, research and government.

The Parliamentary Secretary for Innovation, Industry and Regional Development Mr Tony Lupton led a parliamentary delegation on a tour of the FAWB carpark biofilter and vegetation trials at Monash on 26 February 2007.



**Justin Lewis outlining vegetation trials to Mr Tony Lupton and Ms Marsha Thompson**

In association with Clearwater, the Victorian-based urban water management training and resource agency, and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" in August and September 2006.

Five postgraduates, including two postgraduates from European universities (Sébastien Le Coustumer, - INSA, Lyon, France; and Godecke Blecken - Lulea University of Technology, Sweden), worked on PhD studies associated with FAWB and its staff.



**Postgraduate Belida Hatt presenting at Novatech 2007  
(Dr Tim Fletcher, Session Chair)**



**Postgraduate Yaron Zinger presenting at Novatech 2007**

## **Public Relations and Communications**

### *FAWB website*

The FAWB website came online on 31 March 2006.

The FAWB website address is: [www.monash.edu.au/fawb](http://www.monash.edu.au/fawb). The overall design is the basic Monash website template. An upgrade was made in May/June 2007.

There were 23,632 successful website hits to 30 June 2007 for 2006/2007 compared to a total of 2731 hits recorded for 2005/2006.

The website has been used for the dissemination of publications and other products. For example, the document 'Guideline Specifications for Soil Media in Bioretention Systems' was placed on the FAWB website on 27 July 2006.

A user-registration process for the Guidelines was set up to assist with advising users of updates and gauging industry demands. A total of 174 registrations from 13 Dec 06 to 30 June 2007 were recorded.

**Presentations/Briefings – FAWB 2006-2007**

<b>Date</b>	<b>Speaker (s)</b>	<b>Topic</b>	<b>Organisation/Venue</b>
17 October 2006	Prof Russell Mein; Dr Tony Wong; Mr Matt Viney, MP, Parliamentary Secretary for Innovation and Industry; Mr Graham Rooney, Melbourne Water	Launch of FAWB	FAWB/ Monash University, Clayton Campus
14 November 2006	Assoc Prof Ana Deletic	Facility for Advancing Water Biofiltration (at the Annual Stormwater Industry Association Victoria, SIAV Seminar: 'The Stormwater Alternatives')	Stormwater Industry Association Victoria /Corporate Centre, Manningham City Council, Doncaster
22 November 2006.	Assoc Prof Ana Deletic, Dr Tim Fletcher and Dr Rebekah Brown	FAWB and its research projects	Victorian Water Engineering Branch, Engineers Australia / Engineers Australia, North Melbourne
23 November 2006.	Yaron Zinger, Postgraduate Scholar, Monash University, Project 1 - Technology	Optimisation of the nitrogen retention capacity of stormwater biofiltration systems	FAWB Board/ Monash University, Clayton Campus
15 February 2007	Dr Rebekah Brown, Jodi Clarke- Project 2 Researcher, Dr Tony Wong,	Seminar and workshop to launch the report on "Transition to WSUD: The Story of Melbourne, Australia"	FAWB/ Fenix, Richmond
26 February 2007	Dr Tony Wong, Assoc Prof Ana Deletic, Justin Lewis	Parliamentary delegation tour of FAWB facilities led by Parliamentary Secretary for Innovation, Industry and Regional Development Mr Tony Lupton.	FAWB / Monash University, Clayton Campus, FAWB facilities – Monash Carpark Biofilter and Vegetation Trials.
19 April 2007	Prof Malcolm Cresser, FAWB Project Leaders, Researchers /Postgraduates	Biofiltration Research	FAWB / Monash University, Clayton Campus
June 2007	Dr Rebekah Brown	Transition to water sensitive urban design	Technological University, Delft, The Netherlands
June 2007	Dr Tony Wong	Water Sensitive City	Dutch Ministry of Water Resources, Delft, The Netherlands
June 2007	Assoc Prof Ana Deletic	FAWB and biofiltration research	Pennine Water Group/ University of Sheffield
June 2007	Assoc Prof Ana Deletic	FAWB and biofiltration research	Pennine Water Group/ University of Bradford
June 2007	Dr Tony Wong	FAWB, its joint research/industry collaboration, and its work and findings on biofiltration to date	Singapore Department of Water Resources/ Singapore

**Media References – FAWB 2006-2007**

<b>Date (Page)</b>	<b>Medium</b>	<b>Title / Subject</b>	<b>FAWB Representative /Aspect</b>
25 October 2006	MONASH MEMO: News and information for Monash University staff	Article on 'Biofilter garden unveiled at Clayton - A biofilter garden that collects and filters stormwater has been unveiled at the Clayton campus by the Victorian Parliamentary Secretary for Innovation and Industry, Mr Matt Viney.'	Launch of FAWB, 17 October 2006
09 Nov 2006	Stormwater Industry Association Victoria 'SIAV E-News'	Article on FAWB opening and launch by the Minister for Innovation and Industry, Matt Viney, on 17 October.	In the article it was noted that: 'Several SIAV Committee members were at the launch and we will work with FAWB to disseminate key outcomes of this important research.'
Issue 18, November 2006, Spring/ Summer 2006	Monash Magazine	Trickle Down Technology	Dr Tim Fletcher and Assoc Prof Ana Deletic / Permapave porous paving slab.
14 March 2007	Monash Memo	Parliamentary delegation visits key projects	Dr Tony Wong, FAWB Project Leaders/The delegation visited the "Rain Garden" at the Facility for Advancing Water Biofiltration (FAWB) on February 26 2007.
April 2007 Number 5	National Urban Water Governance Program Newsletter <a href="http://www.urbanwatergovernance.com">www.urbanwatergovernance.com</a>	Transition to a Water Sensitive City	Dr Rebekah Brown/ release of working paper on 'Transition to Water Sensitive Urban Design: The Story Of Melbourne, Australia.'



**Assoc Prof Ana Deletic explaining monitoring aspects to Parliamentary delegation, February 2007**

## EDUCATION AND TRAINING

### Annual Research Workshop

The second Annual Research Workshop was held on 26 September 2006. 26 staff, postgraduate students and visitors attended. Three external Board members and the panel members from the FAWB Research Review, which concluded that morning, also attended.

Postgraduates and researchers participated in the workshop with a number giving presentations on their projects.



*FAWB Annual Workshop in session, Sept 2006*

### Postgraduates

Six postgraduates worked on PhD studies associated with FAWB and its staff. Details of the postgraduates, including their topics and supervisors, are set out in the following table.

### Postgraduates – FAWB 2006-2007

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor(s)	Funding source(s) ARC /Uni/etc	Topic
Godecke Blecken	Luleå University of Technology, Sweden	PhD	Assoc Prof A. Deletic (Monash) Prof M. Viklander (Lulea)	Exchange Student	Biofilter treatment of stormwater
Dale Browne	Monash	PhD	Assoc Prof A. Deletic (Monash) Dr T. Fletcher (Monash) Dr G. Mudd (Monash)	MDS*	Predicting and modelling the clogging of stormwater infiltration systems
Belinda Hatt	Monash	PhD	Assoc Prof A. Deletic (Monash) Dr T. Fletcher (Monash) Dr P. Webley (Monash)	MDS*/James McNeill scholarship	Developing novel stormwater treatment technologies for safe re-use
Sébastien Le Coustumer	Institut National des Sciences Appliquées (INSA) de Lyon.	PhD (enrolled at both INSA and Monash University)	Dr S Barraud (Lyon) Assoc Prof A. Deletic (Monash) Dr T. Fletcher (Monash)	Cotutelle Program, France	Measurement and modelling of hydraulic and environmental performance of urban stormwater infiltration systems
Anke Wendelborn	Monash	PhD	Dr G. Mudd, Assoc Prof A. Deletic, Assoc Prof P. Dillon	MDS*	Stormwater injection aquifer storage and recovery in Melbourne and associated water quality issues.
Yaron Zinger	Monash	PhD	Assoc Prof A. Deletic (Monash) Dr T. Fletcher (Monash)	MDS*/MGS§	Advancing stormwater biofilter technologies

\* Monash Departmental Scholarship

§ Monash Graduate Scholarship



FAWB Postgraduates (L to R): Dale Browne, Godecke Blecken, Belinda Hatt and Yaron Zinger

### Visiting Scholars

Two visiting undergraduate scholars from France worked on research associated with FAWB and its staff. Details of the visiting scholars and their topics, are set out below.

### Visiting Scholars – FAWB 2006-2007

Name	University	Type of enrolment	Supervisor(s)	Funding source(s) ARC /Uni/etc	Topic
Lucie Alcazar	Institut National des Sciences Appliquées (INSA) de Lyon.	Undergraduate	Dr T. Fletcher and Assoc Prof A. Deletic (Monash)	Exchange student	Treatment of pathogens by biofiltration.
Katia Bratières	Institut National des Sciences Appliquées (INSA) de Lyon.	Undergraduate	Dr T. Fletcher (Monash)	Exchange student	Impact of design parameters and operating conditions on nutrient removal by biofilters.



Visiting scholar, Lucie Alcazar

### *Involvement of postgraduates in conferences*

As also mentioned under 'Commercialisation, Public Relations and Communications', postgraduates Dale Browne, Belinda Hatt, Sébastien Le Coustumer and Yaron Zinger were lead authors of papers which they presented at the Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, held in Lyon, France, June 25-28, 2007 Godecke Blecken was the lead author of a paper presented at the Lyon conference by a co-author.



**Sébastien Le Coustumer presenting a paper at Novatech 2007, Lyon.**

### *Training Courses*

In association with Clearwater, the Victorian-based urban water management training and resource agency and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" on:-

- 30th August 2006 (Civic Centre, City of Casey, Narre Warren)
- 7th September 2006 (The Mansion, Werribee)
- 8th September (Emu Bottom Homestead, Sunbury)
- 15th September (Melbourne Business School, Mt Eliza)

Education and training proposals also continued to be developed. In conjunction with Clearwater, planning was initiated for a two-day workshop on biofilter design to be held on 4 and 5 September 2007 at Monash University.

## **PUBLICATIONS 2006-2007**

### **Edited Books**

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Deletic, A. and T. D. Fletcher, Eds. (2006). Proceedings of the 7th Urban Drainage Modelling and 4th Water Sensitive Urban Design Conference, Melbourne, Australia, April 3-7th, 2006. Melbourne, International Water Association, Institute for Sustainable Water Resources, Engineers Australia and Stormwater Industry Association.

Fletcher, T. D. and A. Deletic, Eds. (In press). Data requirements for integrated urban water management. Paris, Taylor & Francis.

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Bertrand-Krajewski, J.-L., T. D. Fletcher and V. G. Mitchell (In press). Chapter 5 - Temporal and spatial scale considerations. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

Breil, P., M. Lafont, T. D. Fletcher and A. Roy (In press). Chapter 20 - Aquatic ecosystems. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

Deletic, A. and T. D. Fletcher (In press). Chapter 2 - Overview of guiding principles. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

Deletic, A. and T. D. Fletcher (In press). Chapter 4 - Selecting variables to monitor. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

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Fletcher, T. D. and J.-L. Bertrand-Krajewski (in press). Chapter 12 - Financial considerations. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

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Shuster, W., T. D. Fletcher and A. Deletic (in press). Chapter 17 - Stormwater. Data requirements for integrated urban water management. T. D. Fletcher and A. Deletic. Paris, Taylor & Francis.

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Duncan, H. P. and T. D. Fletcher (2006). Calibration of MUSIC to Australian wetland data. Melbourne, Institute for Sustainable Water Resources and eWater Cooperative Research Centre.\*

Fletcher, T. D. (2007). SEPP compliance scenarios for the application of WSUD in Gardiners Creek. Melbourne, Melbourne Water Corporation.\*

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Fletcher, T. D. and A. Deletic (2006). A review of Melbourne Water's Pollutant Loads Monitoring Programme for Port Phillip and Western Port. Melbourne, Melbourne Water Corporation.\*

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- Fletcher, T. D., G. Mitchell, A. Deletic, A. Ladson and A. Séven (2007). "Is stormwater harvesting beneficial to urban waterway environmental flows?" *Water Science and Technology* 55(5): 265-272.
- Fletcher, T. D., P. J. Poelsma and H. P. Duncan (in prep). "Assessing the performance of biofilters: are pollutants really removed?" *Water Research*.
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- Hatt, B. E., A. B. Deletic and T. D. Fletcher (2006). "A review of integrated stormwater treatment and re-use in Australia." *Journal of Environmental Management* 76: 102-113.
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- Hatt, B. E., Fletcher, T. D. and Deletic, A. (Submitted). Hydraulic and pollutant removal performance of fine media stormwater filtration systems.
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- Mitchell, V. G., A. Deletic, T. D. Fletcher and B. E. Hatt (2007). "Achieving multiple benefits from stormwater reuse." *Water Science and Technology* 55(4): 135-144.
- Roy, A. H., R. R. Brown, T. D. Fletcher, A. R. Ladson, W. D. Shuster, H. W. Thurston, C. J. Walsh and S. J. Wenger (in prep). "Incentives and impediments to sustainable, watershed-scale urban stormwater management."
- Siriwardene, N., A. Deletic and T. D. Fletcher (2007). "Clogging of stormwater gravel infiltration systems and filters: insights from a laboratory study." *Water Research* 41(7): 1433-1440.
- Siriwardene, N., A. Deletic and T. D. Fletcher (in press). "Preliminary studies of development of clogging prediction method for stormwater infiltration systems." *Water Practice and Technology*.
- Sun, G., and Austin, D. (In Press) A mass balance study on nitrification and de-ammonification in vertical flow constructed wetlands treating landfill leachate. *Water Science and Technology*. ISSN: 0273-1223.\*
- Sun, G., and Austin, D. (2007) Completely autotrophic nitrogen-removal over nitrite in lab-scale constructed wetlands: evidence from a mass balance study. *Chemosphere*. 68: 1120-1128. ISSN: 0045-6535.\*
- Sun, G., Zhao, Y. Q, and Allen, S. (2007) An alternative arrangement of gravel media in tidal flow reed beds treating pig farm wastewater. *Water Air and Soil Pollution*. 182: 13-19. ISSN: 0049-6979. \*
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- Taylor, A. C. and T. D. Fletcher (2006). "'Triple-bottom-line' assessment of urban stormwater projects." *Water Science and Technology* 54(6-7): 459-466.\*

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Taylor, A. C., T. D. Fletcher and L. Peljo (2006). "Triple-bottom-line assessment of stormwater quality projects." *Urban Water* 3(2): 79-90.\*

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Hatt, B. E., Fletcher, T. D. and Deletic, A. (2007). The effects of drying and wetting on pollutant removal by stormwater filters. Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007. GRAIE.

Hatt, B. E., J. F. Lewis, T. D. Fletcher and A. Deletic (2007). Insights from the design, construction and operation of an experimental biofiltration system. 13th International Rainwater Catchment Systems Conference and 5th International Water Sensitive Urban Design. Sydney.

Le Coustumer, S., Fletcher, T.D., Deletic, A., and Barraud, S. (2007) Hydraulic performance of biofilters: first lessons from both laboratory and field studies. Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007. GRAIE.

Le Coustumer, S., Moura, P., Barraud, S., Clozel, B., Varnier, J. C., Deletic A. and Fletcher, T. D. (2007). Spatial analysis and temporal evolution of pollutants in a stormwater infiltration basin – estimation of the mass of trapped pollutants. Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007. GRAIE.

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Robertson, M.E. (2006) Applying WSRD to the Victorian Road network: Looking outside the square and using common sense and realistic options. 7th International Conference on Urban Drainage Modelling and the 4<sup>th</sup> International Conference on Water Sensitive Urban Design, Melbourne, Australia, April 2-7, 2006. Vol.1, p 517.

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Siriwardene, N., A. Deletic and T. D. Fletcher (2007). Modelling of treatment of solids through infiltration systems. Novatech 2007. 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, Lyon, France, June 25-28, 2007. GRAIE.

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#### **Papers, articles in industry journals and other publications**

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# Updated Reference listed as "In press" in 2005-2006 FAWB Annual Report

\* Publication related to FAWB activities and involving FAWB participants, but not directly arising from FAWB Projects.

## **APPENDIX**

**Summary of Performance  
against Program Milestones, Program Objectives and Approved Business Plan**

**Financial Information, Audit**

## **Summary of Performance Against Program Milestones, Program Objectives and Approved Business Plan**

### ***Index***

#### **Schedule 2**

##### Part A - Summary

Completed details included as 'Attachment A'  
(Includes supplementary information as requested by DIIRD)

##### Part B – Performance Report

Completed details included as 'Attachment B'

##### Part C – Budget Report

Completed details included as 'Attachment C'

#### **Schedule 3**

##### Program Milestones for the Year

Completed details included as 'Attachment D'

## Attachment A

### Schedule 2 – Milestones (to 30 June 2007)

#### **Part A – Summary**

(Includes supplementary information as requested by DIIRD)

- *Ongoing recruitment details (i.e. wherever relevant expats returning, experts appointed, etc)*  
The appointment of Belinda Hatt as Project Leader, Project 3, was approved by the FAWB Board at its 24 May 2007 meeting. Belinda commenced in late July 2007.
- *Education and skills related activities*  
Please refer to the previous section on 'Education and Training' in the main report which summarises activities including:
  - Annual Research Workshop
  - Table of Postgraduates
  - Table of Visiting Scholars
  - Involvement of postgraduates in conferences
  - Training courses
- *Description of infrastructure purchases as part of the Program for capital expenditure (eg new buildings, fit-outs, equipment etc);*  
Nil
- *Nature and value of "deals" finalised (eg grants, commercial contracts, financial commitments from Stakeholders);*  
No further deals finalised.
- *Links with prestigious national and international partners and Stakeholders;*  
Please refer to the section in the main report on Cooperative Linkages:
  - Local links
    - o Participants and Collaborators
    - o Joint activity – Research Planning Workshop
  - International collaborative links
    - o Lulea University of Technology (Lulea, Sweden)
    - o INSA de Lyon (Lyon France)
    - o Technological University, Delft, The Netherlands
    - o Dutch Ministry of Water Resources, Delft, The Netherlands
    - o York University, United Kingdom
    - o Pennine Water Group, University of Sheffield and University of Bradford
    - o Singapore Department of Water Resources
- *Short layman's descriptions of key developments, new technology applications and problems that have been solved through the project activities. This might include new discoveries, new treatments, environmental solutions etc.;*

Please refer to the section in the main report on Research, including Key Messages and other Achievements for 2006-2007 for FAWB Projects and Activities in:

Project 1: Technology

Project 2: Policy and Risk

Project 3: Adoption Tools

Project 4: Demonstration and Testing

- *Media articles*  
Five media articles were recorded for 2006-2007 as set out in the Table 'Media References 2006-2007' listed under Public Relations and Communications in the main report section on 'Commercialisation, Public Relations and Communications'
- *Awards and acknowledgements for the Program and people involved.*  
Dr Ana Deletic, FAWB Research Manager, was appointed during November 2006 as Associate Professor, Monash University. At its 23 November 2006 meeting, the FAWB Board congratulated Assoc Prof Deletic on her appointment and its recognition of her outstanding role with FAWB.
- *Value (\$) of deals done*  
An additional \$30k was negotiated with FAWB Collaborator, Landcom, NSW to support additional work on the bioretention system at Second Ponds Creek.
- *Links with prestigious overseas partners*  
As noted above, please refer to the section in the main report on Cooperative Linkages for:
  - International collaborative links
    - o Lulea University of Technology (Lulea, Sweden)
    - o INSA de Lyon (Lyon France)
    - o Technological University, Delft, The Netherlands
    - o Dutch Ministry of Water Resources, Delft, The Netherlands
    - o York University, United Kingdom
    - o Pennine Water Group, University of Sheffield and University of Bradford
    - o Singapore Department of Water Resources
- *Summary of new technologies*  
Technology outputs and data on new findings from FAWB Projects have been listed on the FAWB website. In addition to the Key messages from Projects 1, 2 and 4 have been posted on the website and are listed in the 'Research' section of the main report.
- *People stories (expatriates returning, visiting experts in a field, local experts, etc)*  
Listed under Public Relations and Communications in the main report section on 'Commercialisation, Public Relations and Communications' is a table of 'Presentations or Briefings to Government, Industry, Research and other Organisations 2006-2007'. Twelve presentations or briefings involving FAWB were given.

In addition, as noted in the July 2007 report, Government Representatives visited FAWB at Monash on 2 July 2007

Representatives from Dept Human Services, Dept of Sustainability and Environment, DIIRD and the Environment Protection Authority visited FAWB on Monday afternoon 2 July 2007. The visit by the group of thirteen related to the Parliamentary Delegation tour in February 2007 and the interest shown by Members of Parliament in applying the technology in their constituencies, for example, to redevelopment activities at public hospitals.

Following a briefing by CEO Dr Tony Wong, the group inspected the vegetation experiments and the Monash Carpark Biofilter.



**Government Representatives briefing by Dr Tony Wong, 2 July 2007**

- *Details of skill shortages or recruitment difficulties and details of any actions to overcome or success stories.*  
Nil

- *Details of problems solved*

In addition to the details including 'Key Messages' outlined in the main report under 'Research', testing existing bioretention systems, as noted in the July 2007 report, has assisted in solving problems:

Testing existing bioretention systems –

Work by Sébastien Le Coustumer on existing biofilter systems included hydraulic conductivity testing of 41 sites involving 56 biofilters. Two field methods and one laboratory method had been used.

Data on factors such as:

- Biofilter size relative to catchment area
- Local or site soil conditions
- Initial estimate of hydraulic conductivity for soil used in biofilter

had been collected and assessed in relation to predicting hydraulic conductivity for the completed installations.

Some major influences on hydraulic conductivity were showing up, but the results overall were not very clear. 40% of the group of biofilters had low hydraulic conductivity. Most of the media put in the biofilters had low hydraulic conductivity. There was a fair way to go in setting up a system which could be used to deliver and install media which met the design specifications and intent for hydraulic conductivity.

Sébastien's work is being compiled and a FAWB report, incorporating the findings, is nearing completion.

- *New treatments*

Developing a test for hydraulic conductivity

As noted in the July 2007 report, a potential market opportunity for developing a compelling test of hydraulic conductivity has been considered within FAWB.

Designers, constructors and biofilter operators needed to have confidence in test methods and processes to ensure that specifications on hydraulic conductivity were met.

A reliable process for, and/or test on, hydraulic conductivity could be introduced at some appropriate point in the 'market chain'.

- *Environmental solutions*  
Prof Malcolm Cresser, in his collaboration with FAWB, made some important findings explaining the leaching of nitrogen from unvegetated filters. He developed a simple and highly accurate model that can predict this process. This has been of great assistance in understanding the behaviour of nitrogen and its species in vegetated systems. The approach using the model is also assisting in answering the question of why nitrogen could leach from some biofilters, and for which design and operating conditions.
- *New buildings or other new infrastructure*  
Nil
- *Media attracted*  
Mr Matt Viney, MP, Parliamentary Secretary for Innovation and Industry launched FAWB on 17 October 2006. Two media articles on the launch were published.

Monash University media group attended the Parliamentary Delegation Tour on 26 February 2007 led by the Parliamentary Secretary for Industry and Innovation Mr Tony Lupton, MP. An article was included in the 'Monash Memo'.

**Attachment B**

**Schedule 2**

**Part B – Performance Report**

<b>B. PERFORMANCE REPORT</b>			
<b>Facility for Advancing Water Biofiltration</b>	<b>Progress Achieved v Planned Program Milestones</b>		<b>OUTLOOK</b> List any issues impacting the progress of planned activities or changes in milestones and dates.
	<b>Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)</b>	<b>For specified activities planned Result Achieved/Not achieved</b>	
<u>Task 1 – Management</u>			
M1.1 Establishment of UJV 1-Aug-05	A1.1 Establishment of the Board	Board established under Unincorporated Joint Venture Agreement.	
	A1.2 Appointments of CEO, BM, RM, MTCM,	Appointments of CEO, BM, RM, confirmed at Board meeting of 16 Sept 2005. MTCM appointment deferred.	
	A1.3 Appointment of RAC	Research Advisory Committee established under joint venture agreement. Met as Review Panel, Sept 2006.	
	A1.4 Signing the UJV contract and collaboration agreements	UJV Agreement signed 2 August 2005. Collaboration agreements signed over period December 2005 to May 2006.	
M1.2 Decisions on the main business matters (Quarterly)	A1.5 Regular Management Board meetings (Quarterly)	Board meetings held 16 Sept 05, 24 Nov 05, 21 Feb 06, 25 May 06, 7 Sept 06, 23 Nov 06, 16 Feb 07, 24 May 07.	
M1.3 Reports of SAC (Stakeholder Advisory Committee) (4 times in first year)	A1.6a Regular meetings of SAC	SAC meetings held 4 Aug 05, 10 Mar 06, 18 Aug 06. 4 th meeting held 20 April 07 Meeting scheduled for 19 October 07.	
Reports of RAP (Research Advisory Panel)( Once each year)	A1.6b Annual meetings of RAP	Formal panel met on 25 and 26 September 2006.	
M1.4 Appointment of the staff (Oct 05)	A1.7 Appointment of other staff: RF in plant sci., PhD in soil sci., MSc in crashworthiness, RF in arts, RA for field tests, Lab technician, Programmer	Staff appointed as required in Revised Business Plan. MSc in crashworthiness no longer applicable. Programmer not required. Project Leader, Project 3, appointed.	
M1.5 Submission of Progress Report	A1.8 Annual audit A1.9 Reporting to DIIRD (Quarterly)	Completed & submitted with October 2006 report. Reports submitted for four quarters to 30 June 2006; to 30 September 2006, 31 December 2006, 31 March 2007 and this quarter.	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned Result Achieved/Not achieved	
<u>Task 2 – Technology Development</u>			
M2.1 Detailed technology development plan (Oct 05)	A2.1 Refining the research plan	Project research plans submitted October 2005 to Management Board and approved November 2005.	
M2.2 Design for long term sustainability (30 June 07)	A2.1 Refining the vegetation A2.2 Refining filter types A2.3 Refining design for long term sustainability	On-going	
M2.3 Design for multi-functionality (30 Sept 07)	A2.5 Biofilters for urban developments A2.6 Biofilters for stormwater re-use A2.7 Biofilters for road safety	On-going	
<u>Task 3 – Adoption Facilitation (Policy and Risks)</u>			
M3.1 Detailed adoption facilitation work plan (30 Oct 05)	A3.1 Refining the adoption facilitation work plan	Outline included in updated Business Plan submitted October 2005. Policy and Risk Project Plan approved by Management Board, Nov 2005.	
M3.2 Regulatory, policy and strategic guidance (30 April 06)	A3.2 Regulatory and policy	Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne at final review stage. Final report published June 2007.  Industry launch of report and workshop on 'Transition to WSUD' held 15 Feb 2007.  Launch and Seminar on Final Report to be held in Melbourne for government and industry representatives, 23 July 2007.	
M3.4 Assessed risk perception, liability and opportunities (30 Jan 07)	A3.3 Risk perception, liability and opportunities	On-going	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned Result Achieved/Not achieved	
<u>Task 4 – Design Tool Development</u> (now - Adoption Tools)			
M4.1 Detailed adoption facilitation work plan (15 Nov 06)	A4.1 Refining the design tools work plan	Project 3 Research Plan discussed at 18 August 06 Stakeholders Meeting and approved at 7 Sept 06 Board.  Project 3 title is now 'Adoption Tools'  Project 3 discussed at Stakeholders Meeting 20 April 2007. Re-scoping of Project to be undertaken	
M4.2 Software for design of biofilters for a wide range of applications (30 Dec 07)	A4.2 Development of software	On-going	
M4.3 Design recommendations (30 April 08)	A4.3 Development of design recommendations	On-going	
<u>Task 5 – Demonstration and Testing</u>			
M5.1 Detailed demonstration/testing plan (24 Dec 05)	A5.1 Refining the demonstration and testing plan	Demonstration and Testing Project Plan approved by Management Board, Nov 2005.	
M5.2 Novel systems installed (Jan 08)	A5.2 Building of novel systems according to the	On-going	
M5.3 Field data on filter performance (May 08)	A5.3 Field testing of existing and innovative biofilter designs	On-going	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
Task 6 – Marketing			
M6.1 Strategic Marketing plan established ( 1 Nov 05)	A6.1 Industry/focus group market research - establish market needs and environment (with collaborators)	Agreements with seven FAWB Collaborators, completed: Landcom NSW, Manningham City Council, Melbourne Water, VicRoads. Brisbane CC, Auckland Regional Council and Adelaide & Mount Lofty Ranges Natural Resources Management Board (see also A7.2)	
	A6.2 Establish strategic marketing plans and operational objectives	Strategic Marketing Plan submitted with DIIRD report (Jan 2006)  Revised Strategic Marketing Plan: 'Strategic Marketing and Stakeholders Management Plan' submitted with Jan 2007 report.	
M6.2 Strategic Marketing plan implementation commenced (1 Jan 06)	A.6.3 Internal marketing - establish consistent and robust messages and cultures within the Facility team and collaborators/partners	Board meetings, Stakeholder Advisory Committee meetings, and Research Workshop (Dec 2005) have been used to enhance internal marketing.	
	A6.4 Utilise email newsletter and promotional material (including static website) to establish Facility branding, profile and positioning	FAWB logo established with letterhead and business cards produced. FAWB website set up (14,855 hits for YTD 1 Jul 06 to 31 Mar 07). FAWB was a sponsor of the International Conference on Urban Drainage Modelling (UDM) and Water Sensitive Urban Design (WSUD), 3-7 April 2006. A FAWB display booth was prepared and set up at the UDM/WSUD Conference. The display featured project information and an experimental set-up of a biofilter column.	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06)	A6.5 Preparation of technical and industry targeted reports to establish understanding and confidence in technology as appropriate	<p>A brochure on FAWB and its activities was also prepared with copies being handed out at the above conference</p> <p>Project 2 Report on mapping the institutional transition to adoption of WSUD in Melbourne published as working document..</p> <p>Guideline Specification for soil media prepared to assist planning, design, construction and operation of biofiltration systems. Available on FAWB website July 2006.</p> <p>Registration of users from 13 Dec 2006 – 174 registrations to 30 June 2007 (See also A7.6)</p> <p>Final version of 'Transition to WSUD, the Story of Melbourne' published June 2007.</p>	
	A6.6 Establish regular series of presentations and/or technical workshops to create awareness and understanding/implications of research results	<p>Two training workshop proposals endorsed by Board</p> <p>In association with Clearwater and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" on:-</p> <ul style="list-style-type: none"> <li>- 30 August 2006 (Civic Centre, City of Casey, Narre Warren)</li> <li>- 7 September 2006 (The Mansion, Werribee)</li> <li>- 8 September 2006 (Emu Bottom Homestead, Sunbury)</li> <li>- 15 September 2006 (Melbourne Business School, Mt Eliza)</li> </ul> <p>Industry launch of report and workshop on 'Transition to WSUD' held 15 Feb 2007.</p> <p>Workshops on WSUD – 'Design of Rain Gardens' to be held in conjunction with Clearwater in September 2007.</p>	
	A6.7 Annual planning/reporting w/shop	<p>Planning workshop held December 2005. Second Annual Workshop held 26 September 2006.</p>	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) <i>(continued)</i>	A6.8 Contribute articles/presenters to high profile events and publications within the target market	<p>Article published in CSIRO Ecos magazine, April-May 2006</p> <p>Article in MONASH MEMO: News and information for Monash University staff, 25 October 2006. Article on: 'Biofilter garden unveiled at Clayton - A biofilter garden that collects and filters stormwater has been unveiled at the Clayton campus by the Victorian Parliamentary Secretary for Innovation and Industry, Mr Matt Viney.'</p> <p>Article in Stormwater Industry Association Victoria 'SIAV E-News' Thu, 09 Nov 2006. Article on FAWB opening and launch by the Minister for Innovation and Industry, Matt Viney, on 17 October. In the article it was noted that: 'Several SIAV Committee members were at the launch and we will work with FAWB to disseminate key outcomes of this important research.'</p> <p><i>FAWB Seminars, Public presentations November 2006</i></p> <p>a) Assoc Prof Ana Deletic presented a workshop on the 'Facility for Advancing Water Biofiltration' at the Annual Stormwater Industry Association Victoria, SIAV Seminar: 'The Stormwater Alternatives' held Tuesday 14 November 2006 at the Corporate Centre, Manningham City Council, Doncaster</p> <p>b) Assoc Prof Ana Deletic, Dr Tim Fletcher and Dr Rebekah Brown gave presentations on FAWB and its research projects at a seminar held by the Victorian Water Engineering Branch, Engineers Australia, on Wednesday 22 November 2006 at Engineers Australia, North Melbourne.</p> <p>Industry launch of report and workshop on 'Transition to WSUD' held 15 Feb 2007 with presentations by Dr Rebekah Brown, Dr Tony Wong, and Jodi Clarke..</p> <p>Article in Monash Magazine, Issue 18, November 2006, , Spring/Summer 2006 'Trickle Down Technology'</p> <p>Article in the 'Monash Memo' 14 March 2007 'Parliamentary delegation visits key projects</p> <p>Article piece in: National Urban Water Governance Program <a href="http://www.urbanwatergovernance.com">www.urbanwatergovernance.com</a> Newsletter, April 2007 Number 5, 'Transition to a Water Sensitive City'</p>	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
M6.3 Marketing and promotion activities targeting broader stakeholders including industry practitioners and professional associations (1 Sep 06) <i>(continued)</i>	A6.9 External marketing - build industry conviction/confidence in the research outcomes through practical demonstration and monitoring	<p>Launch of Monash Carpark Biofilter held on 17 October 2006 with substantial invitation list to industry. Over 350 invitations to launch sent out, including invitations to Mayor, CEO and Director Environment/ Infrastructure for all Vic Local Councils</p> <p>Site inspection offered with launch of FAWB at Monash Carpark Biofilter. Considerable interest in Carpark biofilter by audience including local gov reps.</p> <p>The Parliamentary Secretary for Innovation, Industry and Regional Development Mr Tony Lupton led a parliamentary delegation on a tour of FAWB facilities at Monash on Monday 26 February 2007.</p> <p>Government Representatives briefing and tour of FAWB facilities held 2 July 2007.</p> <p>Over 500 invitations sent out for to local government, consultants and Vic gov department staff for Launch and Seminar of report on 'Transition to WSUD' to be held in Melbourne on 23 July 2007.</p>	
M6.4 Industry field days, training courses and site visits delivered and well attended (1Oct 07)	A6.10 Develop industry capacity and confidence to utilise software and other tools developed from research outputs	On-going	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
<u>Task 7-Commercialisation</u>			
M7.1 Revised Strategic Marketing Plan (1 Jul 07)	7.1 Refine the Strategic Marketing Plan and alignment with Business Plan to support potential commercialisation	Ongoing	
M7.2 Commercialisation plan completed (1 Sept 07)	A7.2 Establish and recruit key industry stakeholders with interest in development and commercialisation	Agreements with seven FAWB Collaborators, completed: Landcom NSW, Manningham City Council, Melbourne Water, VicRoads. Brisbane CC, Auckland Regional Council and Adelaide & Mount Lofty Ranges Natural Resources Management Board (see also A6.1)  On-going	
	A7.3 Review in detail identified market needs and context for application.	On-going	
	A7.4 For each potential commercialisation product, establish detailed plans for management of legal, financial, marketing and production aspects	On-going	

Facility for Advancing Water Biofiltration	Progress Achieved v Planned Program Milestones		OUTLOOK List any issues impacting the progress of planned activities or changes in milestones and dates.
	Program Milestones/ Performance Indicators/ Activities Planned (September 2006 Quarter)	For specified activities planned  Result Achieved/Not achieved	
M7.3 Commercialised products introduced to market (1 Jun 08)	A7.5 Develop prototypes for demonstration & industry testing - work with industry collaborators to refine products to meet target market needs	To be identified, scoped and developed.	
	A7.6 Develop market ready products/knowledge in partnership with SMEs and other partners/co-investors	Guideline Specification for soil media prepared to assist planning, design, construction and operation of biofiltration systems. Available on FAWB website July 2006. (See also A6.5)	
	A7.7 Establish clear channels for launch, promotion and delivery of products to market	Links to industry via Collaborators/Stakeholders being pursued. Launch of Monash Biofilter combined with tour of facility Oct 2006.. Soil spec on website and conference participation also used to build confidence in research outcomes from July 2006.. Industry launch of report and workshop on 'Transition to WSUD' held February 2007.  Launch and seminar on Final report to be held 23 July 2007. Workshops being arranged for later in 2007 on Design of Rain Gardens.	
M7.4 Income stream established for Facility (1 Jun 08)	A7.8 Implement industry targeted integrated marketing communications strategy to establish and support product offer in market place.	To be assessed as appropriate for FAWB.	
	A7.9 Ongoing product support & develop. (new product launches or extensions)	To be assessed as appropriate for FAWB.	

Attachment C

Schedule Two  
MONITORING AND REPORTING –

QUARTERLY PERFORMANCE REPORT – AT 30 June 2007

<b>C: BUDGET REPORT</b> The Budget Report is required to be completed in cash terms (compared to accrual terms)							
Budget' denotes planned expenditure as outlined in the Business Plan	Annual Budget (\$)	Actual Year to Date Income (\$)	Year to Date Expenditure (\$)	Year to Date % Variance (provide explanation if >10%)	Total Funds Unexpended To Date (\$)	Planned Income for Next Quarter (\$)	Budget Next Quarter <i>Revise where appropriate</i> (\$)
STI Allocated Funds	760,000	760,000	682,370	10	77,630	65,000	142,630
Consortium Contribution Funds	230,000	271,148	141,614	48#	129,534	0	129,534
Total Program Funds	990,000	1,031,148	823,984	20##	207,164	65,000	272,164

**NOTES TO PART C**

1. *Variance* =100\* (Actual Year to Date Income - Year to Date Expenditure)/ (Actual Year to Date Income).

2. *Notes on variances:*

STI Allocated Funds Variance

*Expenditure to 30 June 2007 allocated firstly to 90% of STI Allocated Funds, balance to Consortium Contribution Funds, giving a variance of 10% for STI Allocated Funds.*

#, ## Consortium Contribution Funds and Total Program Funds Variances

*Unexpended Consortium Contribution funds largely matched by Year to date under-expenditure on Administration Project (\$64,140) and Project 3, Adoption Tools (\$83,790). Later start to Project 3:Adoption Tools in 2007/08, expected to reduce overall under-expenditure on Total Program Funds*

*The contents of this report, including all attachments, are true and correct in every particular to the best of my knowledge after having made all due enquiries.*

Signed\*: Dr Tony Wong

Date: 13 July 2007

Name (print): Dr Tony Wong

Position: CEO

Witness (print): John Molloy

Qualification of Witness: Business Manager

\*The report must be signed by the Chief Executive Officer or Chairman of the Board, or other person approved by the Department

**Attachment D**

**Schedule 3**

**Program Milestones for the Year 2006-2007**

**Compliance details for each Milestone**

<b>Milestone</b>	<b>DIIRD Compliance Date</b>
<ul style="list-style-type: none"><li>• Evidence that progress against the Marketing and Adoption Plans are being implemented</li></ul>	15 October 2006
<ul style="list-style-type: none"><li>• Receipt of revised Strategic Marketing and Adoption Plan.</li><li>• Evidence that the policy and regulatory review for the implementation of biofilters has been completed</li><li>• Evidence that the design development of multi-function bioretention systems has commenced</li></ul>	15 January 2007
<ul style="list-style-type: none"><li>• Evidence that implementation of the commercialisation plan has commenced</li></ul>	15 April 2007
<ul style="list-style-type: none"><li>• Evidence of accessibility/sharing arrangements to the facility</li><li>• Evidence of commencement of development of design tools</li><li>• Receipt of evidence that progress against the revised Marketing and Adoption Plans are being implemented</li></ul>	15 July 2007

<ul style="list-style-type: none"> <li>Evidence that progress against the Marketing and Adoption Plans are being implemented</li> </ul>	15 October 2006
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**Evidence that progress against the Marketing and Adoption Plans are being implemented**

A Progress Report on Communication and Adoption Activities (As in FAWB's Strategic Marketing and Stakeholders Management Plan, (SMSMP) is shown below, using the Summary of Activities, Table 1.(with October 2006 report)

**Table 1 – Summary of Proposed Communication and Adoption Activities to 30 September 2006 (from SMSMP)**

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Status as at 30 September 2006
Design of Logo		\$5,000	Completed	Completed
Launch of FAWB	Launch FAWB in Melbourne, Sydney, Brisbane, Adelaide and Auckland – to coincide with public lecture, technical seminar or training course	\$10,000	<ul style="list-style-type: none"> <li>Melbourne launch scheduled for 4<sup>th</sup> April 2006</li> <li>Launch in Sydney, Brisbane and Adelaide to be completed by July 2006</li> <li>Launch in Auckland in either August or October 2006 (to coincide with the Auckland Regional Council's Stormwater Research Workshop)</li> </ul>	<ul style="list-style-type: none"> <li>Launch by Mr Matt Viney MP, scheduled for 17 Oct 2006 Press release drafted.</li> <li>Launch in Sydney, Brisbane and Adelaide to be planned.</li> <li>Launch in Auckland cancelled due to withdrawal of ARC from FAWB Collaboration Agreement.</li> </ul>
Creation and maintenance of Website		\$10,000 (creation) \$5000/yr (maintenance)	Commenced – scheduled for completion in April 2006	<ul style="list-style-type: none"> <li>FAWB website came online on 31 March 2006.</li> <li>Brochure 'About FAWB' added.1 June 2006</li> </ul>
Tour of Research Facility	Initiate regular tours of the Monash research facility	Nil	To be arranged – target one tour for industry every six months.	<ul style="list-style-type: none"> <li>Tour held in conjunction with Stakeholders meeting, 18 August 06.</li> <li>Tour proposed with Launch of FAWB at Monash Carpark Biofilter 17 Oct 2006.</li> </ul>
Newsletter	Issue quarterly newsletter to stakeholders, and targeted mailing to key industry groups	\$5,000	1 <sup>st</sup> Newsletter available for Melbourne launch – 4 <sup>th</sup> April 2006	<ul style="list-style-type: none"> <li>1<sup>st</sup> newsletter in the form of a 4-page brochure providing an overview of FAWB and its research activities.</li> <li>Draft outline prepared on target audience and newsletter style, frequency, and contents.</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Status as at 30 September 2006
Technical and Issue-based Articles	At least four articles (one from each of the four research projects in the Facility) be submitted each year to targeted industry-based publications. Consider contracting a science writer to write articles with Project Leaders	\$10,000/yr	On-going	<ul style="list-style-type: none"> <li>• Discussed with Project Leaders at Project Leaders meeting.</li> </ul>
Training Courses and Field Visits on the design, operation and maintenance of biofilters		Self-funding	To be presented in the second half of 2006	<ul style="list-style-type: none"> <li>• Two training courses proposed and endorsed by FAWB Board: <ul style="list-style-type: none"> <li>- Design of Bioretention And Wetland Systems (2 days)</li> <li>- WSUD for Landscape Architects (1 day)</li> </ul> </li> <li>• In association with Clearwater and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" on:- <ul style="list-style-type: none"> <li>- 30th August 2006 (Civic Centre, City of Casey, Narre Warren)</li> <li>- 7th September 2006 (The Mansion, Werribee)</li> <li>- 8th September (Emu Bottom Homestead, Sunbury)</li> <li>- 15th September (Melbourne Business School, Mt Eliza)</li> </ul> </li> <li>• 2-day bioretention design course including field trip being organised for Sydney.</li> <li>• Similar courses in Adelaide and Brisbane to be confirmed. Preliminary discussions held with Stake - holders, 18 August 2006.</li> </ul>

<b>Activities</b>	<b>Overview</b>	<b>Notional Budget</b>	<b>Schedule/Status</b> <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	<b>Status as at 30 September 2006</b>
Develop course on bioretention construction methods	To cover issues associated with soil media specifications, on-site assessment and construction practices. The target audience includes contractors, local government and consultants.	\$10,000	Completion in Nov 2006	Not yet commenced
Site inspection of WSUD and biofilter systems for Councillors and Council Executives	To promote familiarisation with WSUD, council's obligations (such as legislative drivers), as well as generally raising awareness of FAWB and its activities	Self Funding	Scheduled for second half of 2006	<ul style="list-style-type: none"> <li>• Proposed tie in with launch of FAWB at Monash Carpark Biofilter.</li> </ul>
Demonstration Projects	Increase the number of demonstration projects associated with FAWB by actively being involved with collaborators	Funded out of Project 4 budget	<ul style="list-style-type: none"> <li>• Two demonstration projects already in place</li> <li>• Other potential demonstration projects with VicRoads and City of Manningham to be investigated.</li> </ul>	<ul style="list-style-type: none"> <li>• Discussions held 18 August 2006 with Stake- holders on further demonstration sites in conjunction with proposed in-kind commitments.</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Status as at 30 September 2006
Engineering Specifications and Construction Guidelines	The preparation of 'interim' guidelines on engineering specifications and construction methods	\$10,000	Document preparation to coincide with the development of the training course on construction methods	<ul style="list-style-type: none"> <li>• Best practice design, construction guide earlier proposed.</li> <li>• Extension to cover operating aspects, including costs, seen as desirable.</li> <li>• 'Guideline Specifications for Soil Media in Bioretention Systems' placed on FAWB website, 27 July 2006. 312 requests since 1 July 06</li> <li>• Discussions held with Stakeholders on 18 August 2006 regarding nature of potential guidelines.</li> </ul>
Mapping Institutional Capacity	Actively promote the institutional capacity mapping of organisations to identify their respective capacity building needs for implementing sustainable stormwater management practices.	Self funding	To commence following completion of methodology development and trials with collaborator organisations	<ul style="list-style-type: none"> <li>• Being developed in Project 2.</li> </ul>
Strategic association with key industry groups	Interaction with key industry groups to include possible sponsorships	\$10,000/yr	On-going	<ul style="list-style-type: none"> <li>• VicUrban to be contacted.</li> </ul>

<ul style="list-style-type: none"> <li>• Receipt of revised Strategic Marketing and Adoption Plan.</li> <li>• Evidence that the policy and regulatory review for the implementation of biofilters has been completed</li> <li>• Evidence that the design development of multi-function bioretention systems has commenced</li> </ul>	15 January 2007
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**Receipt of revised Strategic Marketing and Adoption Plan.**

Revised Strategic Marketing Plan: 'Strategic Marketing and Stakeholders Management Plan' included as 'Attachment E' (with January 2007 report)

**Evidence that the policy and regulatory review for the implementation of biofilters has been completed**

Regulatory and policy

- Transitions Analysis - Draft Transitions Report prepared and external validation phase completed.
- Final Report - Minor changes to the Final Report required - on track.
- Publication / Dissemination: Planning for publication and dissemination of Final Report findings is underway. Industry launch of report on 'Transition to WSUD' scheduled for 15 Feb 2007

Risk perception, liability and opportunities

- Online Questionnaire - Online questionnaire disseminated across the urban water sector.
- Industry Interviews - First phase of Interviews completed.

### ***Evidence that the design development of multi-function bioretention systems has commenced***

#### Design for multi-functionality

- Biofilters for urban developments – Extensive work planned under Project 3.0: Adoption Tools, is to commence in is planned to start in the second quarter of 2007
- Biofilters for stormwater re-use – Work will commence in February 2007, but is also being contributed to by an associated project, funded by SmartWater, and led by Dr. Grace Mitchell at Monash.

• Evidence that implementation of the commercialisation plan has commenced	15 April 2007
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### ***Evidence that implementation of the commercialisation plan has commenced***

Commercialisation opportunities were identified in the FAWB Business Plan, Section 1.6. As noted in earlier reports, these opportunities all relate either directly or indirectly to the costs and issues associated with achieving government mandated water management and water quality standards.

Potential opportunities for FAWB to influence adoption in commercial activities were anticipated to arise in the following areas: Modular biofilter technologies, Software modelling tools, Consulting, Landscape design and development, and Horticulture.

Implementation to date includes the following:

#### Modular biofilter technologies

Work to advance the development of modular biofilter technologies is progressing under:

Activity 4.01: Bioretention System in Western Sydney (Second Ponds Creek)

Activity 4.02: Monash University Car Park Bioretention System, Melbourne

Activity 4.03: Wakerley Bioretention, Brisbane

Activity 4.04: Testing existing bioretention systems – (over 40 biofilters have been tested for hydraulic conductivity and accumulation of metals)

#### Software modelling tools

Project 3, Adoption Tools, is a key part of the work to develop modelling tools.

As earlier reported, Project 3 ( to commence mid-2007) includes: Activity 3.01- Design Algorithm, and Activity 3.02 - Adoption Guidelines.

Key outputs planned for these activities are:

Activity 3.01 - Design Algorithm

- A simple, but robust, design model of biofilter performance
- Biofilter design methodology for a number of possible situations (e.g. residential sites, retrofit, rain gardens, highway runoff treatment, re-use, etc)

Activity 3.02 - Adoption Guidelines

- A comprehensive set of design recommendations that outline the principal design considerations necessary to preserve the effective operational processes of biofilters as water quality improvement measures.

#### Consulting

FAWB is influencing the uptake of water biofiltration technologies by consultants through its ongoing research, the dissemination of the research findings and outputs, and the involvement of FAWB parties in consulting projects.

As previously noted, the substantial involvement and commitment of FAWB and its key staff to the International UDM & WSUD Conference in Melbourne, 3-7 April 2006, was a pivotal step in awareness raising of biofiltration technologies. This was a strategic initiative in building industry networks across government and commercial enterprises as part of FAWB's commercialisation planning.

Dissemination activities include the following publications produced or being prepared:

##### *Project 1:*

- 1 paper in press and one published in Water Science and Technology
- 1 journal paper in review in Water Research (we just have to make a few small changes and it will be in press soon),
- 3 papers submitted to NOVATECH conference
- 1 journal paper drafted and 3 in preparation
- 1 abstract submitted to WSUD-2007 conference

##### *Project 2:*

- 1 major report completed
- 1 paper submitted to NOVATECH conference
- Journal papers in preparation

*Project 4:*

- 2 conference abstracts submitted to a national conference
- 1 preliminary industry report submitted

The commercial party in the FAWB Joint Venture, Ecological Engineering, is active throughout Australia in projects involving water biofiltration. Ecological Engineering is able to directly apply findings by FAWB in its work. Some Monash University staff members in FAWB are also involved in direct consulting projects.

Landscape design and development, Horticulture

As noted above, technology outputs and data on new findings from FAWB Projects are to be listed on the FAWB website. Key messages as listed from Project 1 have particular application to the landscape and horticulture industries.

The FAWB website product, 'Guideline Specifications for Soil Media in Bioretention Systems' is being downloaded by commercial organisations to assist in designing and developing biofilters.

<ul style="list-style-type: none"><li>• Evidence of accessibility/sharing arrangements to the facility</li><li>• Evidence of commencement of development of design tools</li><li>• Receipt of evidence that progress against the revised Marketing and Adoption Plans are being implemented</li></ul>	15 July 2007
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**Evidence of accessibility/sharing arrangements to the facility**

Accessibility/sharing arrangements continue to be strengthened with joint work with stakeholder collaborators including:

- Brisbane City Council (extensive collaborative work on Wakerley Biofilter, pods and existing installations)
- Landcom, Sydney (detailed involvement and sharing of technologies for Second Ponds Creek and existing biofilters)
- Melbourne Water (ongoing access to FAWB technologies and findings, monitoring of existing facilities and also extensive assistance by Melbourne Water with Project 2 study)
- VicRoads (continuing interaction with VicRoads on biofilter technology and active in-kind collaboration)
- Open access to FAWB findings via 'Key Messages' from Projects 1, 2 and 4 on FAWB website. Also listing of 'Guidelines for Soil Media for Bioretention Systems'. Registration system in place so that registered users can be advised of any updates to the guidelines.
- Electronic copy of 'Transition to WSUD' final report available on website.

**Evidence of commencement of development of adoption tools (formerly 'design tools')**

Development steps include:

- Preparation and website publishing of 'Guidelines for Soil Media in Bioretention Systems'
- Appointment of Project Leader to commence late July 2007
- Proposals in hand for re-scoping of project in light of findings from Projects 1, 2, and 4 and interactions with collaborators including Prof Malcolm Cresser.

**Receipt of evidence that progress against the revised Marketing and Adoption Plans are being implemented**

The following table provides an update of the current status of Activities listed in Table 1 of the revised Strategic Marketing and Stakeholders Management Plan

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Schedule/Status <i>Update for 2007</i>	Status as at 9 July 2007
Design of Logo		\$5,000	Completed	Completed	Completed
Launch of FAWB	Launch FAWB in Melbourne, Sydney, Brisbane, Adelaide and Auckland – to coincide with public lecture, technical seminar or training course	\$10,000	Melbourne launch scheduled for 4 <sup>th</sup> April 2006  Launch in Sydney, Brisbane and Adelaide to be completed by July 2006  Launch in Auckland in either August or October 2006 (to coincide with the Auckland Regional Council's Stormwater Research Workshop)	Launch in Melbourne by Mr Matt Viney MP, held 17 Oct 2006 at Monash  FAWB seminars reporting on research insights to be held in Sydney, Brisbane and Adelaide by June 2007 to introduce FAWB, instead of separate launches.	<ul style="list-style-type: none"> <li>• Launch in Melbourne by Mr Matt Viney MP, held 17 Oct 2006 at Monash. Press release issued.</li> <li>• Launch in Sydney, Brisbane and Adelaide no longer appropriate. FAWB seminars reporting on research insights scheduled in these cities for 2007.</li> <li>• Launch in Auckland cancelled due to withdrawal of ARC from FAWB Collaboration Agreement.</li> <li>• Workshops on WSUD being arranged for later in 2007 in Melbourne. Potential for workshops to be taken interstate.</li> </ul>
Creation and maintenance of Website		\$10,000 (creation)  \$5000/yr (maintenance)	Commenced – scheduled for completion in April 2006	FAWB website came online on 31 March 2006.  Updating during 2007 with further products, newsletter, and annual report for 2006/07	<ul style="list-style-type: none"> <li>• FAWB website came online on 31 March 2006.</li> <li>• Brochure 'About FAWB' added. 1 June 2006</li> <li>• Total of 2,731 successful website hits were recorded for 2005/2006</li> <li>• Total of 23,632 hits to 30 June 2007 for 2006/2007</li> </ul>
Tour of Research Facility	Initiate regular tours of the Monash research facility	Nil	To be arranged – target one tour for industry every six months.	Tours to be offered in conjunction with Stakeholder meetings and research briefings during 2007.	<ul style="list-style-type: none"> <li>• Tour held in conjunction with Stakeholders meeting, 18 August 2006.</li> <li>• Tour held with Launch of FAWB at Monash Carpark Biofilter 17 Oct 2006.</li> <li>• Parliamentary Delegation Tour held by FAWB at Monash 26 February 2007</li> <li>• Living Rivers Stormwater Program Advisory Committee (Melb Water, EPA, local government, DSE), Monash University 12 April 2007</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Schedule/Status <i>Update for 2007</i>	Status as at 9 July 2007
Newsletter	Issue quarterly newsletter to stakeholders, and targeted mailing to key industry groups	\$5,000	1 <sup>st</sup> Newsletter available for Melbourne launch – 4 <sup>th</sup> April 2006	Quarterly newsletter to be issued beginning March 2007.	<ul style="list-style-type: none"> <li>• 1<sup>st</sup> newsletter in the form of a 4-page brochure providing an overview of FAWB and its research activities.</li> <li>• Draft outline prepared on target audience and newsletter style, frequency, and contents.</li> <li>• One page 'glossy' proposed with CD or on-line version of FAWB Annual Report</li> </ul>
Technical and Issue-based Articles	At least four articles (one from each of the four research projects in the Facility) be submitted each year to targeted industry-based publications. Consider contracting a science writer to write articles with Project Leaders	\$10,000/yr	On-going	Articles in AWA Water Journal to be published by September 2007	<ul style="list-style-type: none"> <li>• Discussed with Project Leaders at Project Leaders meeting.</li> <li>• FAWB technical seminar for Projects 1 and 4 to be scheduled for second half of 2007</li> <li>• FAWB workshop held in conjunction with the release of Project 2 WSUD working document 15 February 2007.</li> <li>• Conference papers being prepared for International Public Works Conference (Cairns, Aust.)</li> <li>• Papers presented at NovaTech'07 (Lyons, France) in June 2007 by postgraduates B Hatt, S Coustumer, &amp; Y Zinger</li> <li>• Numerous journal papers being prepared.</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Schedule/Status <i>Update for 2007</i>	Status as at 9 July 2007
Training Courses and Field Visits on the design, operation and maintenance of biofilters		Self-funding	To be presented in the second half of 2006	Training Courses and Field Visits on the design, operation and maintenance of biofilters to be held by September 2007 in Sydney, Adelaide and Brisbane.	<ul style="list-style-type: none"> <li>• Two training courses proposed and endorsed by FAWB Board: <ul style="list-style-type: none"> <li>- Design of Bioretention And Wetland Systems (2 days)</li> <li>- WSUD for Landscape Architects (1 day)</li> </ul> </li> <li>• In association with Clearwater and Melbourne Water, FAWB prepared and presented four one-day training courses on "Implementing Water Sensitive Urban Design" on:- <ul style="list-style-type: none"> <li>- 30 August 2006 (Civic Centre, City of Casey, Narre Warren)</li> <li>- 7 September 2006 (The Mansion, Werribee)</li> <li>- 8 September (Emu Bottom Homestead, Sunbury)</li> <li>- 15 September (Melbourne Business School, Mt Eliza)</li> </ul> </li> <li>• 2-day bioretention design course being organised – scheduled for delivery in later 2007.</li> <li>• Similar courses in Adelaide and Brisbane to be confirmed. Preliminary discussions held with Stake - holders, 18 August 2006.</li> </ul>
Develop course on bioretention construction methods	To cover issues associated with soil media specifications, on-site assessment and construction practices. The target audience includes contractors, local government and consultants.	\$10,000	Completion in Nov 2006	Course on bioretention construction methods to be developed and held by September 2007	<ul style="list-style-type: none"> <li>• Course development has commenced</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Schedule/Status <i>Update for 2007</i>	Status as at 9 July 2007
Site inspection of WSUD and biofilter systems for Councillors and Council Executives	To promote familiarisation with WSUD, council's obligations (such as legislative drivers), as well as generally raising awareness of FAWB and its activities	Self Funding	Scheduled for second half of 2006	No further inspections planned following widespread mailout of FAWB launch and opening and tour opportunities.  Discussions with IPWE to be arranged by February 2007 for further interaction with Councils.	<ul style="list-style-type: none"> <li>• Site inspection offered with launch of FAWB at Monash Carpark Biofilter. Considerable interest in Carpark biofilter by audience including local gov reps.</li> <li>• Over 350 invitations to launch sent out, including invitations to Mayor, CEO and Director Environment/ Infrastructure for all Vic Local Councils</li> </ul>
Demonstration Projects	Increase the number of demonstration projects associated with FAWB by actively being involved with collaborators	Funded out of Project 4 budget	Two demonstration projects already in place  Other potential demonstration projects with VicRoads and City of Manningham to be investigated.	Three demonstration projects in place  Testing of existing bioretention systems to be extended during 2007.	<ul style="list-style-type: none"> <li>• Discussions held 18 August 2006 with Stakeholders on further demonstration sites in conjunction with proposed in-kind commitments.</li> <li>• Three demonstration projects in place with Monash Carpark, Second Ponds Ck and Wakerley, Brisbane.</li> <li>• 41 sites involving 56 biofilters tested for their hydraulic conductivity and accumulation of metals as at June 2007.</li> </ul>
Engineering Specifications and Construction Guidelines	The preparation of 'interim' guidelines on engineering specifications and construction methods	\$10,000	Document preparation to coincide with the development of the training course on construction methods	Document preparation to coincide with the development of the training course on construction methods.  As far as practicable, document to cover operating aspects, including costs.  Scheduled for delivery by September 2007.	<ul style="list-style-type: none"> <li>• Best practice design, construction guide earlier proposed.</li> <li>• Extension to cover operating aspects, including costs, seen as desirable.</li> <li>• Guideline Specifications for Soil Media in Bioretention Systems' placed on FAWB website, 27 July 2006. 312 requests since 1 July 06. 174 registrations from 13 Dec 06 to 30 June 2007 following setting up of user registration</li> <li>• Discussions held with Stakeholders on 18 August 2006 regarding nature of potential guidelines.</li> </ul>

Activities	Overview	Notional Budget	Schedule/Status <i>(Status comments as in SMSMP presented to FAWB Board, 21 February 2006)</i>	Schedule/Status <i>Update for 2007</i>	Status as at 9 July 2007
Mapping Institutional Capacity	Actively promote the institutional capacity mapping of organisations to identify their respective capacity building needs for implementing sustainable stormwater management practices.	Self funding	To commence following completion of methodology development and trials with collaborator organisations	Workshop to launch report on 'The Transition to WSUD: The Melbourne Story', and to raise awareness of its findings, to be held in Melbourne, February 2007	<ul style="list-style-type: none"> <li>• FAWB workshop and dinner held 15 Feb 2007 and working document launched.</li> <li>• Final report printed June 2007.</li> <li>• Launch and seminar arranged with funding and logistic support from DIIRD; scheduled for 23 July 2007. Over 500 invitations issued</li> </ul>
Strategic association with key industry groups	Interaction with key industry groups to include possible sponsorships	\$10,000/yr	On-going	<p>VicUrban to be contacted including invitation to Feb 2007 workshop on Transition to WSUD</p> <p>Civil Contractors Federation to be contacted by March 2007 and interaction initiated including invitation to Feb 2007 workshop on Transition to WSUD</p> <p>Further involvement with MAV to be pursued including invitation to Feb 2007 workshop on Transition to WSUD</p>	<ul style="list-style-type: none"> <li>• VicUrban participants attended Feb 2007 workshop on WSUD.</li> <li>• Civil Contractors Federation CEO, Victoria, attended Feb 2007 workshop on WSUD</li> <li>• MAV reps invited to WSUD Feb 2007 workshop; not able to attend.</li> <li>• VicUrban and MAV representatives propose to attend launch and seminar of FAWB report on Transition to WSUD on 23 July 2007.</li> </ul>

## **Financial Information, Audit**

### **Signed Audit Opinions on Financial Reports and Information for Year ended 30 June 2007 Including Participants Contributions**

Copies of signed Audit Opinions provided by the Director, Audit and Risk Management, Monash University, for the FAWB activities for the year ended 30 June 2007 are set out in this section.

Audit Opinions have been provided with respect to the:

- STI Grant Agreement, as addressed to the Minister for Innovation
- Joint Venture Agreement between the Participants Ecological Engineering and Monash University, as addressed to the Board of Management of FAWB.



Greg Connell  
Director, Audit and Risk Management  
Report No : 200726  
Audit Ref : GRANTS03

24 August 2007

The Minister for Innovation  
Department of Innovation, Industry and Regional Development  
Level 35  
121 Exhibition Street  
Melbourne 3000

**Audit Opinion – The Facility For Advancing Water Biofiltration**

This Audit Opinion is prepared for the purposes of the Grant Agreement entered into by the Parties and dated 22 August 2005.

Scope

We have conducted an independent audit in accordance with Australian Auditing Standards of the attached financial statement provided to us that specifies an amount of \$2,272,251 (\$823,984 Cash plus \$1,448,267 In-Kind) of expenditure on the program and an amount of \$1,677,600 (\$229,333 Cash plus \$1,448,267 In-Kind) as Matching Contributions towards the Program in order to express an opinion on it for the purposes of the Agreement.

Our audit involved an examination, on a test basis, of evidence supporting the amount of expenditure incurred, including all Grant funds and the amount of contributions (both cash and in kind) received. This included an examination of the financial records and receipts, and an evaluation of the policies and procedures used to calculate the expenditure of the Program and the Matching Contributions. These procedures have been undertaken to form an opinion as to whether the methodology used to calculate the expenditure and these contributions is in accordance with the Agreement, and that the figures stated are true and fair.

The Audit Opinion expressed in this report has been formed on the above basis.

Audit Opinion

I confirm that in my opinion:

- Expenditure of \$2,272,251 has been incurred on the Program;
- The Matching Contributions to the Program totalling \$1,677,600 (\$229,333 Cash plus \$1,448,267 In-Kind)

in accordance with the terms of the Agreement.

R G Connell

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FACILITY FOR ADVANCING WATER BIOFILTRATION

SUMMARY OF INCOME & EXPENDITURE

For The Year Ended 30 June 2007

	\$	\$
<b>CASH INCOME</b>		
State Government Grants	760,000	
Contributions - Participants (Monash, EE)	109,000	
Contributions - Collaborators	120,333	
Consulting Income	40,925	
Other Income	890	
<b>Total Cash Income</b>	<u>1,031,148</u>	<b>1,031,148</b>
<b>CASH EXPENDITURE</b>		
Salaries	277,947	
Salary Oncosts	47,301	
Infrastructure	102,866	
Scholarships	19,700	
Equipment	1,347	
Consultants	60,714	
Operating Supplies	263,408	
Travel-Australia	33,229	
Travel-Overseas	17,472	
<b>Total Cash Expenditure</b>	<u>823,984</u>	<b>823,984</b>
<b>Surplus - Cash</b>	<u>\$ 207,164</u>	<b>\$ 207,164</b>
<b>IN-KIND INCOME</b>		
Participant Contributions (Monash, EE)	471,857	
Collaborator Contributions	976,410	
<b>Total Inkind Income</b>	<u>1,448,267</u>	<b>1,448,267</b>
<b>IN-KIND EXPENDITURE</b>		
In-kind expenditure, salary and other	1,448,267	
<b>Total Inkind Expenditure</b>	<u>1,448,267</u>	<b>1,448,267</b>
<b>Inkind Surplus/(Deficit)</b>	<u>\$ -</u>	<b>\$ -</b>
<b>Total Expenditure</b>		
Cash	823,984	
InKind	1,448,267	
<b>Total Cash plus Inkind Expenditure</b>	<u>\$ 2,272,251</u>	



Greg Connell  
Director, Audit and Risk Management

Report No : 200726a  
Audit Ref : GRANTS03

24 August 2007

The Board of Management  
The Facility For Advancing Water Biofiltration

## **Audit Opinion – The Facility For Advancing Water Biofiltration**

This Audit Opinion is prepared for the purposes of the Joint Venture Agreement entered into by the Parties and dated 2<sup>nd</sup> August 2005.

### Scope

We have conducted an independent audit of the attached financial statement provided to us that specifies an amount of \$580,857 (\$109,000 Cash plus \$471,857 In-Kind) has been provided to the Program by the Participants ie. Ecological Engineering and Monash University.

Our audit involved an examination of supporting documentation for the receipt of cash contributions and the calculations of in-kind contributions provided by both Monash University and Ecological Engineering.

### Audit Opinion

I confirm that in my opinion:

- Cash totalling \$109,000 has been received by the Program; and summarised as follows - Monash University provided \$99,000 and Ecological Engineering provided \$10,000
- In-kind contributions totalling \$471,857 have been provided to the Project and summarised as follows - Monash University contributed \$356,993 and Ecological Engineering contributed \$114,864

The figures stated are true, fair and in accordance with the terms of the Agreement.

R G Connell



**FACILITY FOR ADVANCING WATER BIOFILTRATION**  
**MONASH UNIVERSITY and ECOLOGICAL ENGINEERING**  
**Summary of Cash and Inkind Contributions**

**For The Year Ended 30 June 2007**

	\$	\$
<b>CASH INCOME</b>		
Monash University	99,000	
Ecological Engineering	<u>10,000</u>	
<b>Total Cash Income</b>		<b>109,000</b>
<b>INKIND CONTRIBUTIONS</b>		
Monash University	356,993	
Ecological Engineering	<u>114,864</u>	
<b>Total Inkind Contributions</b>		<b>471,857</b>
<b>Total Cash and Inkind Contributions</b>	<u><u>\$</u></u>	<u><u>580,857</u></u>