Fresh Water Inc.

Project no:		1	
Registration title: (Max 150 characters)		Design and development of the WaterWally water controller	
Date updated:		25 September 2015	
Project manager:		John Doe	
Start Date:	1 July 2009	**Finish date:**	Ongoing

1. Hypothesis and technical objectives **(Max 4000 characters)**

Fresh Water Inc. (FRESH WATER) has many years of experience with water conservation systems. Their main control product, WaterWally, is envisioned to be a smart solution to effective, remote water management.

This project has been ongoing for several years. The hypothesis of the project in FY15 is to design and develop improvements to the intuitive, multi-functional, water management system. Specific technical objectives of this project include:

- To design and develop a disinfection management system that destroys pathogens in the water flow;
- To design and develop a system that can manage multiple water sources for non-potable applications;
- To design and develop a larger version of WaterWally incorporating more pumps and catering to different OHS requirements;
- To improve efficiency of embedded software code (i.e. memory use);
- To conduct ongoing laboratory testing to prove the operational effectiveness and efficiency of:
  - The disinfection system;
  - The in-line filter purging and contactor operation;
  - The system as a whole;
- To conduct field testing to establish the real-world results when natural elements are introduced (e.g. fauna-borne parasites, coliforms, decaying vegetable in an urban environment) in order to identify and develop suitable solutions if required.

Objectives for FY16 have also already been established as a result of FY15 work—FRESH WATER intends to next develop:

- A universal Modbus interface to allow integration into third-party industrial control and automation systems;
- An automatic pH analysis module has not yet been developed to enable better monitoring and management of stored water;
- An automatic turbidity monitoring module to monitor water clarity to ensure proper operation of downstream ultraviolet disinfection systems;
- An electrical conductivity monitoring module to monitor salinity in the water treatment system;
- A slow-leak detection system to overcome water losses caused by slow leaks within the downstream plumbing system to overcome significant water losses and other inefficiencies;
- A cloud-based management platform for users to remotely monitor and (possibly) take remote control of WaterWally and/or its various modules if required.

2. New knowledge generated (Max 4000 characters)

FRESH WATER has a patent for this system, indicating that this is never-before-seen technology.

However, the WaterWally features more sophisticated technology than any of the above devices. Even the Onga water switch, which is the nearest product to what FRESH WATER is developing, does not have any of the advanced functions that WaterWally will deliver, nor the migration path to commercial systems for higher water volume management.

WaterWally is a new concept in water controllers that is unique in the industry. The system is not just a water switching device; it is an intelligent, high-performance platform that will expand the boundaries of water conservation by applying intelligent management concepts to alternative water sources and improve overall system efficiency. The project is generating new knowledge in the use of micro-controllers to autonomously manage a range of water sources and react to environmental factors such as water quality and water demand.

Specific new knowledge generated in FY15 includes:

- Understanding of the principles underlying the development of a disinfection management system and the power levels required to achieve full disinfection at low turbidity levels;
- Further understanding the correlation between particle size and irradiation effectiveness in ultraviolet sanitation systems;
- Understanding of the principles underlying the development of a larger WaterWally system for use on larger projects, including how to incorporate different requirements, e.g. OHS;
- Understanding of the principles underlying how to improve code efficiency while considering the finite capacity (i.e. memory space limitations) of the active device, i.e. how to use new programming techniques to enable code compaction;
- Understanding the principles underlying designing a system that is able to fit in a certain amount of physical space;
- Understanding how to overcome issues faced with wired (or wireless) floats, i.e. why it is necessary to change the water-sensing mechanism for tanks from a float switch to an intelligent water flow monitoring process—Wired (or wireless) floats can become impractical in many rural (especially third world) sites or industrial applications where distance or electrical interference can pose a problem;
- Understanding the principles of oxygen depletion in stored water and the use of forced aeration as a means of improving water quality. Higher oxygen levels promote the activity of good aerobic bacteria in the tank. This is an effective means of reducing the level of contaminants in the storage vessel and thus improving the quality of the water in preparation for disinfection and subsequent use.

3. Unknown outcome (Max 2000 characters)

It is technically challenging to:

- Develop a larger WaterWally: FRESH WATER must ensure the philosophy still works, i.e. the pressure, flow and the interaction between them on a larger scale. FRESH WATER must also consider material types and effects of larger pumps requiring higher power delivery and pipe sizes to match anticipated higher flow volumes. Larger systems also entail more stringent OHS factors that need to be incorporated into the basic system. Developing a version suitable for larger diameter pipes means that the physical size could become unwieldy. This issue may be overcome by redesigning the hydraulic section so the solenoid valve is incorporated into the T piece to reduce longitudinal dimension.
- Incorporate a disinfection management system: The system must neutralize pathogens so adequate quality standards can be achieved. Automatic disinfection enables more end-use applications.
- Change the water sensing for tanks: Initially, WaterWally was designed to detect an empty tank by sensing absence of water flow but hydraulic surges from air sucked into the tank outlet caused significant and sustained sensing errors, compounded by the ratio of tank

diameter to outlet pipe size. Firmware upgrades and/or hydraulic techniques may overcome this.

- Develop an automatic filter purging system that learns system characteristics, autonomously senses variations and actions appropriate cleaning of specific filters. Variations are complex; suitable algorithms are required.
- Increase efficiency of code while considering memory space limitations. Smarter code must be developed to improve system efficiency; additional memory would increase cost of a device that is destined for low-cost production and use in third-world/developing countries.
- Incorporate a water-quality monitoring process that analyses water quality in real time and instigates appropriate actions should the water quality move outside a set of given parameters.

4. Research and development activities

The company believes its WaterWally solution can be achieved by conducting the following stages of experimental activities:

- Background research to evaluate current knowledge gaps and determine feasibility.
- Design and development of a series of prototypes to achieve the technical objectives.
- Trials and analysis of data to achieve results that can be reproduced to a satisfactory standard and to test the hypothesis.
- Ongoing analysis of customer or user feedback to improve the prototype design.

R&D activities description (Max 2000 characters)	**Start date** (Original)	**End date** (Expected)
Background research of the WaterWally • Literature search and review, including use of WaterWally in third-world/developing countries. This study identified a number of functions that would provide significant additional benefit to these users in the area of water quality and water safety. FRESH WATER's research into global water issues and climate change confirmed an urgent need for improved rainwater harvesting and re-use around the world. To fully address this need on a comprehensive basis, WaterWally must be capable of managing a broader spectrum of water sources and be able to take autonomous action based on a variety of conditions including water-quality changes. Parameters to be developed include pH, turbidity and conductivity; • Analysis of previous design solutions and assessment of key interferences to determine potential solutions; • Consultation with industry professionals and potential customers to determine the feasibility of the solution; • Consultation with key component suppliers to determine the factors they consider important in the design, and to gain an understanding of how the design needs to be structured accordingly.	**Jul 2009**	**Ongoing**

R&D activities description (Max 3000 characters)	**Start date** (Original)	**End date** (Expected)

Design, development and testing of the WaterWally
 	
Hypothesis: That theorized designs/redesigns of WaterWally can be implemented physically into a specific physical space and tested for functionality.
 	
Activities:
• Physically implemented new functions to ensure physical fit with existing computer firmware and other components:
  o Disinfection management system: Developed on-board electronics to sense flow of water through device from mains or tank water and manage attached ultraviolet disinfection module;
  o Additional heat sinks to dissipate higher temperatures generated;
• Recoded embedded software to improve efficiency within space limitations;
• Redesigned disinfection management system using different components with different operational characteristics to overcome space issues without compromising on performance;
• Laboratory-tested disinfection system, in-line filter purging and contactor operation, and system as a whole:
  o At various water volumes;
  o At various turbidity levels;
  o To establish baseline specifications for adequate disinfection;
  o To identify effect of clogged filter elements on results;
• Continued long-term maintenance and reliability testing in existing test sites.
 	
Observations:
• Space limitations:
  o Physical: Resolved by revising main PCB layout and incorporating alternative heat sinks to reduce component footprint; however, led to PCB track length issues and potential EMC noise problems in interconnections between main PCB and sub-modules, requiring further experiments due to proximity of solenoid valve and unshielded nature of devices;
  o Memory: Resolved by repeated revision and compaction of operating code and developing proprietary techniques to address system operation;
• Water disinfection management system: Required as secondary water source (harvested rain/storm water) may not be acceptable standard for use. UV module deals with bacteria and parasites usually only found in secondary water but sometimes enter mains supply in developing countries. FRESH WATER is setting the system up to treat all water sources.
 	
Conclusions:
• Current WaterWally appears stable, though:
  o The low-flow sensing could be a little more sensitive;
	Jul 2012	**Ongoing**

○ The heat sinks could have more capacity; ○ Experimentation with water-sensing mechanism did not achieve desired results; ○ Firmware could also be improved. • Removing the float switch should simplify installation, especially useful if the tank is situated far from the controller, but flow sensing creates additional problems at the point when tank water level reaches the outlet pipe top. This creates significant turbulence and produces wildly inaccurate flow data. Not fully addressed by end FY15 and will be ongoing into FY16. • No new trial sites were installed in FY15 but may be in FY16.		
Design of a larger-scale WaterWally Hypothesis: That FRESH WATER can design the components and layout of a larger-scale WaterWally for larger-scaled projects, incorporating design changes due to different requirements, e.g. OHS. Activities: • Sketches with the goal of reducing manufacturing cost (important due for end users) and shortening the overall length of WaterWally; • 2D technical drawings for: ○ Process assessment; ○ Cross section analysis. • 3D CAD modelling. Key factors examined were: ○ The physical relationships between the various components and the control electronics; ○ The size and positioning of optional modules control electronics. Observations: • FRESH WATER was required to combine several parts to reduce complexity; the company was also required to change, enhance or replace almost all individual components. • The larger-scale WaterWally is not a proportional increase of the original WaterWally because a larger pump will have more pressure and power capacity. A larger pipe might have a thicker wall than the original pipe used. Therefore, FRESH WATER must consider material types and sizes to ensure all parts work together and to ensure that the philosophy (pressure, flow and the interactions between the pressure and flow) behind WaterWally is still applicable. Conclusions: • By end FY15, approximately 15 iterations of drawings covering three major design changes were undertaken. • A mock-up was built for feasibility but is not functional. • Work will continue into FY16, including rapid prototypes of each component before full development.		

R&D activities description (Max 2000 characters)	Start date (Original)	End date (Expected)
Feedback R&D of the WaterWally • Analysis of feedback from testing results, which may serve as starting points for the development of new hypotheses; • Application of minor changes, e.g. tweaks or minor modifications to further enable the testing of the new solution.	**Jul 2013**	**Ongoing**
• The feedback is necessary to evaluate the performance capabilities of the new design in the field; • The feedback is necessary to improve any flaws in the design.	Directly related	

5. Plant and facilities

The research and development is undertaken at FRESH WATER's facilities at XXXXXX, USA.

Off-site field testing is undertaken In XXXXX, USA, with additional testing also completed in XXXXX, USA.

6. Substantiation

Please be aware that, under the current legislation, you must be able to provide evidence to substantiate your R&D activities. In the event of an IRS audit, this documentation may be required to prove that the R&D activities were eligible and took place in a systematic progression of work. We strongly recommend that you store this evidence in a safe place.

Please confirm which of the following documents you have available.

You do not need to send us any of these documents.

Yes / No / Not applicable (n/a)	Documentation type
Yes	Literature review
Yes	Background research
Yes	Project records and laboratory notebooks (some)
Yes	Design documents for system architecture and source code
Yes	Conceptual sketches
Yes	Design drawings
Yes	Photographs / videos of various parts
Yes	Photographs / videos of various stages of build / assembly
Yes	Photographs / videos of initial or intermediate prototypes
Yes	Photographs of completed models
Yes	Testing protocols (partial)

Yes	Results or analysis from testing / trial runs
Yes	Progress reports and meeting minutes or notes (some)
Yes	Screenshots of various build versions / final version
Yes	Staff time sheets (some)
Yes	Tax invoices
Yes	Patent application number