D5.1 Pilot Plan Report

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D5.1

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Executive Summary

A lack of information, management and decision support tools that present meaningful and personalized information about usage, price, and availability of water to end users can hinder efforts to manage water as a resource. WATERNOMICS aims to address these issues using innovative information, communication and technology (ICT) tools. The project will develop and introduce ICT as an enabling technology to manage water as a resource, increase end-user conservation awareness and affect behavioural changes, and to avoid waste through leak and other fault detection and diagnosis.

This deliverable documents the work carried out to-date specific to each of the four project pilot sites in preparation for the pilot control period and presents the planned activities that will be undertaken at each of the sites during the period. The pilot sites were identified to demonstrate, trial and validate the work of WATERNOMICS in the (i) Domestic, (ii) Corporate and (iii) Public/Mixed Use Environments. The planned measures that will be undertaken at each of the pilots and the motivation for this work is described in this report.

The development of a Water Management Programme at each of the pilot sites in line with the WATERNOMICS Methodology's (WATERNOMICS, 2015) Assess and Plan Phases is outlined. These phases culminate in the development of four pilot specific Action Plans. The Pilot Action Plans are presented here as a schedule of individual tasks that will be undertaken framed by water efficiency measures that were in turn motivated by the overall project and pilot specific and objectives also presented.

The linkage between the findings of the earlier project deliverable D1.3 System Architecture and KPIs (WATERNOMICS, 2015) in terms of KPIs and User Requirements is clearly made by the presentation of pilot specific objectives that connect both KPIs and planned water efficiency measures. This report incorporates the work presented in the earlier project deliverable D2.2 Measurement Frameworks (WATERNOMICS, 2015), which described the technology selection and the pilot metering plans at each site.

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1 Introduction

The goal of the WATERNOMICS Project is to explore how ICT can help households, businesses and municipalities to reduce their consumption and losses of water in the framework of a water management program. A key component of the WATERNOMICS Project is the collection of water consumption and contextual information from different sources to allow effective data analytics that will drive decision-making that optimises water consumption: e.g., planning, adjustments and predictions and to raise user awareness of water consumption.

This document, Deliverable 5.1 Pilot Plan (D5.1), is the first report from Work Package 5 (WP5) - the WATERNOMICS implementation phase - and describes, by application of the WATERNOMICS Methodology the work to-date at the project's four pilot sites (Table 1.1). In addition, details are presented of the planned measures to be implemented at each of pilot sites to satisfy both the project and pilot-specific objectives. The report describes the implementation of WATERNOMICS in the demonstration pilots and can thus inform future research or commercial projects that aim to improve water efficiency and increase end-user awareness of water usage.

An overview of WATERNOMICS, its' work packages and deliverables can be found at www.WATERNOMICS.eu. Deliverable 2.1 (D2.1), which described the WATERNOMICS methodology referred to in this report can be accessed through this site.

Table 1-1: WATERNOMICS Pilot Sites

Environment	Site	User Description
Corporate	Linate Airport, Italy	Corporate Users & Customers
Domestic	Thermi, Greece	Domestic Users & Utility Providers
Public/Mixed Use	National University of Ireland Galway, Ireland	University Students, Staff & Management, Public
Public/Mixed Use	Coláiste na Coiribe, Galway, Ireland	School Students, Staff & Management, Public

1.1 Work Package 5 Objectives

The high level objectives of WP5 are to:

- Pilot, demonstrate and validate the innovative WATERNOMICS Platform at the identified pilot sites representing commercial, domestic and municipal (mixed-use) water users;
- Analyse the efficacy of the deployed systems to enable increased awareness and reduced water consumption;
- Determine the feasibility and efficiency of the flexible tariff (pricing) mechanisms/incentives and their effect on demand prediction, demand management, and water consumption;
- Gain feedback from consumers and utilities on system performance to include;
    - personalised interaction with the system
    - ease of data accessibility
    - longitudinal user awareness/behavioural surveys at the demonstration sites
    - the WATERNOMICS game

- Evaluate the WATERNOMICS Platform as an information platform for both water providers and water users.

1.2 The Role of Deliverable D5.1

The role of this report is to provide documentation of the expectations, conduct and reporting requirements for the execution phase of the pilots.

This report follows on from previous deliverables including (i) Work Package 1 Deliverables, in particular D1.1 and D1.3 that describe the user requirements and Key Performance Indicators (KPIs) as determined from stakeholder's interaction (ii) Work Package 2 deliverables (D2.1 and 2.2) that detail the WATERNOMICS methodology and the measurement framework that informs the metering plan in each pilot. (iii) Work Package 3 deliverables (D3.1.1 and 3.2) detailing fundamentals of the developing WATERNOMICS software platform including data management plans, associated software, support services API's and components' libraries. Work Package 4 future deliverables (D4.1, D4.2 and D4.3) will present details of innovative metering techniques and the results of analysis and diagnostics trailed at the pilot sites. Further details on these deliverables are available at www.WATERNOMICS.eu.

This report outlines the specific measures that will be undertaken at each of the pilot sites to examine the effect of ICT interventions on the awareness and behaviour of stakeholders in terms of water consumption. In addition, this report outlines our proposals for the assessment and validation of the effects of the interventions.

1.3 Relationship with other Activities in the Project

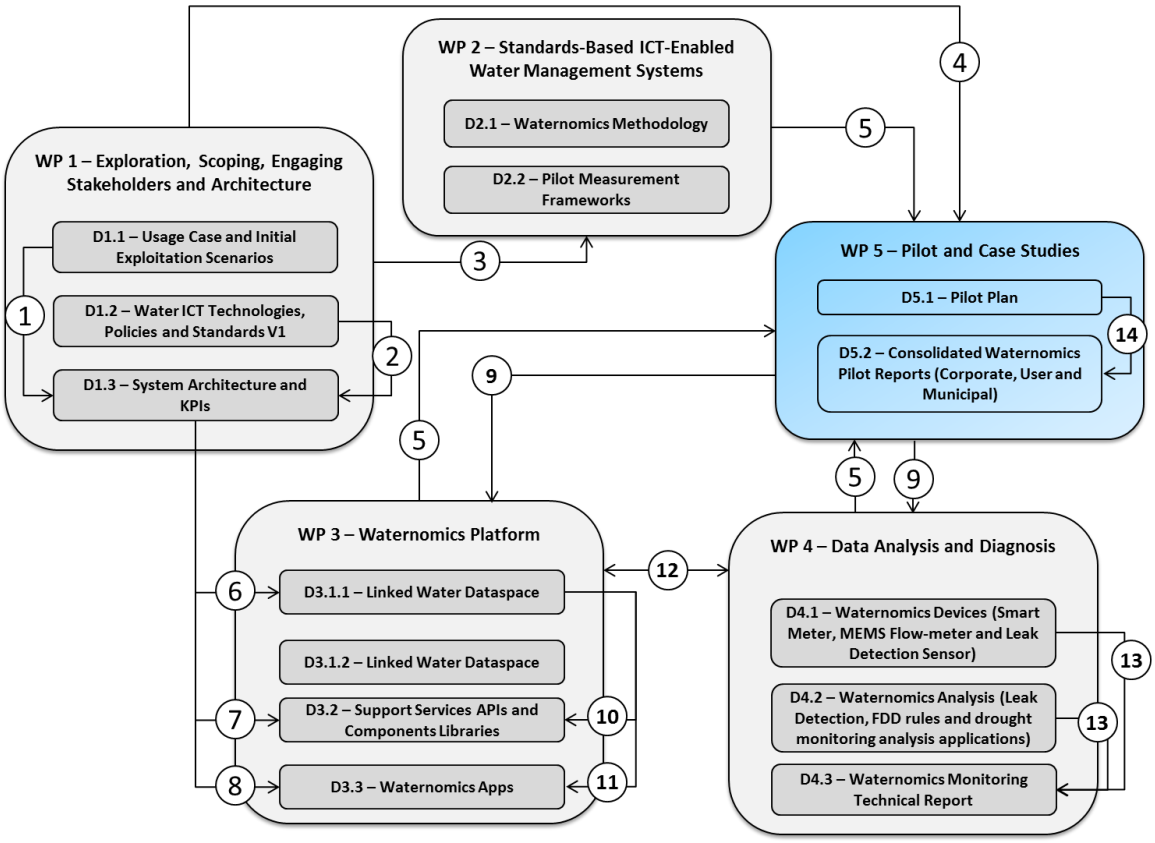


Figure 1-1: Interrelationship of Project Work Packages

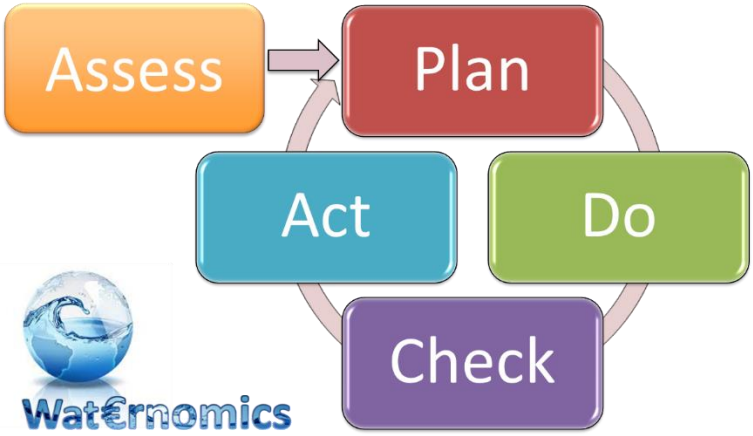


Figure 1-2: Basic Framework for the WATERNOMICS Methodology c.f. D2.1

The basis of the WATERNOMICS Methodology is detailed in D2.1 as a Five Phase Framework (Figure 1-2). The Activities in Phases 0 Assess and 1 Plan are principally complete for the four pilots (Figure 1-3) and many of the results are documented in the earlier project deliverables listed below;

1. D1.1 Usage Case and Initial Exploitation Scenario
2. D1.2 Water ICT
3. D1.3 System Architecture and KPIs
4. D2.1 WATERNOMICS Methodology
5. D2.2 Measurement Framework
6. D3.2 Support Services, APIs and Component Libraries

This report focuses on previously unreported work carried out to-date in executing the WATERNOMICS Methodology at each of the pilot sites and presents the Action Plans that have been developed for each pilot including the planned implementation of a water information system (WIS), the WATERNOMICS water information platform (WIP), at each pilot.

Figure 1-3: The WATERNOMICS Methodology c.f. D2.1

1.4 Management & Coordination of the Project Pilots

As described in the WATERNOMICS Description of Works (WATERNOMICS, 2013), and in the case of Coláiste na Coiribe, in later project reporting, each of the four pilot sites is managed at a project level by a WATERNOMICS consortium partner. Table 1.2 below, describes the consortium partner assigned to each pilot site and the nominated representative from the partner organisation. These pilot site managers work closely with representatives from the permanent staff at each of the pilot sites to ensure the successful implementation of the WATERNOMICS hardware and software requirements, that the project and pilot specific objectives are achieved and that there is continued support and control of the planned interventions.

Table 1-2: WATERNOMICS Pilot Site Managers

Pilot Site	Consortium Partner	Nominated Representative
Linate Airport, Italy	R2M	Domenico Perfido
Thermi, Greece	Thermi	Christos Kouroupetroglou
NUI Galway, Ireland	NUIG	Louise Hannon
Coláiste na Coiribe, Galway, Ireland	NUIG	Louise Hannon

The web-based project management application Trello (www.trello.com) was adopted by the WATERNOMICS Project in May 2015. A WATERNOMICS Trello site was created and Trello Boards for each of the four pilots were customised by reference to the WATERNOMICS Methodology. The application serves as a project management, communication and information tool for the planning, control and coordination of WP5 and also of the individual pilot sites. Figure 1-4 shows the NUIG Pilot Site Trello Board with each of the Methodology Phases represented by a dedicated card that lists necessary activities to be carried out in that phase. A sixth column captures associated research tasks and activities of interest to the WATERNOMICS Team. Clicking on a phase or activity, opens a description of that phase or activity, the status of the activity and previous discussions/documents related to that field. All WATERNOMICS personnel are members of the Trello Boards and can choose to join particular cards or tasks thereby ensuring that they receive alerts when new information is added or comments are posted. In this way, the Trello tool promotes knowledge sharing and dissemination within the project team as well are tracking progress and prompting action.

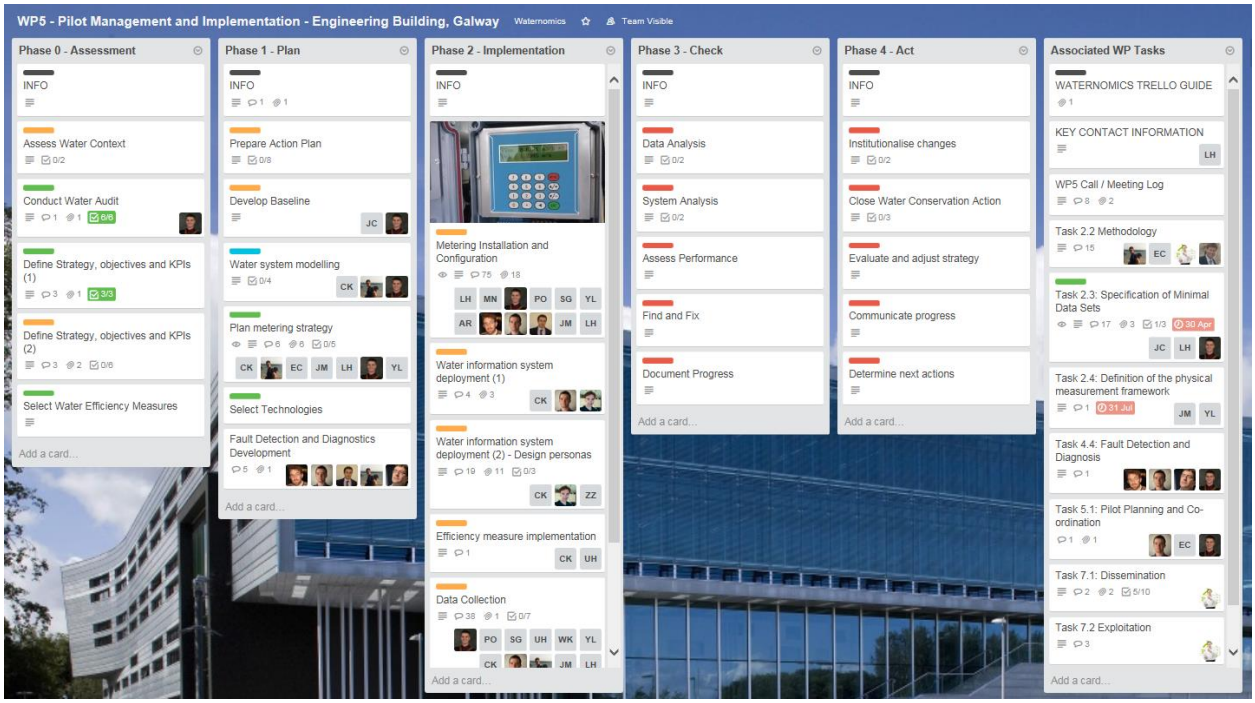


Figure 1-4 The NUI Galway pilot Trello Board

Weekly WP5 meetings are held via Skype to update and coordinate the WATERNOMICS Pilot Site Implementation. These meetings always include pilot site updates from each of the four pilots, generally these are given by the Pilot Managers. These meeting promote coordination of the work at the pilots, facilitate troubleshooting and encourage innovation and knowledge sharing activities. The minutes of these meetings are available to all WATERNOMICS Team Members on google drive folder and a link to these is also included on the 6th Card on the NUIG Trello board, entitled Associated WP Tasks.

At the project level, the pilots are controlled by three Milestones which are in brief:

1) Milestone 3: ICT technologies ready at M18
2) Milestone 4: Installation and Planning (D5.1) Complete and the Initiation of a 12 month monitoring period
3) Milestone 6: Conclusion of pilots and handover at M33 as to allow 3 months to analyse, draw conclusions and iteratively improve technology and methodology aspects before project conclusion.

Management of the pilots is also facilitated by the methodology itself. It is standards based, common to each of the pilots, and how to move through pre, during, and post pilot activities (to include assessment) is part of the methodology itself. For this reason, it was a logical choice to structure this D5.1 planning document in accordance with the methodology itself.

1.5 Document Outline

Chapter 1 presents an overview of the WATERNOMICS Project, the role of WP5 and the function of this deliverable as well as commentary on the management and coordination of the pilot sites from a project perspective.

Chapters 2, 3, 4 and 5 describe for each of the pilot sites the characteristics of the site in particular those that influence the use and consumption of water. Each of the four chapters are dedicated to a pilot site and define the specific objectives for implementing a Water Management Program at each site. An overview of the work undertaken to date at each of the pilot sites in the development of each Pilot's Action Plan is outlined in Chapters 2 – 5, inclusive.

Chapters 6, 7, 8 and 9 present the Pilot Plans developed for each of the pilot sites and the work currently underway at each pilot in implementing these plans. Each of the four chapters are dedicated to a pilot site.

Chapter 10 presents in general terms the proposed approach of the pilots to the later Check and Act Stages of the methodology.

2 Pilot Plan Development - Pilot 1 Linate Airport

Linate Airport is deeply embedded in the urban belt of Milan (Italy), in the south- east of the Milan province. It has a total area of approximately 350 hectares (mainly on the territory of the municipality of Peschiera Borromeo and, to a lesser extent, municipalities and Segrate Milan). The grounds border are Forlanini Park and a seaplane station. SEA Corporate is the manager of the airport services. In general the territory around Milan is mostly flat and full of water: it is crossed by important rivers, such as the Ticino and Adda; by a network of rivers and streams, Olona, Seveso and Lambro, and an ancient system of channels, including the Martesana and the Naviglio Grande play an important role in irrigation[1].

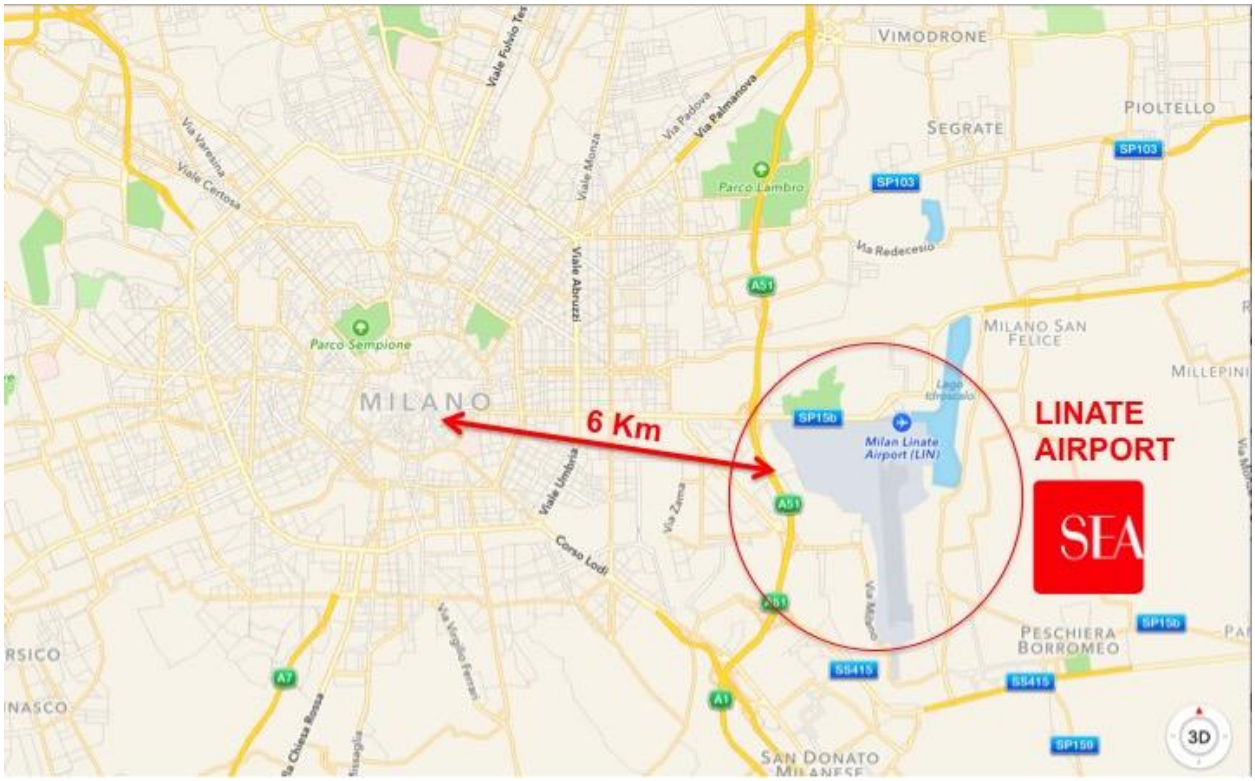


Figure 2-1: Linate pilot site and SEA corporate

2.1 Pilot Site Overview

The airport clientele are predominantly "frequent-flyer" passengers on particular national and international particular routes (the latter both within the EU and outside of it). In 2012, the Linate airport has operated for 6.3 % of the passengers, and 2.2 % of the quantity of goods in transit through Italian airports.

The airport has two runways for landing and take-off, the first (2,442 m long) intended for commercial aviation, and the second (601 m long) intended for general aviation. The airport aprons, ramps and parking stands allow for the simultaneous parking of 46 aircraft. The passenger terminal, which extends over five levels with a total area of about 75000 m2 (of which about 33000 are open to the public), is equipped with 71 check-in counter and 24 gates, five of which served as a loading-bridge. Approximately 21% of the area open to the public is dedicated to commercial activities (shops, restaurants, bars, car rentals, banking services, post offices,

[1] information gained from the website: http://www.cittametropolitana.milano.it/area_metropolitana/incifre/index.html (accessed September 2015)

branches of public services) and 7.5% to the services provided by airlines (check-in, ticketing). Table 3 summarises aircraft and passenger traffic over a three year period at Linate Airport.

Table 2-1: Passenger traffic in Linate Airport

Year	Number of flights	Number of passengers
2010	91,907	8,295,436
2011	94,547	9,061,749
2012	96,186	9,175,619
Average over the three years		
	94,213	8,844,268

Given the complexity of an airport, a key aspect of pilot planning has been the cooperation of SEA corporate in providing key documents and plans that describe both airport activities and infrastructure. In particular, passenger information, information on commercial activities and information on key water consumers within the airport and water and wastewater infrastructure has been readily available.

Existing Water Infrastructure

Linate Airport is equipped with autonomous supply and distribution networks. The water is drawn from artesian wells, 9 exist and 8 are operational. They are built inside of the airport grounds and have a depth varying from 30 m to 121 m.

The Lombardia Regional Authority governs water pumping from these wells. The water from these wells is distributed to all the users for different uses (e.g. drinking water, sanitation, industrial and fire protection). At the airport there are two active ring networks for independent water supply. One is dedicated to industrial uses (e.g. primarily air conditioning and fire) and one for potable water. Figure 2-2 presents a schematic of the water distribution system.

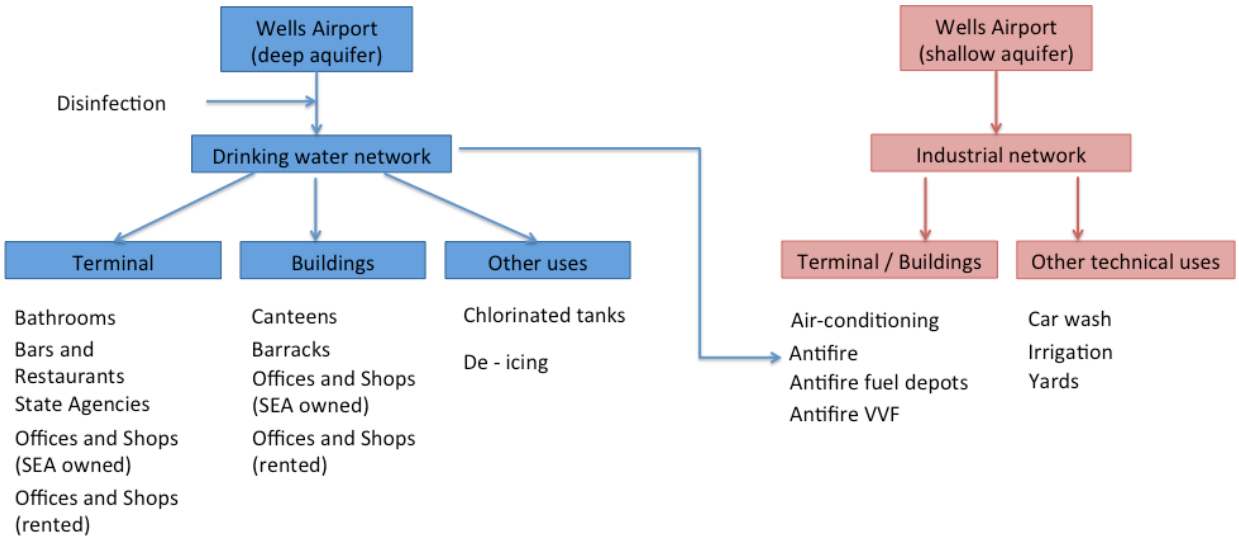


Figure 2-2: Linate Airport water infrastructure schematic

There is a connection between the two ring networks to ensure that in cases of emergency there is sufficient pressure for firefighting networks with the addition of the drinking water network.

At the current time only select water meters are in place on the water system at Linate Airport mainly to measure the water consumption for the commercial consumers and for the offices (to enable billing within the airport). These meters are not connected to a water management system (WMS) and thus flow data recorded by the meters is not stored automatically and can only be read and stored manually. In the Linate Airport pilot, WATERNOMICS will concentrate on the potable water network. Examples of the principal water uses from the potable water supply include offices, shops, restaurants, bathrooms, cleaning within office and passenger areas and de-icing for the airplanes.

Pipe network

From the evidence gathered, several significant aspects are revealed:

- 60% of the pipes date back to the period between 1935 and the end of 1938
- 30% of the pipes are from the early '50s and late '60s
- In most cases the pipes are made of cast iron and in only a few short stretches, from the early ‘70s (the remaining 10% of the total) are made of steel
- The airport has expanded over time with discrete construction efforts

Due to the old age and condition of the networks in some areas, even slight pressure spikes can create hydraulic problems (water losses/leakages).

As such, losses are suspected to be a significant problem arising from the condition of antiquated water mains. These losses are estimated to vary widely within various water networks and parts of networks at the airport. The lower estimated bound is 15% of water lost to leakages and the upper estimated bound 58% present in the older systems.

The water pressure in the network is set to 5 bar to ensure service to all the users. This pressure would, in the context of many water networks, be considered a relatively high pressure particularly in areas where high-pressure heads are not required (e.g. low office buildings close to pumping stations).

Excessive pressure acts negatively on two fronts; (i) excessive the energy consumption for pumping and (ii) increased losses. The Linate distribution network does not have pressure gauges and flow meters in the main branches of the network (nor in the minor branches).

While, in general, a distribution network without losses is probably an unattainable goal, it is necessary to know the level of efficiency of the system that can be sustainably and economically achieved. The monitoring of the water balance (volumes injected into the system and volumes emerging from it for consumption or loss) is the essential tool for efficient management of the water network.

Existing Water Usage Characteristics

Baselining existing water usage in terms of quantity, end uses and use characteristics is a key first step in the WATERNOMICS methodology presented in the D2.1 report referred to previously. Thus significant attention was focused on this aspect of the pilot. Table 2-2 gives an overview of the breakdown of water consumption between the two aforementioned water ring mains in Linate airport between 2008 and 2013.

Table 2-2: Overview of the water consumption in Linate Airport

Year	Annual water consumption (m^3)	Water utilization
2008	668,041	Withdrawals from wells "Industrial" - conditioning / Fire
	821,273	Withdrawals from wells Drinking (requirement Airport Operator + requirement Dealers)
Total	1,368,876	
2009	1,245,149	Withdrawals from wells "Industrial" - conditioning / Fire
	821,273	Withdrawals from wells Drinking (requirement Airport Operator + requirement Dealers)
Total	2,066,422	
2010	1,502,285	Withdrawals from wells "Industrial" - conditioning / Fire
	434,508	Withdrawals from wells Drinking (requirement Airport Operator)
	242,215	Withdrawals from wells Drinking (requirement Dealers)
Total	2,179,008	
2011	1,624,917	Withdrawals from wells "Industrial" - conditioning / Fire
	706,502	Withdrawals from wells Drinking (requirement Airport Operator)
	139,057	Withdrawals from wells Drinking (requirement Dealers)
Total	2,470,476	
2012	1,237,115	Withdrawals from wells "Industrial" - conditioning / Fire
	636,714	Withdrawals from wells Drinking (requirement Airport Operator)
	154,487	Withdrawals from wells Drinking (requirement Dealers)
Total	2,028,316	
2013	742,202	Withdrawals from wells "Industrial" - conditioning / Fire
	577,175	Withdrawals from wells Drinking (requirement Airport Operator)
	154,411	Withdrawals from wells Drinking (requirement Dealers)

Total	1,473,788	

The wells were constructed at different times and most of them between 60 and 70 years of age and some of the extraction points for the wells are equipped with electromagnetic flow meters thus SEA have detailed information regarding water extraction.

Only 3 wells are used for potable water supply and each work with 2 - 4 pumps. When the system requires more water to be drawn from an area of the loop, the pumps automatically turn on to provide the additional pressure and thus water to the system.

Using as a start point the International Water Association standard water balance[1] a potable water balance has been developed. The block diagram used to do this for this pilot divides water usage into several components, namely; (i) water measured and billed, (ii) measured but not billed, (iii) not measured and not billed, and (iv) losses.

The different components comply with the following definitions:

- Water quantity as measured entering into the network (e.g. pumped from the wells)
- Water consumption: includes consumption actually measured (invoiced or not) and those not measured (invoiced or not) which can include quantified volumes provided at a flat rate or not quantified volumes invoiced at a flat rate.
- Non-revenue water: is the difference between the total volume placed into the network and water consumption billed. It consists of non-billed water consumption (generally a minority component in the budget) and water losses.

Tables 2-3 and Figure 2-3 shows a water balance diagram for the potable water network at Linate airport using the average values registered in the years from 2011 to 2013 [2]

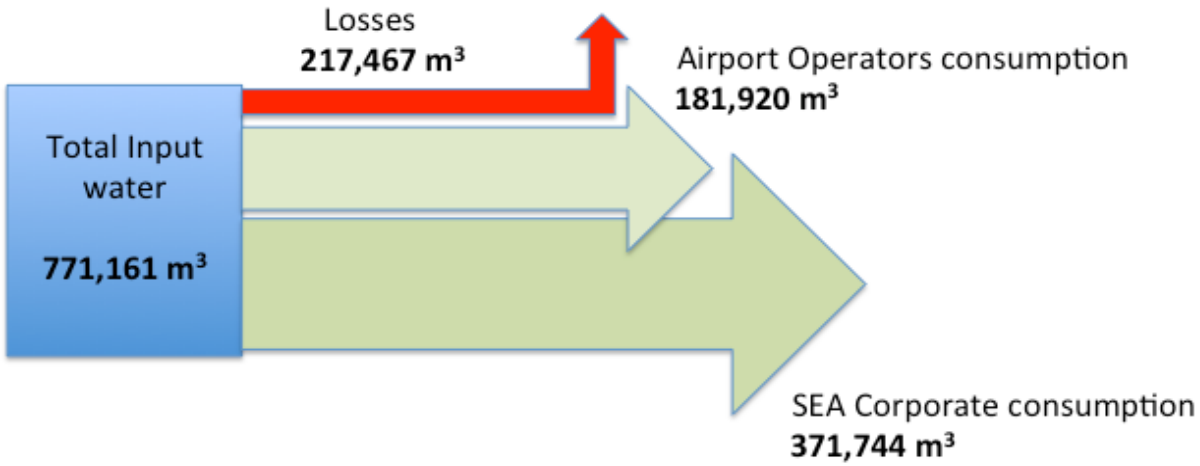


Figure 2-3: Water balance diagram for the potable water network at Linate airport

[1] A. Lambert, F. Mendaza "Water Losses Management and Techniques" - International Water Association Congress – Berlin 2001

[2] Information provided by SEA Corporate

Table 2-3: Water balance details for the water network at Linate airport

<table>
<tr><th>Water fed into the grid (m^3/annum)</th><th>Typologies</th><th>Detail quantity (m^3/annum)</th><th colspan="2">Note</th><th>Water discharged (m^3/annum)</th></tr>
<tr><td rowspan="4">Water quantity entering aqueduct
771,161</td><td rowspan="3">Water consumption</td><td rowspan="2">Billed consumption to third parties and operators
181,920</td><td>Billed consumption</td><td rowspan="2">Water Billed</td><td rowspan="3">Wastewater formally discharged into the sewer system
771,161</td></tr>
<tr><td>Consumption is not measured, but billed</td></tr>
<tr><td rowspan="2">Consumption not invoiced or SEA
371,774</td><td>Consumption measured but not invoiced</td><td rowspan="3">Unbilled Water</td></tr>
<tr><td>Possible consumption not measured and not invoiced</td></tr>
<tr><td>Water Losses</td><td rowspan="2">Potential losses</td><td>Consumption improper</td><td rowspan="2">Hypothesised wastewater effectively discharged into the sewer system
553,694 m^3</td></tr>
<tr><td>Measurement errors</td></tr>
<tr><td></td><td>Losses estimated as 28.2% of the total
217,467 m^3</td><td>Losses core network and secondary</td><td></td></tr>
</table>

In particular, two important aspects are highlighted:

a) Currently, SEA must pay a charge for all water discharged to the sewer network. This volume is defined under their current contract as being equal to their total abstracted water from the wells (meaning they pay for losses and water consumed as if it was entering the sewer network). SEA has identified the requirement to change this contract type with the AMIACQUE (local water utility) so that they only pay for the actual volumetric discharge to the sewer network. However, to make this contract change, they must provide more complete and accurate water balance information such as what could be provided using the WATERNOMICS approach, platform and methodology.

SEA estimates they discharge about 217,000 m^3/year less than the volume they are currently invoiced for. Given the current pricing of the cost of removal and purification € 0.5688/m^3 equal it is estimated this “excess” sewer charge can cost them between €100,000 and €120,000 per year. Additional savings of approximately 30-40% may be attainable if losses are factored out and conservation measures are implemented.

b) The need to install in the network appropriate sensors and gauges to determine with acceptable precision the actual water losses within the network.

2.2 Pilot Specific Project Objectives

The Project Specific Objectives of the WATERNOMICS Management Program are summarised below and shown in Figure 2-4. These objectives given in are derived from grouping the Specific User and Functional Requirements and KPIs identified in the D1.3 System Architecture report.

Figure 2-4: Pilot Specific Objectives - LINATE Airport

Objectives

Increase Awareness of water consumption among SEA and other commercial employees and passengers

Key to this will be the provision of timely and relevant information regarding water usage and the water infrastructure the managers, engineers and operational teams. WATERNOMICS aims to involve employees in water issues and effect change, using WIP towards the consumption of water. The WATERNOMICS WIP aims to display information that is customized for each individual end user for maximum effect.

Passengers are a somewhat unique target audience in that they are transient, have short term stays within airports and are often engaged heavily in negotiating various aspects of airport travel and thus the key challenge will be to engage them with WATERNOMICS during their short stay. Airport passengers will be engaged with touch screen displays that will enable both information display and passenger interaction.

Reduce Water Consumption and Energy

To reduce water consumption and save energy objectives will be pursued not only through the increasing awareness of water consumption between staff and passengers but also through the detection of leakages and faults detection in the existing water network and the application of the Water Efficiency Measures.

Improve Water Management and Water System Operation

To provide timely and relevant information regarding water usage and the water infrastructure also by developing a hydraulic model of the water network to enable more efficient water management and system operation. In addition to provide Managers with KPIs that allow decision making and the development and execution of water efficiency strategy.

Promote Environmental Responsibility

To promote and increase environmental responsibility around water consumption and to increase passengers and staff knowledge about water, its consumption and their role in. its conservation is a key objective of the WATERNOMICS project. To achieve this target, the water information system will provide customized data to engage and encourage staff and passengers in implementing water conservation actions.

All these objectives will contribute both to increase awareness of considering water as a resource and to improve the Sustainability image of the Corporate with regards to their water consumption and water footprint.

Table 2-4: KPIs & User Requirements – Pilot Specific Objectives

No.	KPIs & User Requirements	Description	Origin	Related Objective
1	Incoming / outgoing water & wastewater volumes	A water balance is the start point to implement a water management system	D1.3 Appendix B - Top KPIs - LINATE	Improve Operation
2	Comparison of consumption with past periods (reduction or increase)	The ability to compare actual and past water consumption and report to senior management	D1.3 Appendix B - Top KPIs - LINATE	Increase awareness & Improve Operation
3	Comparison of consumption with future targets	The ability to compare actual and future water consumption to know the demand under future scenarios	D1.3 Appendix B - Top KPIs - LINATE	Increase awareness & Improve Operation
4	Comparison of consumption between different sections / sensors (difference)	The ability to compare water consumption for different sectors of the water network	D1.3 Appendix B - Top KPIs - LINATE	Educate Passengers/Staff by promoting environmental responsibility
5	Simulation of new pricing policies with seasonal variations	The ability to negotiate changes contract with the regional bodies responsible for water pricing and model flexible	D1.3 Appendix B - Top KPIs - LINATE	Increase awareness & Improve Operation
6	Simulation of new infrastructure effects	Development of an hydraulic model of the water network to help in decision making	D1.3 Appendix B - Top KPIs - LINATE	Improve Operation
7	Benchmarking new infrastructure effects	The ability to monitor and register the WEMs effects in the water network	D1.3 Appendix B - Top KPIs - LINATE	Improve Operation
8	Detection of leakages / faults	Relate water data to energy costs/impacts of running the system to detect anomalies	D1.3 Appendix B - Top KPIs - LINATE	Reduce Water consumption
9	Estimation of leakage / faults costs	The ability to relate faults and leakages with savings	D1.3 Appendix B - Top KPIs - LINATE	Reduce Water consumption

10	Benchmarking of repairs	Features related to planning and operation of physical water infrastructure	D1.3 Appendix B - Top KPIs - LINATE	Improve Operation

2.3 The WATERNOMICS Methodology at Linate Airport

This section outlines how the WATERNOMICS methodology has been applied to Linate airport to develop the pilot site plan.

2.3.1 Phase 0 - Assess

The goal of the “Assess” - phase is to determine whether or not an end user or decision maker should engage in the construct of a water management program, take water efficiency measures and/or implement a water information system. During this phase a decision making team should identify if a water management program can realistically be deployed and if so, what goals should be met and which strategy is the best to reach these goals.

The activities conducted and outlined in the text below, in this phase and indeed as will be presented for all pilots were:

1. Assess water context
2. Conduct a water audit
3. Select strategy, objectives and KPIs
4. Select Water Efficiency Measures

Assess Water Context

Earlier Project Reports, D1.1 and D1.2 described the water context at the Linate airport and the suitability of the environment for a water management program.

Moreover, from interviews and meetings conducted with the SEA corporate managers the key actions required in this pilot are to:

- implement a water mangement program that will lead to an overall water consumption reduction
- negotiates a change of contract type with the AMIACQUE (local water utility) to realize a payment for sewage based on the actual volumetric discharge (instead of the amounts taken from the wells)
- implement a water smart grid in the pilot to have real time data for decision making
- reduce leakages in the water network also by regulating the water pressure and identifying leakages

Conduct water audit

The aim is to provide end users with a detailed profile of their water use and system, allowing for more effective management of resources and improved reliability. In doing so partner SEA has made available documents of data, drawings, plans CAD files, and past analysis releated to the existing water network, its history, consumption patterns, use and maintenance. In particular, important information have been provided relating to the airport passengers, water and

wastewater networks, the wells, the existing buildings the users classified as “non SEA or Dealers” users and the general water managements system.

Users interview and physical inspections of the pilot have been conducted and several needs were identified such as:

- upgrade existing sensors with telemetry facility: data system transfer
- a simulation tool in case of failure to get data from metering sensors
- augmenting the actual physical description of the pilot with reasonable assumptions because the network has been constructed over a series of decades, with intermittent repairs and it has been identified that of the network are not accessible

Select strategy

Understanding the network and conducting site visits has in parallel helped shape the choice of the effective pilot area for the Linate Airport and the strategy to follow. This choice reflected the desire to also measure sewage flow.

Initially, one pilot ambition was to attain a global water balance for the entire airport property (measurement of all inputs and outputs). However, after mapping analyses and physical inspections it became apparent this was infeasible within the scope of the project due to:

- The complexity of sewage access points (in many cases they are junctions of multiple ingresses resulting in turbulent flow)
- In several cases there are water flow entrances into the sewage channel after the access points where measurement would be possible
- The construction of new access points in some cases would disrupt vehicle or aircraft traffic areas making intervention very challenging
- The best way to measure all sewage points would be at each exit / entrance to the water authority – but this is off the airport property and requires external permissions and long planning cycle. Initial inquiries for permission were not responded to and requests left open.

Given these constraints and considering the overall project budget, it was necessary to isolate and localize a selected segment of the airport water loop.

Since Linate Airport is a large-scale pilot, it was necessary to carry out the work in selected pilot areas (District meter Area n. 6 and Terminal Building area are presented in the paragraph 2.3.2 and detailed in D2.2) This strategy would enable overall WATERNOMICS and the Linate pilot objectives to be met but would also be within the aforementioned constraints.

Objectives and KPIs

In addition to the requirement to trial and validate the WATERNOMICS Methodology, the overall objectives in implementing a Water Management Program at the Linate pilot summarized in 2.2 above are presented below in terms of specific metrics.

The KPIs associated with these objectives are discussed below:

Awareness: A key indicator of the success of the Water Management Program and in particular the associated water information system would be realized by an increase in awareness of water consumption among staff at Linate pilot. This will be carried out by implementing the Water Information System for the corporate staff (Managers, Technicians, and Employees) and by implementing a questionnaire studies that will analyse water conservation awareness and self-reported behaviour among staff members. Questionnaires will be based principally on the New Human Interdependence Paradigm (NHIP) Scale (Corral-Verdugo et al. 2008) together with the work of Steg and de Groot (2010) in identifying personal norms.

By measuring water conservation awareness and self-reported behaviour in advance of the introduction of water management interventions at the Pilot Site, a baseline can be established. In addition, this baseline can be further validated by conducting the same measurements among a peer group where water management interventions will not be introduced or among the same group before implementing the water management interventions.

The questionnaire study will involve a minimum group of 10 staff members. By repeating the questionnaire study at intervals over Pilot Control Period, changes in awareness and self-reported behaviour should be perceptible.

Promote environmental responsibility and education: Education to passengers will be delivered by providing them with information about water consumption in simple, informative and visually appealing ways. The WATERNOMICS platform will leverage techniques such as gamification, metaphors, quiz game and sustainable tips on water consumption that will be displayed in 3 multimedia touch screen displays planned to be installed in Linate airport. To measure maximum impact data will be collected regarding the visits of users to such multimedia touch screen display and the interactions they have with the pieces of information (read, comment, share, etc.). Such data will inform improvements to the platform after initial implementation. Also the overall water consumption of one bathroom in the Terminal building will be monitored to support some possible changes in behaviour with physical measurement.

Education to staff members will be mainly delivered by providing them with information about water consumption, by comparison of consumption between different sections of the corporate enabling some level of competition and by reporting data in varying levels of detail depending on a staff members role within the corporate. As mentioned previously staff will be interviewed regarding the impacts of the platform and the numbers of visits and how staff interact with the platform will be measured.

Reduce water consumption: A key facility of the WATERNOMICS water information system will be the timely and accessible reporting of water consumption information and the associated energy usage. A reduction in the consumption of water through detection of leakages / faults and their associated costs will indicate a positive performance of the system.

***Water management and system operation*:** The provision of timely and relevant information regarding water usage and the water infrastructure will enable more efficient water management and system operation will lead to informed choices on the global water network.

In particular:

- a real time water balance will help to understand the water network problems
- comparison of consumption with past periods and with future targets
- the automatic detection and diagnosis of faults in the system will result in efficiencies in the time to identify and isolate faults in the system and to take remedial action
- benchmarking of repairs

Select Water Efficiency Measures (WEMs)

At Linate pilot, the planned WEMs are mostly Hardware and Educational based as described in Section 2.2.1 of D2.1. The proposed WEMs in general will include:

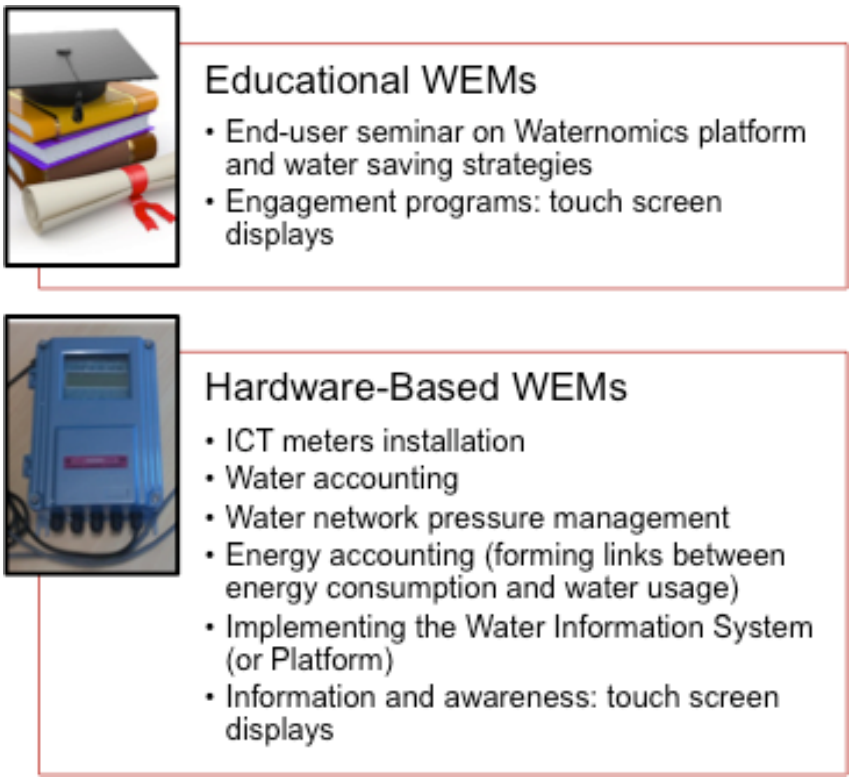


Figure 2-5: Linate pilot Suitable WEM Types

2.3.2 Phase 1 - Plan

The goal of the Plan Phase is to take all necessary actions to fully prepare WEMs for implementation. The activities that make up this phase are:

1. Develop baseline
2. Conduct water system modelling (if applicable)
3. Plan metering strategy
4. Select technology

Develop baseline

The results of the baselining analysis of water usage at the Linate pilot were presented in Section 2.1.

The baseline has been developed with water meter data recorded by the original metering infrastructure already existing in the Linate pilot.

The results of this baselining indicate a significant usage of water between some commercial users placed in Terminal building (Bars and Restaurants mainly) however the major water usage is associated with SEA corporate use. Moreover, also considering the old age and condition of the networks, even slight pressure spikes can create hydraulic problems (losses). As such, losses are a significant problem arising from the conditions of antiquated water mains. These losses are estimated to vary widely within networks and parts of networks.

Conduct water system modelling

The development of a model simulation of the water network is a necessity for Linate pilot. It is a helpful instrument both for the researchers and for SEA technicians. Such models can investigate

the possibility to reduce the current operating pressure of the network and how this will impact on all end-users. SEA technicians of the Maintenance and Design Departments will also have a tool that can, for example, evaluate the consequences of different set points in the water network (e.g. in the case of upgrading the network or of the expansion of the water network). The model is finalized in the geometry and it has to be implemented with the water demand pattern available after the meters installation in Linate pilot. In several cases underground inspections have been made to get better information about the existing water network.

Plan metering strategy

As mentioned previously, the final choice for the effective pilot area was to isolate one area of the water loop where it is possible to develop a local water balance and to augment this by metering the terminal building. In addition, these measurements plus selected others make a reasonable calibration of a hydraulic model of the entire airport network possible.

As result and as detailed explained in D2.2, the Linate Pilot effective pilot area is the following:

DMA6. One “water district” named DMA6 as shown in Figure 2-6. This metering plan also allows a simple extension of the concept in the future by isolating two additional DMAs (DMA5 and DMA7). DMA6 hosts a Freight building and other auxiliary buildings used for airport maintenance operations. DMA6 comprises 14 buildings with the freight building being the largest one. The freight building hosts offices and has approximately 300 users that work there daily.

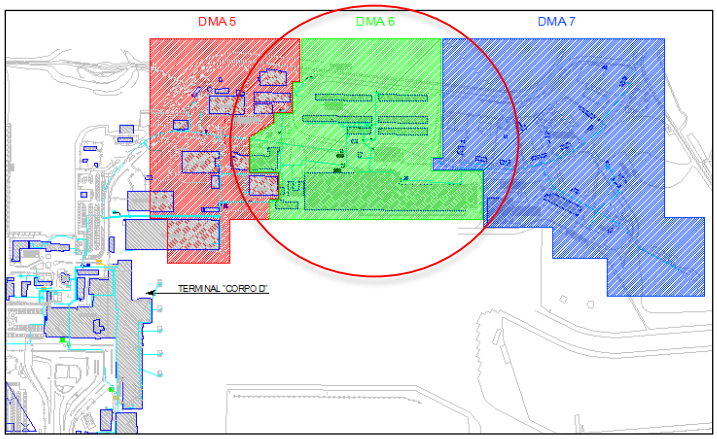


Figure 2-6: Three Proposed DMAs (District Meter Areas) at Linate.

(Figure 2-6 shows the three proposed DMAs that could be implemented in the future with the metering plan proposed. DMA6, shaded green, will be the effective pilot area for the global water balance.)

Terminal Building. This water metering area was selected to enable WATERNOMICS interact with airport terminal staff, passengers that use the terminal, and the shops and common areas that are located within it. The terminal building and its relation to the rest of the buildings and airport infrastructure is shown in Figure 2-7.

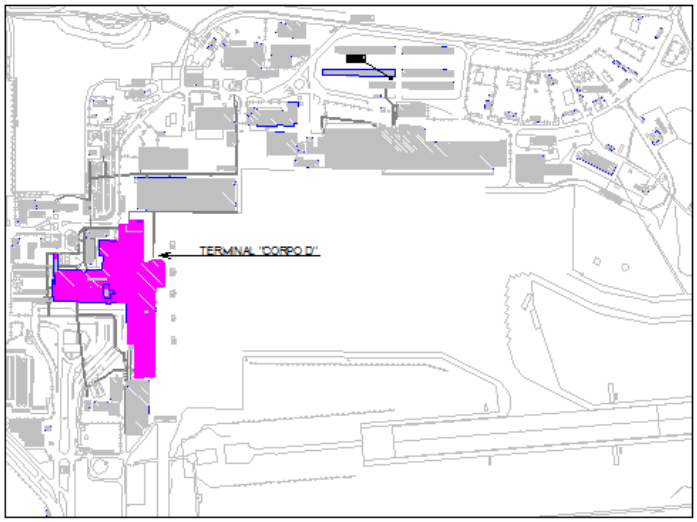


Figure 2-7: Terminal Building, the core of Linate Airport

The metering strategy for the Linate Pilot is discussed in detail in D2.2. Pilot Measurement Frameworks. The metering strategy reflects the concept of a minimal dataset as discussed in the WATERNOMICS Methodology Section 3.

Select technology

Leveraging the technologies inventory developed in D1.2 and cost benefit study in D2.2 and the Linate site characteristics a selection process identified the optimal technologies for measurement of potable water flow, pressure, wastewater flow measurement, groundwater level and energy consumed by pumps system measurement but also related to leak detection and water network pressure control in this pilot. In a pilot site such as that of Linate Airport the main requirements with regard to technology selection included:

- accuracy of the metering
- low maintenance and low costs of installation (cost-effective)
- easily installation
- minor or avoid flow interruption

Using the above criteria the suitable technologies were selected and these are described in detail in D2.2.

Moreover in order to understand the influence of WATERNOMICS project on users (passengers) behaviour three touch screen displays will be installed in Linate Airport to convey information about WATERNOMICS project, WATERNOMICS success and involving the users in improving their water consumption behaviour through video / tips / games.

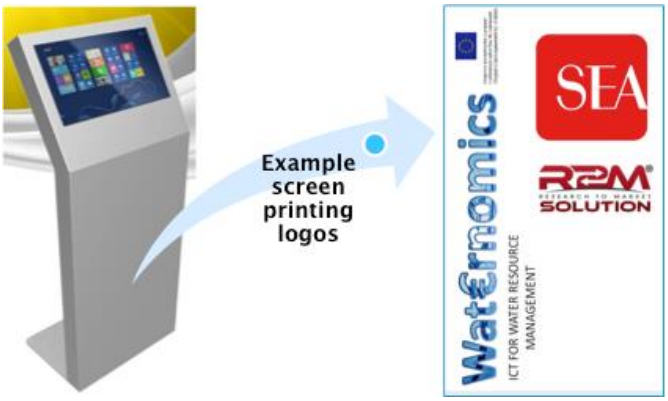


Figure 2-8: An example of touch screen display planned to be installed in Linate Airport

3 Pilot Plan Development - Pilot 2 Thermi

The Municipality of Thermi is situated in the eastern area of the prefecture of Thessaloniki (region of Central Macedonia), at a distance of 15 km from the metropolitan centre of Thessaloniki and 5 km from the 'MACEDONIA' airport. The Municipality of Thermi consists of 14 communities with Thermi being the seat of the Municipality, covering an area of 38.34 ha. The total population of the Municipality of Thermi, according to the 2011, census is 53,070 people but the actual population is now estimated at 70,000 people.

3.1 Pilot Site Overview

The main land use in the area is agriculture, however land use is changing with more land being dedicated to various types of buildings and infrastructure. Situated in close proximity to the Thessaloniki Urban Agglomeration (TUA), Thermi, while a rural area, has a strong developmental relationship with this urban area. It is a rapidly growing and economically viable zone, which is developed as a residential expansion of the TUA, but also as a pole for the location of industrial plants, tertiary sector activities and highly specialized services, maintaining, at the same time, the characteristics of a developed suburban agricultural economy.

At the south east part of the settlement there is a planned area of soft manufacturing activities which has as a natural separator, the stream and a green zone from. Finally, there are some large land property areas, such as the military installations, the airport, the American Farm School and the buildings of Aristotle University of Thessaloniki (AUTH), which cover a significant amount of land in the area.

For the pilot purpose a selection of 10 household has been made. Households were selected so that they represent a wide variety of types of houses and families in order to examine the effects in different types of domestic users.

Existing Water Infrastructure

The Municipality of Thermi is owner of Municipal Water and Sewerage Municipal (MWSM) of Thermi, a company with a total of 25,000 active water meters in place (December 2014) and an annual water consumption in the year 2014 to reach 3,307,000 m^3. The length of water supply network in all municipal departments is 1,200,000 m and sewerage 60,000 m. The supply of water to residents of the Municipality of Thermi is taken via an aquifer with 57 access points. Balance storage tanks with a capacity over 9,500 m^3 provide short term storage for the area.

All households selected are metered with water meters for different periods of time depending on when the buildings were built and when residents moved in them. The type of water meter installed varies among households depending on the year the installation was completed. These water meters are checked manually by the water utility to bill households for water usage in a quarterly interval.

None of the selected households have additional meters installed and the information regarding for their water use is provided only with their quarterly water bill.

Existing Water Usage Characteristics

Households include a wide variety of water uses that are usually encountered in domestic environments such as kitchen and bathroom taps, showers, toilet flushes, washing machines, dishwashers, boilers for heating water, etc. In some cases there are also uses of water for gardening and irrigation.

3.2 Pilot Specific Project Objectives

Figure 3-1 below summarizes the project objectives at Thermi.

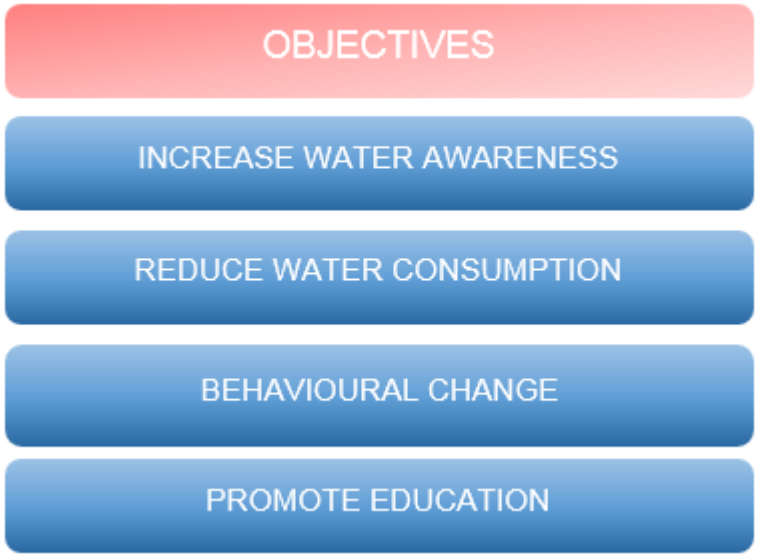


Figure 3-1: Thermi pilot specific objectives

Objectives

Increase Awareness of Water Consumption

To increase awareness of water consumption at households involving all members and effect behavioural change, in particular using ICTs, towards the consumption of water;

Educate Domestic Consumers about Water Consumption and their role in Conservation

To educate domestic consumers, the water information system will provide data to engage users by providing meaningful and actionable information and insights on their consumption.

Enable behaviour changes in water consumption

By increasing awareness of water consumption and educating users we also expect to achieve a third objective which is to enable and trigger behaviour changes in water consumption patterns.

Reduce Water Consumption and Energy

The behaviour change in turn is expected to lead to reduce of water consumption.

Having presented the pilot specific objectives the following table presents how these connect with the KPI's in terms of user requirements presented in D1.3.

Table 3-1: KPIs & User Requirements – Pilot Specific Objectives

	Description	Origin	Related Objective
Benchmarking / Water Footprints:	This included methods for comparing building or site water footprint against peers or industry norms (i.e. benchmarking).	D1.3 Table 1 KPI Summary	Awareness Water consumption
Budgeting / Forecasting / Planning:	The ability to use water pricing information to forecast spending under future scenarios, for the purpose of management and planning. This relates to forward projections, and the ability to forecast future consumption and cost based on past trends.	D1.3 Table 1 KPI Summary	Behaviour change Water consumption
Consumption / Quantity / Volume:	The ability to display water consumption information for various periods (e.g. total water volume consumed this month)	D1.3 Table 1 KPI Summary	Awareness Water consumption
Data Access:	Open access to water data (i.e. not proprietary 'closed' data models).	D1.3 Table 1 KPI Summary	Awareness
Economics / Costs:	The ability to relate water data to economics / cost information for the purpose of financial reporting.	D1.3 Table 1 KPI Summary	Awareness Behaviour change Water consumption
Energy:	The ability to equate water consumption data to equivalent information pertaining to the energy costs/impacts of running the system (e.g. pumping and heating energy costs, kWh & €).	D1.3 Table 1 KPI Summary	Awareness Education Behaviour change Water consumption
Environment:	The ability to infer environmental impact information from water consumption data (e.g. the carbon emissions related to water consumption, and thus the environmental impact of water/energy saving).	D1.3 Table 1 KPI Summary	Awareness Education Behaviour change Water consumption
Leaks / Faults:	The ability for the system to detect and alert the user to faults in the network automatically	D1.3 Table 1 KPI Summary	Awareness Water consumption

Water Quality:	Access to information pertaining to water quality (e.g. contaminants, pollutants).	D1.3 Table 1 KPI Summary	Awareness
Water Awareness:	General awareness of water consumption	D1.3 Table 1 KPI Summary	Awareness

3.3 The WATERNOMICS Methodology at Thermi

3.3.1 Phase 0 - Assess

Water Context

Earlier Project Reports, D1.1 and D1.2 described the water context for Thermi's domestic environment pilot. The major challenge in a domestic environment is to provide appropriate information about water consumption in a more timely fashion than the quarterly bills that currently exist so that people can assess and control their consumption.

Water Audit

The water audit carried out revealed that there all households use a common pattern in their network and similar usages in many cases. In particular all households are connected to the water utility network through a main water supply pipe which in its connection has a water meter used for billing water consumption. Moreover, water network inside the households included a variety of outlets but some of them are very common almost in household such as kitchen and bathroom taps, showers, washing machines and dishwashers. In some household cases water for irrigation of small gardens and cleaning of verandas was also parts of the water uses.

Select Strategy

For the Thermi pilot a Transformational strategy (see chapter 3.3 of Deliverable D2.1) was selected as the best fit. Domestic user tend to have subjective views of their water consumption as they do not have available a lot of information for their water consumption apart from the quarterly water bills. Therefore, the water consumption reality is formed based on the availability heuristics which relate with information that is easily available to them but might be incomplete or even misleading. Some examples of reasons that lead to this incomplete picture are:

- Domestic users might not be aware water is a scarce resource because of the area they live (which might not face a significant problem)
- Domestic users might not have context to compare their own water usage to
- Domestic users might not have easily accessible data
- Domestic users might have limited time and interest for the problem

That is why the transformational strategy was selected for the domestic environment pilot. So that users will receive objective data about their water usage consumption and initiate actions and changes based on that continuous sense-making and discovering of new futures and destinies. This continuous discovery and sense making can be helped by engagement strategies such as games and gamification elements. So the strategy is to change behaviour includes not only linking water consumption it to energy and water savings but also by making them more aware by giving them the opportunity to explore issues, in an exciting way, around water consumption

Objectives & KPIs

In addition to the requirement to trial and validate the WATERNOMICS Methodology, the overall objectives in implementing a Water Management Program at the Thermi pilot summarized in 2.2.4 above are presented below in terms of specific metrics.

The methodologies and tools to measure these objectives are discussed below and summarized in Table 3-2

***Awareness*:** A key indicator of the success of the Water Management Program and in particular the associated water information system would be realized by an increase in awareness of water consumption among domestic environment users. It is proposed that a questionnaire study be developed for the measurement of the water conservation awareness among household members. The questionnaire will be based principally on the New Human Interdependence Paradigm (NHIP) Scale (Corral-Verdugo et al. 2008) together with the work of Steg and de Groot (2010) in identifying personal norms.

By measuring water conservation awareness in advance of the introduction of water management interventions at the Pilot Site, a baseline will be established. In addition, this baseline can be further validated by conducting the same measurements among a peer group where water management interventions will not be introduced. This process is described further in Section 2.3.6 below.

The questionnaire study will involve a minimum group of 20 household members. By repeating the questionnaire study at intervals over Pilot Control Period, changes in awareness and self-reported behaviour should be perceptible. This process is described further in Section 2.3.6 below.

***Behaviour change*:** The results of the questionnaire will be further enhanced with results from focus groups that will be conducted at intervals over the Pilot Control Period in order to investigate furthermore changes in behaviour. Focus groups will help in identifying common patterns in behavioural changes and will also help to exchange behaviour changes that happened in different households so that they find application in other households as well.

***Education*:** Education to domestic users will be delivered by specific learning and news portal applications in the WATERNOMICS applications platform. Therefore to measure the effect of education we will collect data regarding the visits of users to such applications and the interactions they have with the pieces of information (read, comment, share, etc.)

***Water consumption*:** A key facility of the WATERNOMICS water information system will be the timely and accessible reporting of water consumption information. A reduction in the consumption of water in the Pilot Control Period will indicate a positive performance of the system.

Table 3-2: Methodologies and tools to measure impact of different objectives

	Questionnaires	Focus groups	Water consumption data	Web analytics data
Awareness	X	X		X
Behaviour change	X	X		
Education	X	X		X

Water consumption			X	
Water management and decision making		X	X	

Select Water Efficiency Measures (WEMs)

At Thermi pilot, the planned WEMs are mostly Hardware and Educational based as described in Section 2.2.1 of D2.1. The proposed WEMs in general are shown in Figure 3-2. However, some additional WEM's might also be implemented if households' owners decide so. For example some households based on the water accounting might select to replace equipment or perform retrofits in their installations.

Educational WEMs

- End-user seminars on Waternomics platform and water saving strategies
- In-school training

Hardware-Based WEMs

- Universal metering of total household consumption
- Water consumption accountability
- Information and education

Figure 3-2: Thermi pilot Suitable WEM Types

3.3.2 **Phase 1 - Plan**

Develop Baseline

To develop a baseline of consumption in the participant household, historical data from the water utility of Thermi for the specific households that date back to a minimum of 4 years depending on the household and the time the owners moved in, were collected

Moreover, since the water utility measurements were done over 6 and 4 month periods, households were given a form where pilot participants were asked to manually record their monthly usage based on their water meters (since M8 of WATERNOMICS).

Conduct Water System Modelling

Water system modelling was not carried out as part of this Planning Stage and is not central to this pilot.

Plan Metering Strategy

The metering strategy for the domestic environments of Thermi pilot is discussed in detail in D2.2. Pilot Measurement Frameworks. The metering strategy reflects the concept of a minimal dataset as discussed in the WATERNOMICS Methodology Section 3.

Select Technologies

The most significant factors in the selection of metering technologies for were the following:

- The requirement to minimize any invasive installation works;
- The cost of the metering;
- The significance for the user of the measurements for different measurement points; For a domestic user information about how much is the consumption in various outlets in the house is of less significance than the total consumption of the household which is measured by the water utility.
- Physical space to install the metering. Domestic users wanted to have sensors that do not take a lot of space when installed.

4 Developing the Pilot Plan - Pilot 3 NUI Galway

NUI Galway, is one of Ireland's National Universities, founded in 1845, it is ranked in the top 2% of universities in the world. Located in the city of Galway (population 70,000 approximately) on the west coast of Ireland, NUI Galway has more than 17,000 students and 2,500 staff.

4.1 Pilot Site Overview

The Engineering Building at NUI Galway is a state of the art educational facility designed to be a 'living laboratory' where the building itself is an interactive teaching tool. The Engineering Building opened in 2011, it is the largest engineering building in Ireland and includes lecture halls, classrooms, offices, laboratory facilities, a café, and showers and bathrooms.

Figure 4-1 NUI Galway Engineering Building

The building accommodates approximately 1,100 students and 100 staff in 14,000 m^2 of floor space on four floors. The majority of students are undergraduates aged 18-24 years.

Existing Water Infrastructure

The existing water infrastructure network at the Engineering Building is provided by a pressurised system of copper pipes supplied principally by a connection to the municipal mains water supply. A rainwater harvesting system which becomes the grey water supply (GWS) provides water for toilet flushing in the building.

The mains water supply (MWS) at the Engineering Building feeds both the cold water supply (CWS) and domestic hot water supply (DHW) as well as providing top-up to the rain water harvesting system.

At the time of its opening in 2011, twelve water meters were in place on the water system at the Engineering Building. Of these original twelve, eleven of which are now operating, all are connected to the Building Management System (BMS) allowing water flow data recorded by the meters to be stored and later retrieved for review and analysis.

The existing water meters are all in-line devices that record a pulse for every litre/cubic meter of water that pass through them. The data is collected by the BMS at 7.5 minute intervals.

Examples of the principal water uses from the different supplies are given below in Table 4-1.

Table 4-1: Principal Water Uses by Supply Type at NUIG Engineering Building

No.	Water Supply System	Example of Usage
1	CWS - Cold Water Supply	Potable Water at Water Fountains, Canteen, Laboratory Eye/Emergency Wash etc.
2	MWS - Mains Water Supply	Significant and varied usage: Laboratory Work, Bathroom Sinks, Showers, Canteen, Cleaning, Top-up
3	DHW – Domestic Hot Water supply	Bathroom Sinks, Showers, Canteen, Cleaning
4	GWS – Grey Water Supply	Bathrooms for Toilet Flushing

Existing Water Usage Characteristics

Table 4.2 below gives a global picture of water usage at the Engineering Building based on existing mains water metering over a 2 year period. The mains water information was recorded by the building's BMS system and indicates some variation in annual water usage between 2013 and 2014. Assessment work is ongoing to discover the cause of this increase in water usage and it is likely that it is linked to the commencement of a fault in the rainwater harvesting top up system as student and staff numbers at the building have remained relatively consistent over the 2-year period.

Although, the average monthly usage values given below do show consistently lower average water usage during the main out of academic period of June and July, than that recorded in the principal academic periods, a more significant difference was expected.

The initial water usage characteristic and baselining is limited by the amount and quality of BMS water meter data available at the Engineering Building. However following the installation of the additional water meters as part of the WATERNOMICS Project, a further period of baselining to establish more comprehensively the existing water usage baseline characteristics at the Pilot Site is proposed as part of the Pilot Plan. This is described later in Section 4.3.

Table 4-2: Monthly MWS Use in NUI Galway Engineering Building

Year	Average Monthly MWS Use Jan - Dec, Incl. (m^3)	Average Monthly MWS Use Excl. June & July (m^3)	Average Monthly MWS Use June & July Only (m^3)
2013	970 (265)	1036 (265)	638 (66)
2014	1014 (162)	1028 (162)	940 (20)

(Standard deviation shown in brackets)

4.2 Pilot Specific Project Objectives

At the outset of the WATERNOMICS Project, the Project Team identified a number of high level key outcomes to be achieved by implementing a Water Management Program at the NUIG Pilot site (Figure 4-2).

Figure 4-2 WATERNOMICS key outcomes

The key outcomes, given in the Figure above, formed the basis for the identification of four primary Project Specific Objectives summarised in Figure 4-3 below and described following.

Figure 4-3 Pilot Specific Objectives NUIG Engineering Building

Objectives

Increase Awareness

To increase awareness of water consumption at the NUIG Engineering Building, involve younger adults (17-24) in water issues and effect behavioural change, in particular using ICTs to increase awareness of water consumption;

Reduce Water Consumption

To reduce water consumption and save energy;

Improve Water Network Operation

To provide timely and relevant information regarding water usage and the water infrastructure to enable more efficient water management and system operation. The pilot will also demonstrate fault detection and diagnosis (FDD) systems e.g. FDD based around the rainwater harvesting systems and the potable water system, which have both been subject to faults that result in systems being offline or unnecessary costs for water in the building.

Promote Education

To promote educational activities around water consumption and to educate students and staff about water, its consumption and their role in it's conservation. To engage students in the issue of water consumption; the WATERNOMICS Platform will provide data to engage students in analytics, app development, research, etc.

The development of the Project Specific Objectives described above were further informed by the need to fully capture the Specific User and Functional Requirements and KPIs identified in D1.3 System Architecture and in particular the KPIs that are summarises in Table 4-3 below.

Table 4-3: KPIs & User Requirements – Pilot Specific Objectives

No	KPIs & User Requirements	Description	Origin	Related Pilot Specific Objective
1	Retention Time	Facility to help monitor & control the length of time potable water stays within the building's water system prevent the water stagnation its potential effects	D1.3 App. 6 Table B Top KPIs NUIG	Improve Operation
2	Data Access Events	Count metric to indicate us of the WIP and the demand for data on water usage	D1.3 App. 6 Table B Top KPIs NUIG	Promote Education
3	Benchmarking/ Foot printing	Methods for comparing building or site water footprint against peers or industry norms	D1.3 Table 1 KPI Summary	Improve Operation
4	Budgeting/Forecasting/ Planning	Use water pricing information to forecast spending under future scenarios	D1.3 Table 1 KPI Summary	Improve Operation
5	Consumption/ Quantity/ Volume	Display water consumption information for various periods	D1.3 Table 1 KPI Summary & D1.3	Reduce Consumption

			App. 6 Table B Top KPIs NUIG	
6	Data Access	Open access to water data (i.e. not proprietary 'closed' data models)	D1.3 Table 1 KPI Summary	Promote Education
7	Economics /Costs	Facility to relate water data to economics / cost information for the purpose of financial reporting	D1.3 Table 1 KPI Summary	Improve Operation
8	Energy	Facility to equate water consumption data and energy consumption, costs & impacts of running the system kWh & €	D1.3 Table 1 KPI Summary	Increase Awareness
9	Environment	Facility to equate he ability to infer environmental impact information from water consumption data	D1.3 Table 1 KPI Summary	Increase Awareness
10	Infrastructure	Features related to planning and operation of physical water infrastructure	D1.3 Table 1 KPI Summary	Improve Operation
11	Fault detection	Facility to detect and alert the user to faults in the network	D1.3 Table 1 KPI Summary	Improve Operation
12	Water Quality	Provide information re water quality (e.g. contaminants, pollutants).	D1.3 Table 1 KPI Summary	Improve Operation
13	Water Awareness	General awareness of water consumption.	D1.3 Table 1 KPI	Increase Awareness

4.3 The WATERNOMICS Methodology at NUI Galway

The following sections describe, in brief, the work carried out at the NUI Galway pilot site to develop the action plan or pilot site plan.

4.3.1 Phase 0 Assess

Water Context

Earlier Project Reports, D1.1 and D1.2 described the water context at the NUI Galway Engineering Building and the suitability of the environment for a water management program.

Water Audit

The water audit in the NUIG engineering building was carried out by identifying all of the known water inputs and uses at the building. Meter readings (for the academic year of 2013/2014, Sept-Aug) and reasonable assumptions were used to establish the volumes of water supplied at each system and utilised by the inputs and outputs respectively. The inputs and outputs were grouped and summed together to check whether they balanced accordingly. This purpose of this

assessment is to highlight any anomalies in the system by trying to account for the use of all of the water supplied. The water audit can identify errors that may otherwise be overlooked and could potentially result in distorted baselining at the next stage. It should be noted that a perfect water balance is rarely attainable and that a balance between water uses and sources of between 10 and 20% is deemed acceptable in most cases (US DOE, 2010).

Based on the principal water systems, corresponding usage described in Chapter 4.2 and the approach described above, the water audit concluded the following:

- The vast majority of the water usage within the building is from the CWS outlets. Potable MWS outlets contribute only ~7% to the overall usage in the building;
- Over half of the MWS usage is unaccounted for. The reason for this is not known, however this is not alarming considering how small of a contribution MWS usage is in the overall water usage in the building;
- The majority of the known CWS water usage can be attributes to the male showers, labs and female showers, while the hand wash sinks and café non-potable usage demand relatively little (~2%).
- Similarly to the case of the MWS flow quantity, over half of the CWS water usage is unaccounted for. This is more concerning than the MWS case however, as the CWS's 'lost' water is more than half of the building's overall water usage, although some of this is likely to be accounted for on further detailed assessment of cleaning activities etc.
- The water audit will be reassessed prior to final baselining when supplementary information provided by additional metering becomes available.

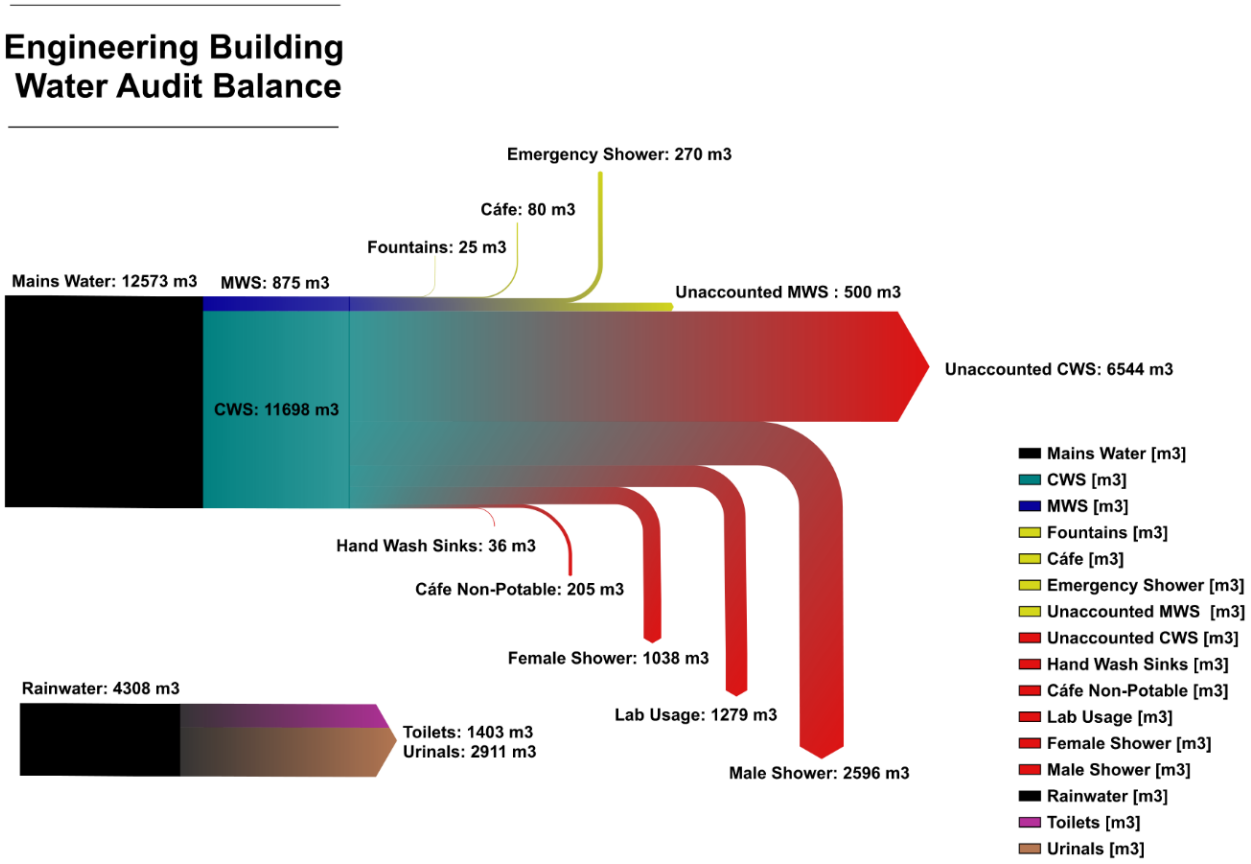


Figure 4-4 Sankey Diagram for NUIG Engineering Building - annual water flows (2013/2014)

Select Strategy

In keeping with the nature of the NUI Galway Engineering Building as an educational facility, a Learning Strategy (Boonstra, 2013) has been selected as an appropriate change strategy for implementation of a Water Management Program at the site and corresponding information system, D2.1 Section 3.3.

The Learning Strategy is defined as follows (Boonstra, 2013) - The idea behind the learning strategy is that people act on the basis of assumptions, emotions, feelings and almost unconscious patterns. Making people aware of these assumptions and patterns and making it possible to discuss the feelings create space for learning processes in which people change their behaviour. The underlying idea is that learning takes place in a cyclical process in which concrete experiences are followed by reflective observation of these experiences. These reflections are then analysed and incorporated in new concepts and frames of reality. It is about mental clearing of limiting beliefs and the creation of new images of reality.

Objectives & KPIs

In addition to the requirement to trial and validate the WATERNOMICS Methodology, the four key Project Specific Objectives in implementing a Water Management Program at the NUIG Engineering Building, were presented in Section 4.2 above.

These pilot specific objectives are further defined below in terms of the specific metrics that are proposed for assessing success of the project in meeting them.

Increase Awareness – A key indicator of the success of the Water Management Program and in particular the associated water information system would be realized by an increase in awareness of water consumption among staff and students at the NUIG Engineering Building. It is proposed that a questionnaire study be developed for the measurement of the water conservation awareness and self-reported behaviour among first-year engineering students at the NUIG Engineering Building. The questionnaire will be based principally on the New Human Interdependence Paradigm (NHIP) Scale (Corral-Verdugo et al. 2008) together with the work of Steg and de Groot (2010) in identifying personal norms.

By measuring water conservation awareness and self-reported behaviour in advance of the introduction of water management interventions at the Pilot Site, a baseline can be established. In addition, this baseline can be further validated by conducting the same measurements among a peer group where water management interventions will not be introduced. This process is described further in Section 4.3.2 below.

The questionnaire study will involve a minimum group of 50 first-year students. By repeating the questionnaire study at intervals over Pilot Control Period, changes in awareness and self-reported behaviour should be perceptible. This process is described further in Section 4.3.2 below.

Reduce Water Consumption – A key facility of the WATERNOMICS water information system will be the timely and accessible reporting of water consumption information and the associated energy usage. A reduction in the consumption of water in the Pilot Control Period will indicate a positive performance of the system.

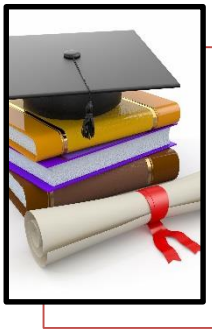
Promote Education - Item 2 from Table 4-3 above lists Data Access Events will provide data on how often and by whom (i.e. student, staff or public) data from the water information is accessed. At present, water information is distributed by BMS administrators as required to students for particular research purposes. An increase over the Pilot Control Period in undergraduate and other research and or development projects that use information from the Water Information System will indicate a positive performance of in terms of Education.

Improve Water Network operation – The provision of timely and relevant information regarding water usage and the water infrastructure will enable more efficient water management and system operation. In particular, the automatic detection and diagnosis of faults in the system will result in

efficiencies in the time to identify and isolate faults in the system and to take remedial action. Non – critical faults, or those without immediate and obvious consequences, in the water system are often only identified by increased billing volumes that are issued quarterly. Of particular concern in the Engineering Building are excessive residence times of potable water that can have serious health implications, there is currently no indicator on the system that residence times are being exceeded. A reduction in time to identify faults will indicate a positive performance of the system.

Select Water Efficiency Measures (WEMs)

At the NUIG Engineering Building, Educational and Hardware-based WEMs (as described in Section 2.2.1 of D2.1) were identified as being suitable for implementation. Figure 4-5 below lists the specific measures proposed related to the WEM type.



Educational WEMs

- Dissemination Programs
- Educational Programs
- Engagement Programs
- Information Kiosks

Hardware-Based WEMs

- Additional Metering
- Implement Water Information Platform
- Physical Intervention Demonstrations

Figure 4-5 NUIG Engineering Building Suitable WEM Types

4.3.2 Phase 1 - Plan

Develop Baseline

The results of very early baselining analysis of water usage at the Engineering Building are presented above in Section 4.1. A more detailed baselining study was also carried out on the existing water network data for the 2013 and 2014 periods.

Water meter data recorded by the original metering infrastructure was retrieved from the building's BMS system and analysed to provide initial baselining information. The operational meters used to provide data for baselining are listed in Table 4-4 below. The data reported from each meter is available from the BMS database as hourly, daily, weekly and monthly usage.

Table 4-4: Existing Water Meters Providing Baselining Data

No.	Water meter Ref. and Supply	Water Usage Description Measurement	Units
1	MR.WM.001_MW MWS	All mains water supplied to the building	m^3
2	MR.WM.002_CW CWS	All cold water supplied to the building	m^3
3	FL.WM.GW GWS	Rain water pumped to storage tanks for the Rainwater Harvesting System	L
4	Canteen MWS1	The mains (Potable) water for use in the Canteen	L
5	Water Fountain MWS2	A small water fountain on the ground floor east corridor of the building	L
6	Ladies Hand Wash CWS1	All cold water for sinks in the Ladies ground floor east corridor toilet block	L
7	Ladies Hand Wash HWS1	Water Usage Description Measurement	L
8	Men's Hand Wash CWS2	All cold water for sinks in the Ladies ground floor east corridor toilet block	L
9	Ladies RWP RWP1	All water used for toilet flushing in the Ladies ground floor east corridors toilet block	L
10	Men's RWP RWP2	All water used for toilet flushing in the Ladies ground floor east corridors toilet block	L

The results of this more detailed baselining do not indicate the significant reduction (i.e. ~60%) in mains water usage between the academic periods and non-academic periods that was expected at the project outset. The results of more detailed baselining, based on average daily usage for academic and non-academic week-day and week-end periods indicate only a 30% reduction in average daily mains water usage between academic periods and non-academic period, indicating potential faults with the existing water infrastructure or indeed the metering infrastructure. The proposed metering to be implemented as part of the WATERNOMICS project will validate these early diagnosis and provide confidence in the baselining.

In addition, the detailed analysis highlighted the limitations of some of the existing BMS data recording mechanisms, in particular with respect to low flow volume devices i.e. the reporting resolution of the BMS connected water meters is such that a pulse is only recorded when a litre / cubic meter of water is used, thus for many low volume usage devices (drinking fountain, bathroom sink) extended periods may register on the system as 'zero' usage while the minimum pulse unit is accumulated.

However, from the initial baselining work, potential inefficiencies and/or faults in the following aspects of the Engineering Building water system have been identified:

- The Rain Water Harvesting System (RWHS);
- The Domestic Hot Water System (DHWS) and its interaction with the solar panels;

- Shower usage and the potential for smart metering in the building

These elements are the subject of further assessment and have been identified for particular consideration and are being used to develop rule-based and model-based FDD for water systems as described in the WATERNOMICS DOW (Waternomics, 2013).

The conclusion of the initial baselining is that validation of the metering data is required as well as an additional period of baselining following the installation of new meters.

Conduct Water System Modelling

Water system modelling was not carried out as part of this Planning Stage for the NUI Galway Pilot Site.

Plan Metering Strategy

The metering strategy for the NUIG Engineering Building is discussed in detail in D2.2. Pilot Measurement Frameworks. The metering strategy reflects the concept of a minimal dataset as discussed in the WATERNOMICS Methodology Section 3. The metering plan for the NUIG Pilot site is listed in Chapter 8 of this report for reference. The data reported from each meter will be available as hourly, daily, weekly and monthly usage.

Select Technologies

The proposed metering selected for installation at the NUI Galway Pilot are

- Small-size in-line pulse flowmeter
- VTEC Ultrasonic Flowmeter UFM-TM/TS

The most significant factors in the selection of metering technologies for were the following:

- The requirement to minimize any invasive installation works;
- The cost of the metering;
- The development of innovative low-cost ultrasonic flow metering by the project team.

Figure 4-6 In-line pulse Flowmeter

Figure 4-7 VTEC Ultrasonic Flowmeter

5 Developing the Pilot Plan - Pilot 4 Coláiste na Coiribe

Coláiste na Coiribe is an Irish language secondary school with approximately 350 students and 25 teaching and administrative staff. The existing school is housed at a small city centre location. To facilitate the demand for places at the school and to address space pressures, a new 7,400 m^2 school is currently construction at a new sub-urban location in Galway.

Figure 5-1 Coláiste na Coiribe Pilot Site

5.1 Pilot Site Overview

This new school building is WATERNOMICS Pilot 4. It will accommodate up to 720 students (aged 12-18) and include classrooms, offices, sports halls and associated toilet and shower facilities. As the school was identified as a suitable Pilot Site at the early stages of construction it provided an opportunity for the WATERNOMICS Project Team at NUIG to engage with the designers and contractors in the deciding on the provision of water metering and water information infrastructure for the building. In addition, it provides a unique opportunity to monitor this new building from the beginning of its occupation.

The new school building will open in October 2015, it will facilitate engagement with students at an early age regarding water consumption behaviour. Furthermore these students can test and give feedback to the project on how the platform functions in communication complex water-related data to a wider audience. Indeed it is expected collaboration between the school and the WATERNOMICS team will result in students actively developing inputs to the project (e.g. user interface design, apps etc.). The school management also face key budgetary and conservation targets; to date reporting on water and associated energy consumption has been limited or not possible. The pilot will also inform future design of similar buildings with particular focus on water conservation measures and rainwater harvesting systems

Existing Water Infrastructure

The water system at the Coláiste na Coiribe Pilot site is fed primarily from a single municipal connection, the mains water supply, located in the school's plant room. This also feeds a 6,000 litre cold water storage tank in the attic area which is the cold water supply. The cold water supply also feeds the domestic hot water system to allow hot water for handwashing and showers etc. Water is also collected from roof areas and other hard-standings and collected via a gravity system before being pumped to a 9,000 litre grey water storage tank, the grey water supply, located adjacent to the cold water tank also in the attic area of the building.

The water level in both the grey water and cold water storage tanks are controlled by level sensors. The grey water storage tank has a secondary mains water feed that is activated only when grey water from the rainwater harvesting system is unavailable i.e. after period of dry weather. However this secondary supply system is controlled by solenoid valve only providing water to a minimum level under secondary supply conditions.

Examples of the main water uses of the different water supplies at Coláiste na Coiribe are given in Table 5-1.

Table 5-1: Principal Water Uses by Supply Type at Coláiste na Coiribe

No.	Water Supply	Example of Usage
1	CWS - Cold Water Supply	Significant and varied usage: Laboratory Work, Bathroom Sinks, Showers, Staff Kitchen, Cleaning, Rainwater Top-up, Practical Rooms
2	MWS - Mains Water Supply	Potable Water at Water Fountains, Staff Kitchen, Home Economics & other Practical Rooms, Laboratory Eye/Emergency Wash etc.
3	DHW – Domestic Hot Water supply	Bathroom Sinks, Showers, Canteen, Cleaning, Staff Kitchen,
4	GWS – Grey Water Supply	Bathrooms for Toilet Flushing

Existing Water Usage Characteristics

Water usage at Coláiste na Coiribe will vary significantly over the academic year. Secondary schools in Ireland are required to be open a total of 167 days in an academic year which commences at the beginning of September. Water usage obviously declines to a minimum for a prolonged period during the summer holiday period June to August, inclusive. A transitional period will occur in June when state exams for approximately 40% of students (i.e. 3rd years and 6th years) are held. Other standard secondary school holiday periods are typically as follows:

- October mid-term: Commencing end of October for 1 week
- Christmas Break: Commencing third-quarter of December for 2.5 weeks
- February mid-term: Commencing third-quarter of February for 1 week
- Easter Break: Commencing end of March for 2 weeks
- Summer Break: Commencing end of May for 3 months

Water usage will also vary over the school day with classes starting at 09:00 each day and finishing at 15:30 generally.

The primary usage of water at the Coláiste na Coiribe Pilot is expected to be from the CWS and GWS for bathrooms.

5.2 Pilot Specific Project Objectives

The high level key outcomes to be achieved by implementing a Water Management Program at the Coláiste na Coiribe Pilot site are as indicated in Section 4.2 for the NUIG Pilot Site. The high level key outcomes were transferred to the Project Specific Objectives for the Coláiste na Coiribe Pilot Site which are also in line with those for the NUIG pilot. The Coláiste na Coiribe pilot specific Objectives are summarised in the Figure 5-2 below and described following.

Figure 5-2 Pilot Specific Objectives at Coláiste na Coiribe

Objectives

Increase Awareness

To increase awareness of water consumption at the school, involve a younger audience (12-18 years) in water issues and effect behavioural change, in particular using ICTs increase awareness of water consumption;

Reduce Water Consumption

To reduce water consumption and save energy at the school;

Improve Water Network Operation

To provide timely and relevant information regarding water usage and the water infrastructure to enable more efficient water management and system operation;

Promote Education

To promote education activities around water consumption and to educate students and staff about Water, its consumption and their role in it's conservation. The water information system will provide data to engage students in analytics, app development, research, etc.

The development of the Project Specific Objectives described above were further informed by the need to fully capture the Specific User and Functional Requirements and KPIs identified in D1.3 System Architecture and KPIs. Table 5-2 below summarises the KPIs and Requirements identified for the Coláiste na Coiribe Pilot Site and links each of these to a Project Specific Objective.

Table 5-2: KPIs & User Requirements – Pilot Specific Objectives

No	KPIs & Requirements	Description	Origin	Related Objective
1	Data Access Events	Count metric to indicate the demand for data on water usage	D1.3 App. B Table 7 Top KPIs CnaC	Promote Education
2	Benchmarking/ Foot printing	Methods for comparing building or site water footprint against peers or industry norms	D1.3 Table 1 KPI Summary D1.3 App. B Table 7 Top KPIs CnaC	Improve Operation
3	Budgeting/Forecasting/ Planning	Use water pricing information to forecast spending under future scenarios	D1.3 Table 1 KPI Summary	Improve Operation
4	Consumption/ Quantity/ Volume	Display water consumption information for various periods	D1.3 Table 1 KPI Summary & D1.3 App. B Table 7 Top KPIs CnaC	Reduce Consumption
5	Control/System Optimisation	Facility to take historic water consumption data and system profile information to optimise the overall system operation efficiency	D1.3 Table 1 KPI Summary D1.3 App. B Table 7 Top KPIs CnaC	Improve Operation
6	Data Access	Open access to water data (i.e. not proprietary 'closed' data models)	D1.3 Table 1 KPI Summary	Promote Education
7	Economics /Costs	Facility to relate water data to economics / cost information for the purpose of financial reporting	D1.3 Table 1 KPI Summary	Improve Operation
8	Energy	Facility to equate water consumption data and energy consumption, costs & impacts of running the system kWh & €	D1.3 Table 1 KPI Summary	Improve Operation
9	Environment	Facility to equate he ability to infer environmental impact information from water consumption data	D1.3 Table 1 KPI Summary	Increase Awareness
10	Infrastructure	Features related to planning and operation of physical water infrastructure	D1.3 Table 1 KPI Summary	Improve Operation
11	Leaks/Faults	Facility to detect and alert the user to faults in the network	D1.3 Table 1 KPI Summary	Improve Operation
12	Water Quality	Provide information re water quality (e.g. contaminants, pollutants).	D1.3 Table 1 KPI Summary	Improve Operation

13	Water Awareness	General awareness of water consumption.	D1.3 Table 1 KPI	Increase Awareness Reduce Consumption

5.3 The WATERNOMICS Methodology Coláiste na Coiribe

5.3.1 Phase 0 - Assess

Water Context

As described in Section 1 of this Report, the new Coláiste na Coiribe School Building will be opened in October 2015. Early engagement with staff at the school confirmed their interest in the implementation of measures to monitor, control and compare water and energy consumption activities at the new school building. In addition to optimising system operation of the system and use of the available data as to compliment and facilitate educational activities was a key motivation for the involvement of Coláiste na Coiribe in engaging with the WATERNOMICS Platform and the involve Earlier Project Reports, D1.1 and D1.2 described the water context at the NUIG Engineering Building and the suitability of the environment for a water management program.

Water Audit

The whole school building will be the subject of the water use/consumption study. The water infrastructure at Coláiste na Coiribe Pilot Site is as described above with a single mains water connection fed from the municipal supply being the primary water source to the building and a grey water supply from the rain water harvesting system providing water to bathrooms for flushing. The primary water use in the building is likely to be at the bathrooms.

Select Strategy

In keeping with the nature of the Coláiste na Coiribe Pilot as an educational facility, a Learning Strategy (Boonstra, 2013) has been selected as an appropriate change strategy for implementation of a Water Management Program and corresponding information system, D2.1 Section 3.3. The Learning Strategy is defined in Section 4.3.1 above.

Objectives & KPIs

In addition to the requirement to trial and validate the WATERNOMICS Methodology, the four key Project Specific Objectives in implementing a Water Management Program at the Coláiste na Coiribe Pilot, were presented in Section 5.2 above.

These pilot specific objectives are described below in terms of the specific metrics for that will be used for assessing success of the project in meeting these objectives.

Increase Awareness – A key indicator of the success of the Water Management Program and in particular the associated water information system would be realized by an increase in awareness of water consumption among staff and students at the School Building. It is proposed that a questionnaire study be developed for the measurement of the water conservation awareness and self-reported behaviour among students at School. The questionnaire will be similar to that developed for the NUIG Pilot Site and based principally on the New Human Interdependence Paradigm (NHIP) Scale (Corral-Verdugo et al. 2008) together with the work of Steg and de Groot (2010) in identifying personal norms.

By measuring water conservation awareness and self-reported behaviour in advance of the introduction of water management interventions or water efficiency measures at the Pilot Site, an 'Awareness' baseline can be established. In addition, this baseline can be further validated by conducting the same measurements among a peer group from a similar school where water management interventions will not be introduced.

The questionnaire study will involve a minimum group of 50 students from a variety of classes. By repeating the questionnaire study at intervals over Pilot Control Period, changes in awareness and self-reported behaviour should be perceptible. This process is described further in Section 5.3.2 below.

Reduce Water consumption – A key feature of the WATERNOMICS Information System is the timely, accessible and detailed reporting of water consumption information and the associated energy usage. A reduction in the consumption of water and therefore energy in the Pilot Control Period will indicate a positive performance of the system.

Improve Water Network Operation – The provision of timely, relevant and detailed information regarding water usage and the water infrastructure will enable more efficient water management and system operation. In particular, the automatic detection and diagnosis of faults in the system will result in efficiencies in the time to identify and isolate faults in the system and to take remedial action. Non – critical faults, or those without immediate and obvious consequences, in the water system are often only identified by increased billing volumes that are issued quarterly. A reduction in time to identify faults will indicate a positive performance of the system.

Promote Education - Item 1 from Table 5-2 above lists Data Access Events as a KPI & System requirement. This will provide data on how often and by whom (i.e. student, staff or public) data from the water information system is accessed. Following an initial baselining period and dissemination regarding the WATERNOMICS Platform, an initial increase followed by sustained activity over the Pilot Control Period in school projects that use information from the Water Information System will indicate a positive performance of in terms of Education.

Select Water Efficiency Measures (WEMs)

At Coláiste na Coiribe, the following types of Educational and Hardware-based WEMs (as described in Section 2.2.1 of D2.1) were identified as being suitable for implementation see Figure 5-3 below.

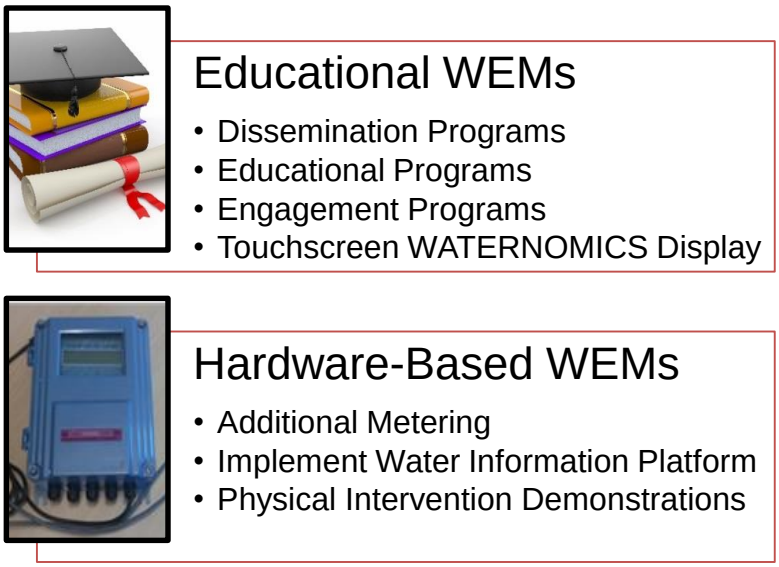


Figure 5-3 Coláiste na Coiribe Suitable WEM Types

5.3.2 Phase 1 - Plan

Develop Baseline

In total 14 water meters will be installed at the new Coláiste na Coiribe School building these will be connected to the in-house Building's Cylon (www.cylon.com). The meters will record, hourly, daily, monthly and cumulative water usage in litres or cubic meters. A baselining period will commence from the time of opening of the building in October 2015 to January 2015.

It is likely that the baselining period will identify the limitations of some of the BMS-type data recording mechanisms in particular with respect to low volume devices i.e. the reporting resolution of the BMS connected water meters is such that a pulse is only recorded when a litre / cubic meter of water is used, thus for many low volume usage devices (drinking fountain, bathroom sink) extended periods may register on the system as 'zero' usage while the minimum pulse unit is accumulated.

The baselining period will provide data showing typical trends in water usage at the new school building.

Conduct Water System Modelling

Water system modelling was not carried out as part of this Planning Stage.

Plan Metering Strategy

The metering strategy for the Coláiste na Coiribe Pilot Site is discussed in detail in D2.2. Pilot Measurement Frameworks. The metering strategy reflects the concept of a minimal dataset as discussed in the WATERNOMICS Methodology Section 3. The metering plan for the pilot site is listed in Chapter 9 of this report for reference. The data reported from each meter will be available as hourly, daily, weekly and monthly usage.

Select Technologies

The most significant factors in the selection of metering technologies for the Coláiste na Coiribe Pilot were the following:

- Compatibility with the detailed Mechanical and Electrical Tendered Design;
- The cost of the metering;

6 The Pilot Plan – Linate Airport

The WEMs to be introduced at the Linate pilot are presented in the next paragraphs in chronological order.

WEM 1: Installation of sensors

Description: Water / energy and pressure sensors will be installed in the pilot site according to the implemented physical measurement framework (metering plan above mentioned) and initial tests will be conducted for ensuring the proper functioning and data collection from them.

Related Objectives: Awareness, Water consumption, Improve water management

Responsibility: SEA will be responsible for the installation works

Deadline: Sensors will be installed between M21 and M24.

WEM 2: Installation of touch screen display

Description: Three touch screen displays will be installed in the pilot site in order to understand the influence of WATERNOMICS project on users (passengers). The screens will convey information about WATERNOMICS project, WATERNOMICS success and involving the users in improving their water consumption behaviour through video / tips / games.

Related Objectives: Awareness, Promote education and environmental responsibility

Responsibility: R2M and SEA will be responsible for display acquisition and installation works. Ultra4 will develop the application to be installed in the touch screen displays

Deadline: Touch screen displays will be installed between M21 and M24.

WEM 3: Implementing the WATER Information System (WATERNOMICS Platform)

Description: the platform introduction will be accompanied with the introduction of the first set of applications relating to monitoring consumption through graphing and reporting components.

Related Objectives: Awareness, Water consumption, Improve water management

Responsibility: Ultra4 will be responsible for installing and implementing the WIS.

Deadline: The overall applications platform will be introduced in M25.

WEM 4: Introduction of WATERNOMICS Learning Applications

Description: The introduction of end-users to learning applications will be conducted through a series of meetings and will be targeted to them introducing the new applications through specifically developed presentations.

Related Objectives: Awareness, Promote education and environmental responsibility, Water consumption, Improve water management

Responsibility: Ultra4 is responsible for the development of the Learning applications while R2M and SEA will be responsible for providing the training among the end-users.

Deadline: The learning applications will be introduced in M26.

Review: The effect of the learning applications will be reviewed in M28 and in M33 after its introduction

WEM 5: Introduction of WATERNOMICS Exploration Applications

Description: Exploration applications such as prediction services, comparison watches and applications that help users explore and benchmark specific scenarios or enforced measures. Similarly to Learning applications this set of applications will be introduced via presentation to end-users.

Related Objectives: Awareness, Water consumption, Improve water management

Responsibility: Ultra4 is responsible for the development of the Exploration applications while R2M and SEA will be responsible for providing the training among the end-users.

Deadline: The exploration applications will be introduced in M28.

Review: The effect of the exploration applications will be reviewed in M30 and in M33 after its introduction

WEM 6: Open End-user WATERNOMICS seminar

Description: An open end-user seminar will be organised in the last set of WEMs in M30. The open end-user seminar allow the end-users of the WATERNOMICS project to share their experience. For example large businesses of the wider municipality area will be invited to learn from the experiences in the Linate airport pilot and school teachers will be invited to learn from the experiences in the NEB and Coláiste na Coiribe pilots.

Related Objectives: Awareness, Promote education and environmental responsibility, Water consumption, Improve water management

Responsibility: R2M and SEA will be responsible for organising the End-user seminar while all partners will contribute with presentations and content for it.

Deadline: The open end-user seminar will be conducted in M30.

Review: The effect of the open end-user seminar will be reviewed at the end of its running period (M30).

The following table summarize the specific relationship between the aforementioned WEMs and the Linate pilot specific objectives.

Table 6-1: Relation between objectives and specific WEMs

	WEM 1	WEM 2	WEM 3	WEM 4	WEM 5	WEM 6
Awareness	X	X	X	X	X	X
Reduce water / Energy consumption	X		X	X	X	X
Improve water management and decision making	X		X	X	X	X
Promote environmental responsibility and education		X		X		X

6.1 WEM Dissemination activities at Linate Pilot

The Table below summarises the dissemination activities associated with the proposed efficiency measures described in the pilot plan.

Table 6-2: Dissemination activities and WEMs for Linate Pilot

No	WEM Ref.	Specific Dissemination Result	Month	Targeted audience			
				Corporate Staff	Managers	Operational Staff	Passengers
01	WEM 1	Sensors installation will improve the knowledge of the water network among internal users	M24	x	x	x	
02	WEM 2	Familiarize passengers with the Waternomics targets	M24				x
03	WEM 3	Familiarize Managers and operational people with the Waternomics information platform	M25	x	x	x	
04	WEM 4	Familiarize end-users with learning applications	M26	x	x	x	
05	WEM 5	Familiarize users with exploration applications	M28	x	x	x	
06	WEM 6	Promote the exchange of experience between end users	M30	x	x	x	

6.2 Implementing the Pilot Plan Phase 2 – Do

This chapter details the implementation plan for the Linate pilot - i.e. the "DO" phase of the WATERNOMICS methodology. At the moment the project is aligned with the WATERNOMICS Gantt as showed in Figure 6-1 below.

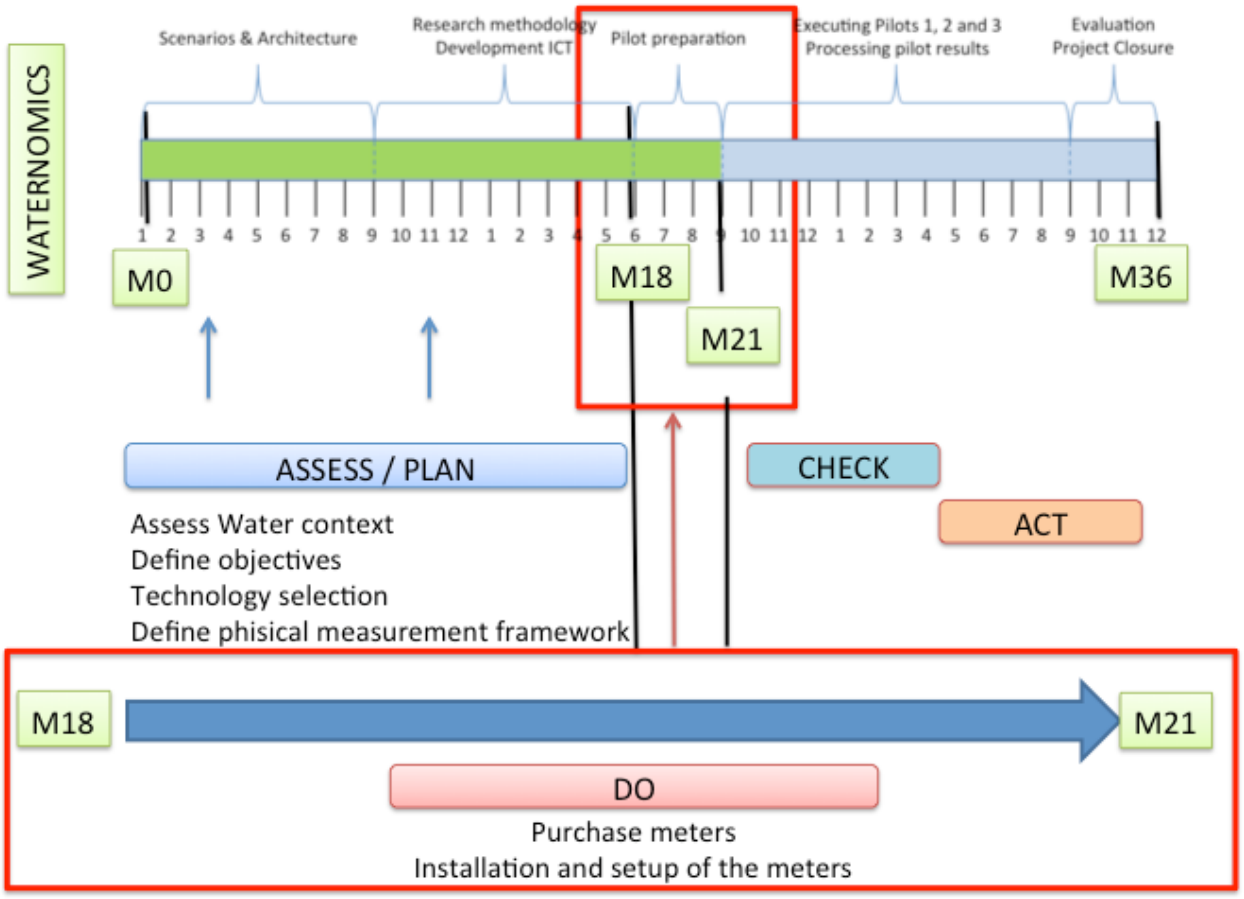


Figure 6-1: Linate Airport WATERNOMICS Methodology Phase 2 Do

This phase executes previous planning activities and begins the data collection for charting and analysis in the following "CHECK" and "ACT" steps. It consists of the following activities:

- Meter installation and configuration
- Efficiency measure implementation
- Data collection
- Water information system deployment
- Staff training

Meter Installation and Configuration

With the metering plan in place (D2.2) and the metering objectives clear the purchasing and installation phases of the required sensors can take place.

For the Linate pilot, the purchasing must follow a specific administrative process and a public tender issued. The public tender has been drafted, approved and published. Selection of the vendor will be executed in November 2015 installation work will start in December 2015.

Concurrently, one of the five Ultrasonic Meters as proposed in Project Report D2.2 Measurement Frameworks, will be installed before the public tender is executed and after the implementation

of the necessary changes to make it become a stand-alone powered sensor. Other Ultrasonic flow meters cannot be installed because the installation requires additional building works (power line, LAN line, etc.) and these works are all included in the tender budget.

The physical installation work of the first Ultrasonic meters will be carried out by R2M in collaboration with SEA technicians, while the other Ultrasonic meters will be installed also with the help of VTEC.

Efficiency Measurement Implementation

Efficiency measurement implementation begins in parallel with metering installation and/or the availability of data from portable or fixed measurements.

The overall installation configuration of the meters will allow delineating the baseline from the reporting period and with it will also start the process of data collection and data management to have real time information about the water network. The data captured from the water meters represent important information both for managers / maintenance technicians in order to have a solid basis for decisions support and for employees and Airport users to have knowledge about water consumption to lead a change in behaviour with regard of water resource.

The efficiency measure implementation will involve the installation of hardware (infrastructure upgrade), implementation of software (such as the WATERNOMICS Information System), commencement of awareness campaigns or any combination of activities as driven by the selected WEMs in the assessment phase.

Data Collection

In Linate Pilot are planned to be installed different kind of meters to measure the water flow:

- Electromagnetic flow meters
- Open channel flow meters (Raven Eye)
- Ultrasonic flow meters

A method to transmit the measurement data and a way to create a database is necessary in implementing the installation phase. This section aims to explain the different kind of system data transfer planned for Linate Pilot. We have two kinds of system data transfer setup and they are not function of the kind of measure to implement but of the different kind of technologies used to get measurement. So we will setup:

- a system data transfer for the electromagnetic flow meters based on the combination of a GPRS module and of a Web data cloud controlled by SEA
- a system data transfer for ultrasonic flow meters and open channel flow meter based on the BeagleBone Black board equipped with a GPRS module.

Both the system will send the measurement data to a web cloud controlled by SEA (for example ISOD@M or any other server propriety of SEA) and from this cloud the data will be sent to the Amazon Web Sevice cloud and made available for the WATERNOMICS Platform and end users.

System data Transfer for Electromagnetic flow meters

Electromagnetic flow meters will be equipped with a GPRS module named “ML255 FLOWIZ™ Next” battery operated. This system data transfer doesn’t require power in place.

The characteristics of FLOWIZ™ Next is the wide range of new features all integrated in one single housing: flow and pressure measuring modules, data logger, batteries, main power supply and 4-bands GPRS modem. In the accompanying figures an overview of the proposed system and its advantages are provided.

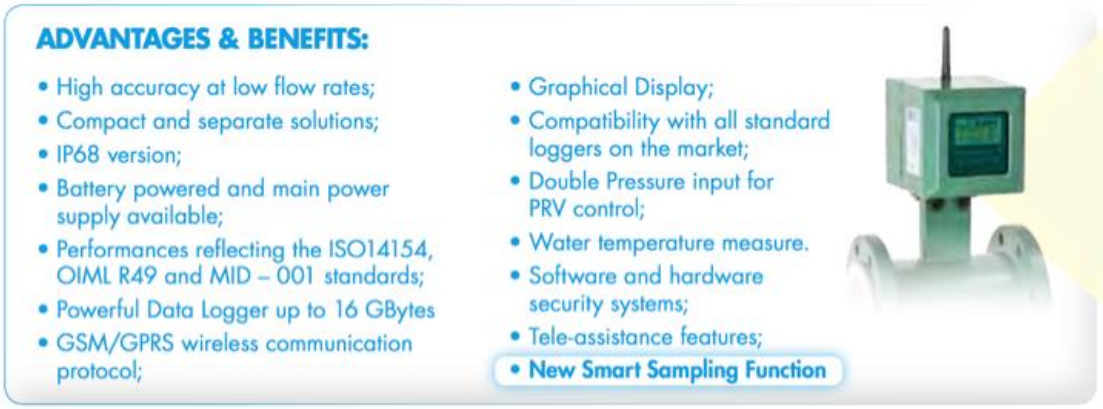


Figure 6-2: Advantages and Benefits in in choosing ML255 Flowitz NEXT

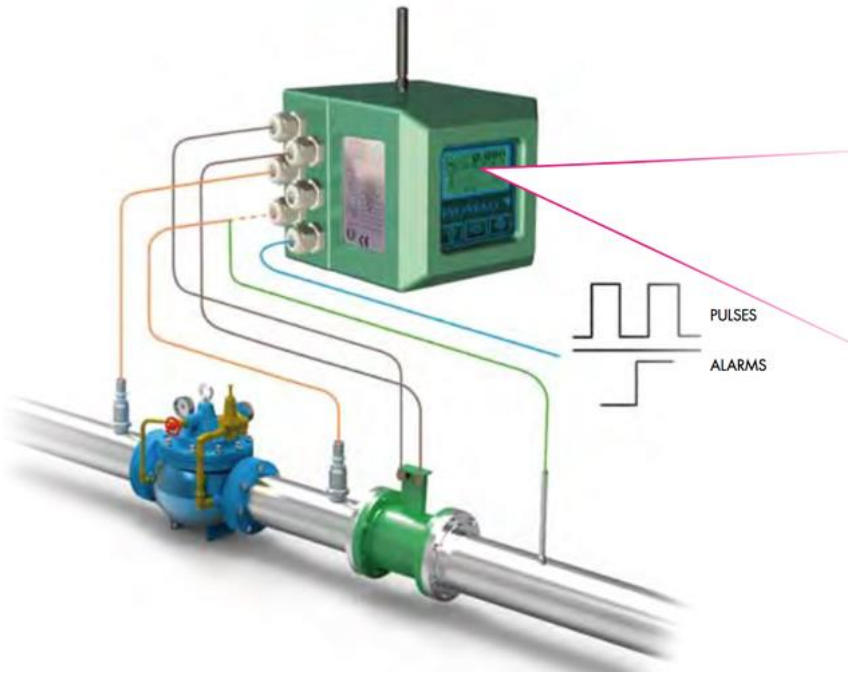


Figure 6-3: Possible connections to the ML255 Flowiz NEXT (pressure sensors and flow meters)

The electromagnetic flow meters will be also equipped with software named FlowizTM Next EXTRACTOR. Every day, at preset intervals, each installed unit sends an e-mail through the GPRS protocol to a dedicated e-mail account. These e-mails have excel files as attachments which contain all process data collected during the day and saved into the instruments logger according to the preset interval. The free FlowizTM Next EXTRACTOR software automatically extracts all the received files and creates folders with the name of the different instruments. All data will be organized and the operator only needs to open the required folders in the proper directory to get them.

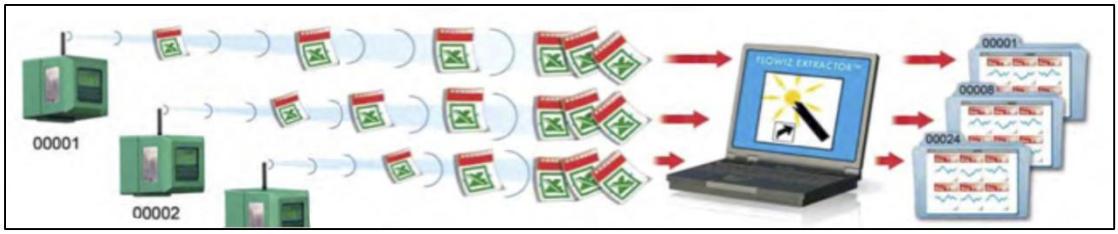


Figure 6-4: Schematic - Flowiz NEXT Extractor free software

Linate pilot will be equipped with Web based data acquisition and management cloud controlled by SEA (for example: ISOD@M). The system proposed provides an easy solution to monitor the instruments in the field, easily, collect, store and analyse all data and events.

It is easily accessible from the WEB and the data will be fully protected through dedicated access requiring a registered account and password moreover a multilevel authority structure allows to assign limited access to each individual operator strictly connected with the function.

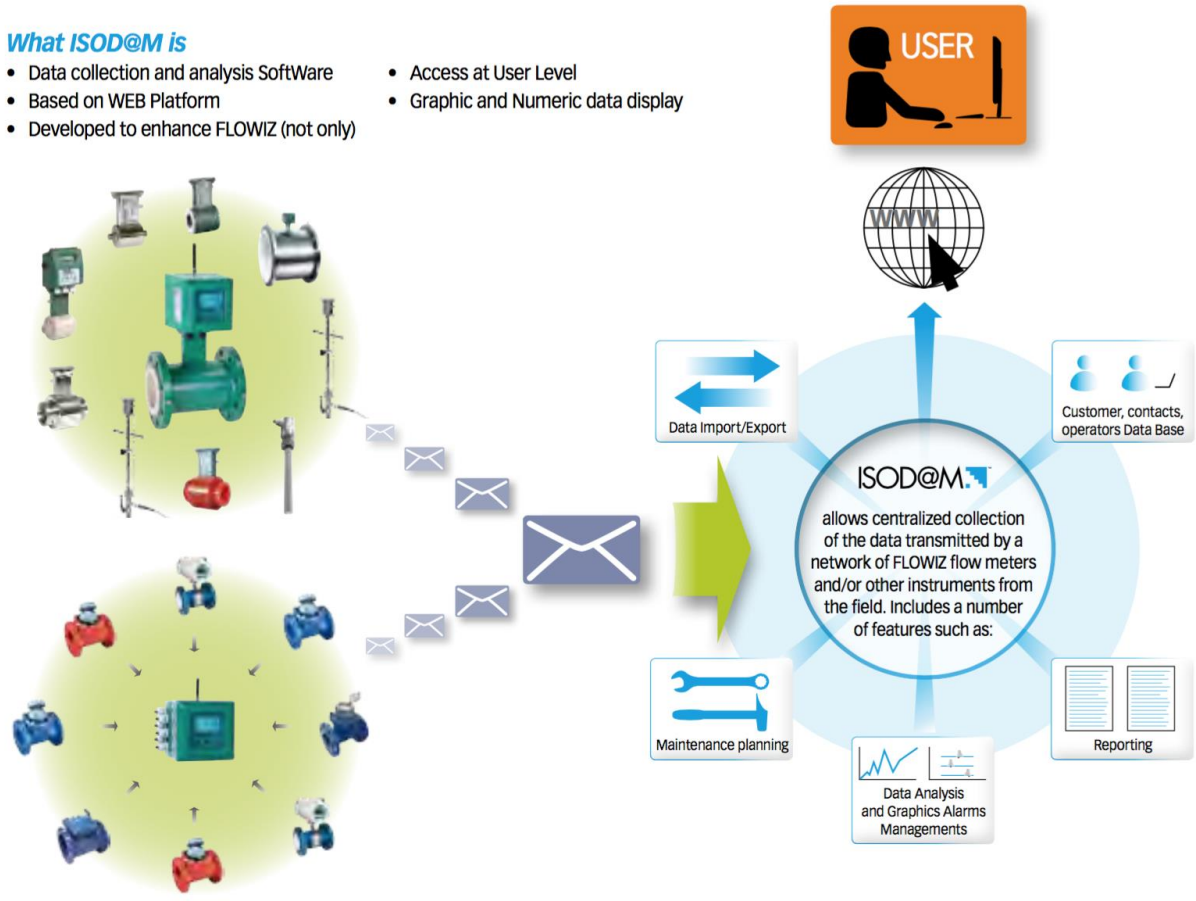


Figure 6-5: Schematic Interrelationship Flowiz NEXT / Flowiz NEXT Extractor / ISODAM and AWS

The data will be sent through the GPRS protocol to the cloud controlled by SEA than they will be sent to the Amazon cloud and they will be accessible by WATERNOMICS platform and users.

System data Transfer for Ultrasonic flow meters and Raven Eye

Ultrasonic flow meters and the open channel flow meter (raven Eye) will be equipped with BeagleBone Black (BBB) provided with a GPRS data transmission system. The data thanks the

BBB will be sent to the WATERNOMICS Platform through the GPRS protocol. This system data transfer requires power in place.

Figure 6-6: How Ultrasonic flow meters and BBB work together

The choice of a system data transfer based on GPRS transmission protocol and battery powered was an obvious choice due the problem that not all the metering points in the water network are provided by power and by a Wi-Fi network or LAN cable available.

In contrast, metering points where we have planned to install Ultrasonic flow meters and Raven Eye, the power and the LAN cable are already existing or will be available after construction works (public tender).

The accompanying Table summarizes the main characteristics of the two selected system data transfer.

Table 6-3: Main requirement for the two kind of system data transfer

Typology of system data transfer	GPRS Protocol	Power
Type A **(Electromagnetic flow meters)**	Yes	No
Type B **(Ultrasonic flow meters and Raven Eye)**	Yes	Yes

The accompanying image (Figure 6-7) shows in an intuitive way the overall data transfer system that will be implemented in Linate pilot.

Both data provided by Electromagnetic flow meters and ultrasonic flow meters will be sent through the GPRS protocol to the WATERNOMICS Platform and they will be accessible from researchers and stakeholders.

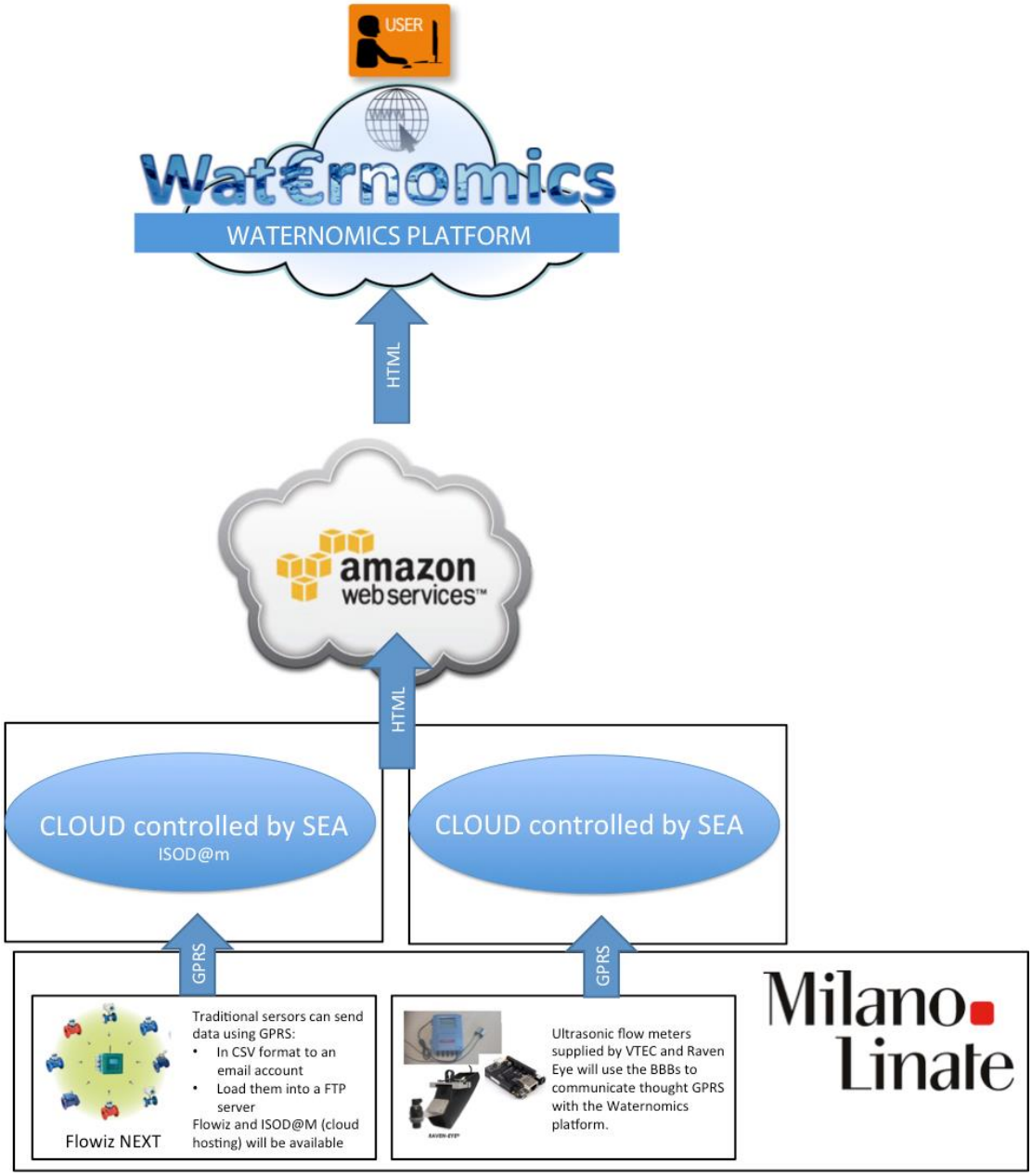


Figure 6-7: Overview of the overall system data transfer for Linate Pilot

Water Information System Deployment

WATERNOMICS provides an environment customizable and available to a broader set of end users. Due the different typology of end-users (domestic, corporate, municipal), the functionalities and system deployment needs will also be different. For example, at Linate pilot managers, employees and related business managers need to have access to the airport's water information in a way that supports decision making, while passengers need to have suggestions to increase their awareness related to water consumption.

The WATERNOMICS information system for water use is a simple instrument that can be immediately understood by operational decision makers to achieve the water efficiency and use

reduction[1]. Indeed as almost always happens, a mere graph of the probability density function is usually not immediately understood by decision makers, so the aim of the WATERNOMICS information system is to collect all the available data dealing with water consumption, network leakages, maintenance and to show them in a simple way through, for example, graphs created "ad hoc" for the end users necessities. The information system of WATERNOMICS is an instrument that focuses mainly on water efficiency at end users level through their change behaviours to achieve reduced water usage and improved operation and maintenance by utilities. Of course it is the main instrument through which WATERNOMICS aims to change water consumption behaviour and it will provide a personalized and customizable solution and application to end-users and doing so it will be able to help in changing water consumption behaviours and policies.

Customization of the WIS at Linate allows the managers to receive information about corporate water consumption in different periods (days, weeks and Years), information about the leakage, maintenance interventions, alerts on failures and other important data to support decisions making; while the maintenance technicians can receive information about water consumption of the overall water network or of single water network sector to control if there are problems, alert on water network fault which may interfere with the correct hydraulic functioning of the water network with consequent disruption to passengers, dealers and employees.

Additionally, in customizing the WATERNOMICS Information System to unique end user needs, personas have been developed. A persona is a way of communicating information from a group of users and it is depicted as a single user but represents a group or community. Personas have numerous benefits and the most frequently mentioned are:

- Increase communication about the target users with the design team and stakeholders
- Creating empathy, goals and motivation when it comes to water efficiency
- Engaging, familiarizing and motivating the end user to use the platform
- The personas help both in the design of user specific applications and in the deployment of the system itself.

Personas specific to the project Linate pilot are:

- Communication manager
- Environmental manager
- Operational manager

Figure 6-8 shows the Communication persona as an example.

[1] Christos Kouroupetroglou, Jesse Van Slooten, Eoghan Clifford, Daniel Coackley, Edward Curry, Sander Smit, Domenico Perfido (2015), *Waternomics: Serving diverge user needs under a single water information platform*. In the 36th IAHR World Congress, the Hague, The Netherlands.

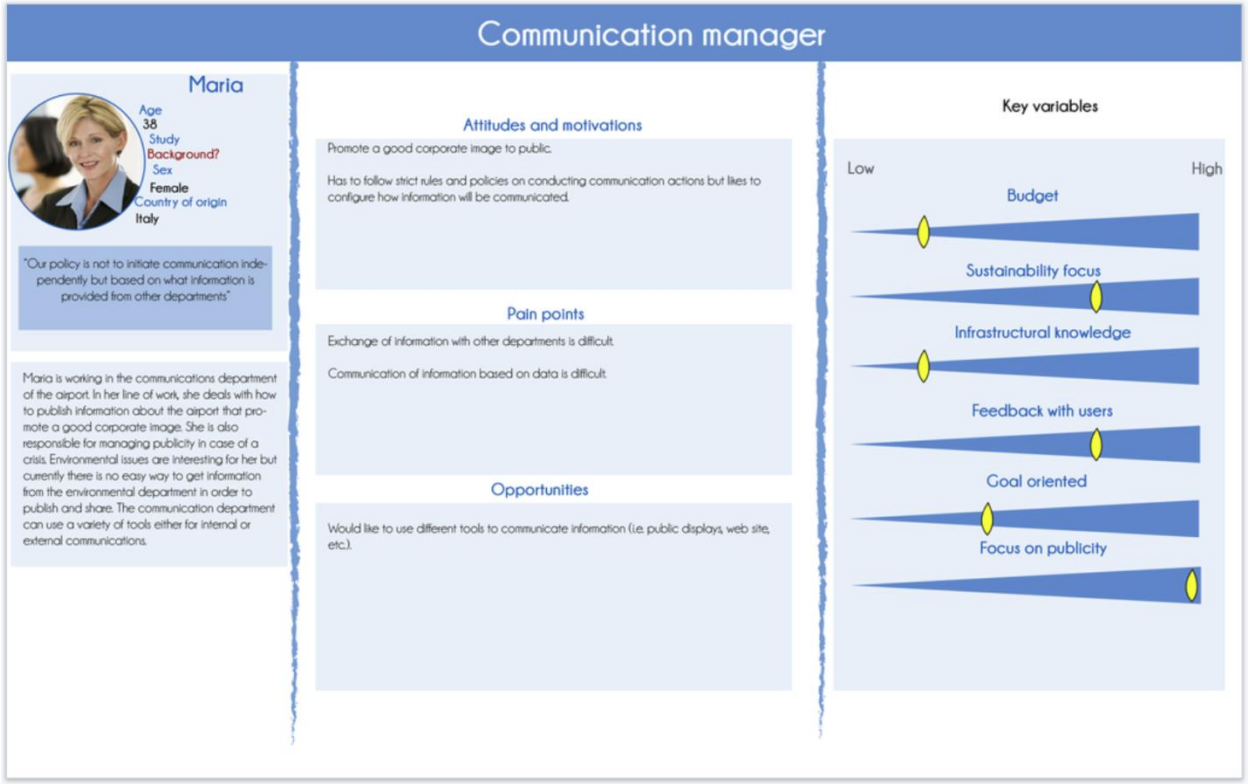


Figure 6-8: Communication manager personas

The WATERNIMICS information system is a valid ICT tools to implement 'smarter' water management programs, conduct data analysis of consumption, leak detection and repair and most importantly facilitate communication among stakeholders to raise awareness of source exploitation in the Linate pilot.

Staff Training

In addition to personas and training within the tool itself, staff training should be deliberately organized and scheduled with each type of stakeholder and end user so that WIS and overall water efficiency strategy can have maximum impact.

In Linate pilot the targeted users are:

- Environmental Managers
- Operational Managers
- Design technicians
- Maintenance technicians
- Airport passengers

To implement an effective training about the WATERNOMICS Water Information System both internal and external training will be implemented.

In particular the internal training mainly involve the involvement of Managers, Technicians and in general corporate employees.

The target of the “internal” training is to explain how the Water Information System works and can be managed and also how the information gathered form the WIS can be interpret and can help targeted users in doing their work raising their awareness about the importance of saving water resource.

The training will aim to ensure that all relevant personnel receive training for the types of activities or responsibilities they must carry out. It includes the general concept of water management as

well as skills training (usually on-the-job) to allow personnel to carry out their tasks with an awareness of the impact their activities can have on the water performance. In order to achieve these objectives periodic meeting will be scheduled in Linate pilot. Topics and cadences are provided in Table 10.

Table 6-4: Types of Training their Target users and cadences

Type of Training	Target users	Cadences
WEMs awareness	all employees	Quarterly
WEMs implementation training	Management Representative Water Management Team	Monthly
Water Information System training	All System users	Bimestrial

Airport passenger involvement will be carried out through the installation in the airport terminal of touch screen displays and the projection of WATERNOMICS messages in existing video terminals. The objective of this “external” training is to create curiosity in passengers encouraging them to consider water as a precious resource not to be wasted. To achieve this objective we have to give to them the opportunity to know what WATERNOMICS is doing. Of course this new kind of external approach will be managed by the Communication Department of SEA corporate through the implementation of a communication plan dealing with external users and also with the people directly involved in the management and maintenance of the pilot site.

7 The Pilot Plan - Thermi

The WEMs to be introduced at the Thermi pilot are presented in this section in chronological order.

WEM 1: Installation of sensors

Description: Sensors will be installed in all households and initial tests will be conducted for ensuring the proper functioning and data collection from them.

Related Objectives: Awareness, Water consumption

Responsibility: Thermi will be responsible for communicating and organising an event for the platform introduction.

Deadline: Sensors will be installed between M22 and M24.

WEM 2: Introduction of WATERNOMICS Applications Platform and initial Monitoring applications

Description: An event will be held in the municipality of Thermi's premises where the WATERNOMICS Applications Platform will be formally introduced and presented to users through a demonstration event. Users will be presented with the platform's capabilities and the concept of the applications platform and then they will have the opportunity to use the platform with their own credentials and experience first-hand the platform.

Moreover the platform introduction will be accompanied with the introduction of the first set of applications regarding the monitoring of consumption through graphing and reporting components.

Related Objectives: Awareness, Water consumption

Responsibility: Thermi will be responsible for communicating and organising an event for the platform introduction.

Deadline: The monitoring applications and the overall applications platform will be introduced in M24.

Review: The effect of the monitoring applications will be reviewed 2 (M26), 6 (M30) and 9 (M33) Months after its introduction

WEM 3: Introduction of WATERNOMICS Learning Applications

Description: The introduction of end-users to learning applications will be conducted through a series of email newsletters that will introduce new applications through a series of use-case examples that demonstrate the value of such applications. Moreover, the learning applications will be accompanied with a set of social features such as sharing and following content shared from peers in the social networks in order to engage even more users with the platform.

Related Objectives: Awareness, Education, Behaviour change, Water consumption

Responsibility: Ultra4 is responsible for the development of the Learning applications while NUIG, UNESCO-IHE and TUD will be responsible for providing educational content.

Deadline: The learning applications will be introduced in M26.

Review: The effect of the learning applications will be reviewed 2 (M28) and 7 (M33) Months after its introduction

WEM 4: In-school training program

Description: An in-school training program will present WATERNOMICS in school classes of children at about 10-12 years old within the context of an environmental education lesson.

Children will be able to see in a demonstration all aspects of the WATERNOMICS platform with emphasis on applications targeting school children especially. The pilot of Coláiste na Coiribe will be presented as an example accompanied by applications that will be open to public and especially targeting children and education.

Related Objectives: Awareness, Education, Behaviour change

Responsibility: Ultra4 is responsible for the development of the applications and Thermi will be responsible for creating and distributing the email newsletters to end-users.

Deadline: In-school training programs will be conducted between M26 and M28.

Review: The effect of the in-school training program will be reviewed in the end of its running period (M28).

WEM 5: Introduction of WATERNOMICS Exploration Applications

Description: Exploration applications concentrating on prediction services, comparisons between users and applications that help users explore and benchmark specific scenarios or enforced measures. Similarly to the learning applications this set of applications will be introduced via a set of email newsletters to users using once again specific use case scenarios that demonstrate their value and usefulness. After the introduction a set of newsletter will also be sent to users with specific to trigger greater user engagement with the applications.

Related Objectives: Awareness, Behaviour change, Water consumption, Water management and decision making

Responsibility: Ultra4 is responsible for the development of the applications and Thermi will be responsible for creating and distributing the email newsletters to end-users.

Deadline: The exploration applications will be introduced in M28.

Review: The effect of the exploration applications will be reviewed 2 (M30) and 5 (M33) Months after its introduction

WEM 6: Open End-user WATERNOMICS seminar

Description: An open end-user seminar will be organised in the last set of WEMs to be introduced in M30. The open end-user seminar will bring together current household participants in the WATERNOMICS project to share their experience with other interested potential household users. Moreover the open end-user seminar will link results and experiences from other pilots with specific end-users in the municipality area that might as well be interested. For example large businesses of the wider municipality area will be invited to learn from the experiences in the Linate airport pilot and school teachers will be invited to learn from the experiences in the NEB and Coláiste na Coiribe pilots.

Related Objectives: Awareness, Education, Behaviour change, Water consumption, Water management and decision making

Responsibility: Thermi will be responsible for organising the End-user seminar while all partners will contribute with presentations and content for it.

Deadline: The open end-user seminar will be conducted in M30.

Review: The effect of the open end-user seminar will be reviewed at the end of its running period (M30).

WEM 7: Introduction of WATERNOMICS Gaming Applications and Gamification features

Description: As part for the end-user seminar the WATERNOMICS gaming applications will be also launched and presented to participants. Gaming applications will be accompanied with a set of gamification features introduced in the platform. The objective of these features is to engage

users even more in the different applications while also help them connect even more with other households. Such features will further enhance the experience of users and improve existing learning applications but also add an element of exploration and fun to platform

Related Objectives: Education, Behaviour change, Water consumption

Responsibility: Ultra4 is responsible for the development of the Gaming applications and the gamification features.

Deadline: The gaming applications and gamification elements will be introduced in M30.

Review: The effect of the gaming applications and gamification elements will be reviewed 3 (M33) months after their introduction

WEM 8: WATERNOMICS public data to be linked with the municipality website

Description: Having launched the full spectrum of applications to end-users the Thermi municipality website will be linked with the applications platforms and more specifically with an application showing public data from the pilot. The data to be used and shown in this application will not reveal any user-specific sensitive information but rather focus on presenting aggregated data from all the participant household in the pilot.

Related Objectives: Awareness

Responsibility: Ultra4 is responsible for the development of the application and Thermi will be responsible for creating the link from their website.

Deadline: The link with the municipality's web site will be introduced in M30.

Review: The effect of the link with the municipality web site will be reviewed 3 (M33) months after its introduction

7.1 WEM Dissemination activities at Thermi

Table 7-1 below summarises the dissemination activities associated with the proposed efficiency measures described in the pilot plan.

Table 7-1: Dissemination activities and WEMs for Thermi

No	WEM Ref.	Dissemination Objective	Month	Targeted audience						
				Thermi participant users	Other interested users	Developers community	Research Community	Public	Water utilities	Media
01	WEM 2	Familiarize users with	M24	X					X	

		Waternomics platform								
	WEM 2	Familiarize students as future developers with the Waternomics information platform	M24			X	X			
02	WEM 3	Familiarize end-users with learning applications	M26	X	X			X		
03	WEM 3	Involve stakeholders in providing content for the learning applications	M25				X		X	
04	WEM 4	Raise awareness on schools about water consumption	M26	X	X			X	X	
05	WEM 5	Familiarize users with exploration applications	M28	X			X		X	
06	WEM 6	Introduce the Waternomics platform to additional potential future users	M30	X	X			X	X	X
07	WEM 6	Present sample external applications to developers to involve developers community in further development	M30			X		X		

08	WEM 7	Engage users in gamification aspects and gaming applications that raise awareness about water consumption	M30	X			X		X	
09	WEM 8	Communicate results of the pilot period in public	M30	X	X			X	X	X

7.2 Implementing the Pilot Plan Phase 2 – Do

Efficiency Measurement Implementation

The Action Plan outlined in Section 2.2.7 above describes the specific WEMs proposed for the pilot in Thermi. The programme of implementation of the measures is outlined in the Gantt chart given in Appendix C of this report

Meter Installation and Configuration

The installation of 6 mini water meter sensors in one household was completed in September 2015 as a test installation. Following that a thorough investigation and analysis of possible measurement points in the other 9 participant households followed and a detailed plan is compiled based on the mattering plan described on D2.2. Currently a public tender is being prepare by the municipality of Thermi to sub-contract the installation works for the rest of the participant households. This process is expected to last about 1 month so the installation process for the rest of the households is expected to start in November 2015 and end by December 2015.

Kitchen Installation

Bathroom Installation

Figure 7-1: Installation in the first test household

Data Collection

Water usage data recorded by VTEC sensors installed (mini water meters and ultrasonic) will be transferred from the meter unit to VTEC cloud as a temporary storage facility and then uploaded to the Amazon Web Space.

Data from the VTEC meters is currently available to view and download directly from VTEC-cloud web site e.g. http://vtec-cloud.com/gh_01.html and http://vtec-cloud.com/vl_usf_05.html. Figure 7-2 shows the output from the meters installed in the kitchen of one of the households.

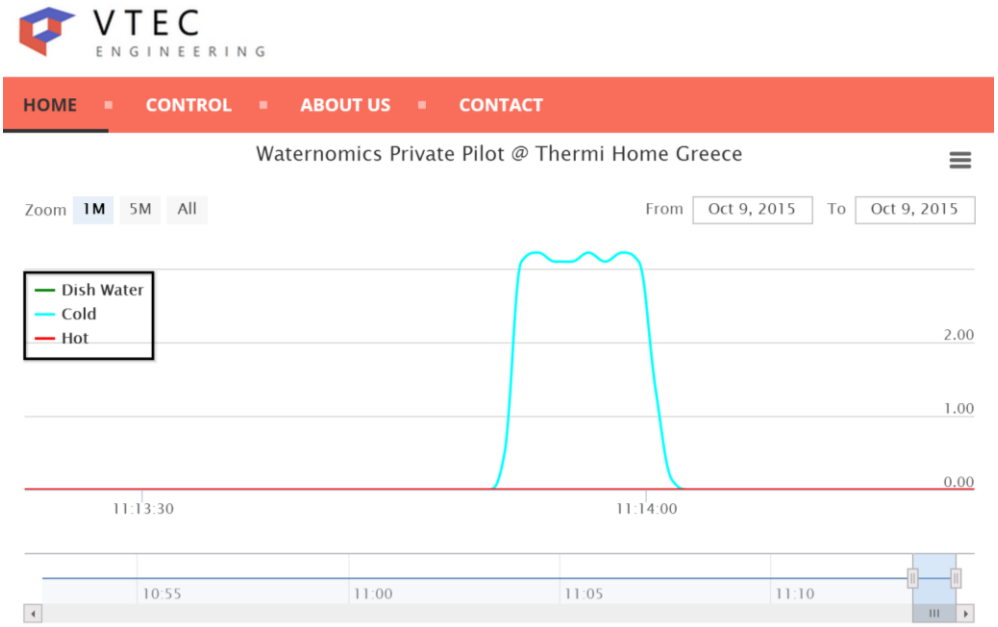


Figure 7-2: Screenshot from VTEC cloud web site showing real time water consumption from 3 sensors installed in kitchen

Water Information System Deployment

The WATERNOMICS Platform developed by the WATERNOMICS Project Team will be launched in January 2016 (M26). Dissemination and introduction of features of the platform is described in the Action Plan outlined in Section 2.2.7.

Staff Training

Initial training of end users will be conducted through end-user seminar accompanying the introduction of the WATERNOMICS Applications Platform (WEM 2 of the Action Plan).

8 The Pilot Plan – NUI Galway

Figure 8-1 following summarises the measures that are proposed to achieve each of the pilot specific objectives, described in Section 4.2 above, for implementing a Water Management Program at the NUIG Pilot Site.

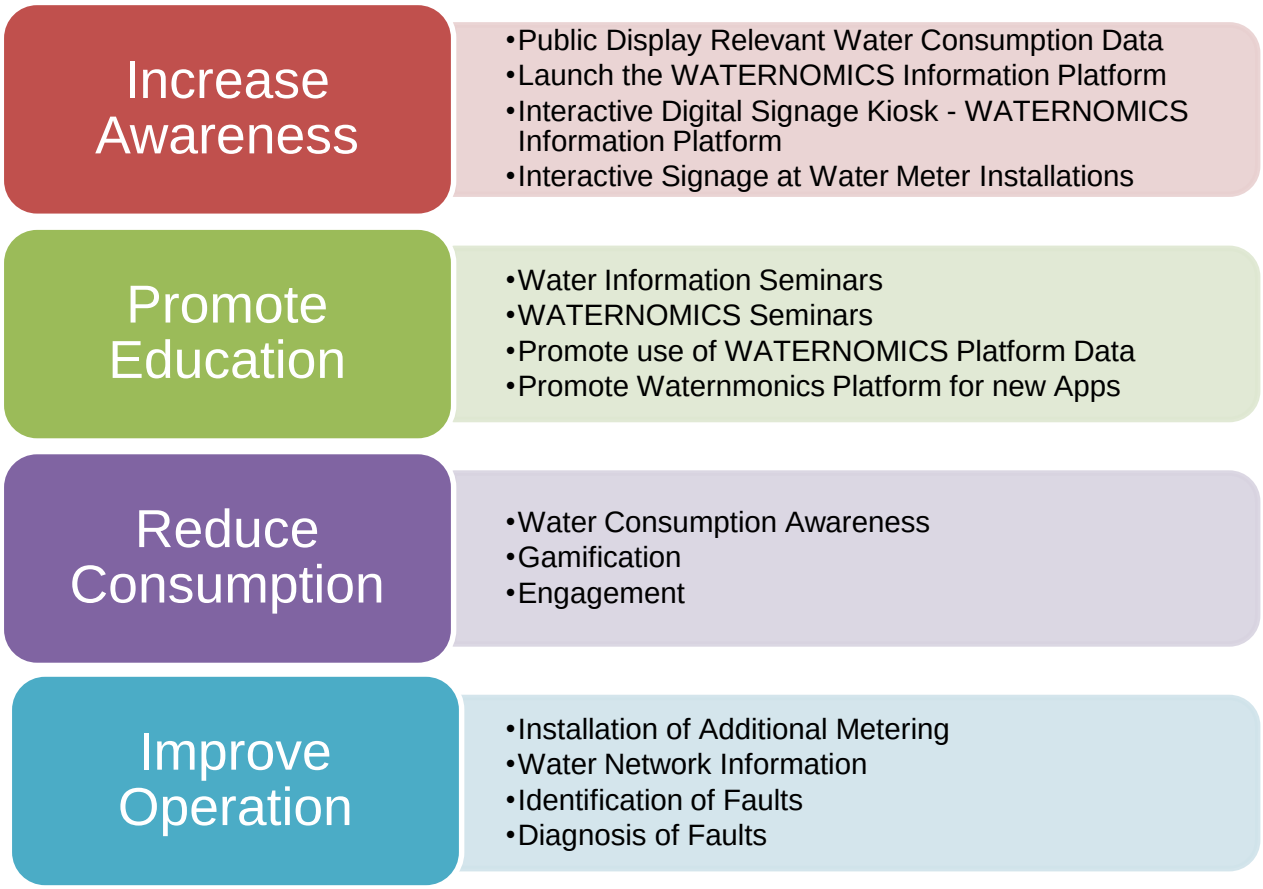


Figure 8-1 Action Plan Summary: Objectives and Associated WEMs

The planned measures at the NUIG Pilot Site are described in detail below. The planned implementation schedule for the measures is given in the Programme in Appendix A.

Objective 1: Increase Awareness

The four key WEMs identified to **Increase Awareness** of water consumption at the Pilot Site, are discussed below. As introduced in Section 4.3.1, to comprehensively determine whether an increase in awareness of water consumption has been achieved among a subject group, a baseline must first be established. As described, it is proposed that in advance of the introduction of any WEMs, a random group of first year students based in the Engineering Building will be subject to a questionnaire survey. This survey will also be carried out on a similar-sized peer group not based in the Engineering Building to establish a control. Following implementation of the proposed WEMs described below, the survey questionnaire will be repeated with the exposed students and the control group and in this way the effect of the WEMs can be established.

WEM 1: Public Display Relevant to Water Consumption

Description: An existing Public Display Screen in the main entrance foyer of the Engineering Building will display visuals Relevant to water consumption. The data will be displayed in be easily relatable visuals and may include recent consumption trends etc.

Responsibility: The NUIG-Deri WATERNOMICS Team will provide the information feed to the public display screen.

Deadline: The public display will initially be launched in the period after January 2016 – March 2016 (M24- M26).

Review: The effect of this WEM will be reviewed on a weekly basis for a 2 month period following its introduction.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

Figure 8-2 Eng. Building Foyer

WEM 2: Launch the WATERNOMICS Platform

Description: The development of the WATERNOMICS Platform as an interactive water information system is a key element of the overall WATERNOMICS Project. At the NUIG Pilot Site a number of specific applications are currently under development in response to the findings of D1.3 in relation to the NUIG Pilot. These Applications are listed in the Table following the Plan.

Following its launch, the WATERNOMICS Platform will be available to NUIG staff and students in the Engineering Building. The availability of this Water Information Platform will be notified to staff and students by a series of introductory emails that will include a link to a demonstration video.

Responsibility: The NUIG-Deri WATERNOMICS Team will launch the Platform.

Deadline: The WATERNOMICS Platform will be launched in January 2016 (M24).

Review: The effect of this WEM will be reviewed on a monthly basis for the pilot control period.

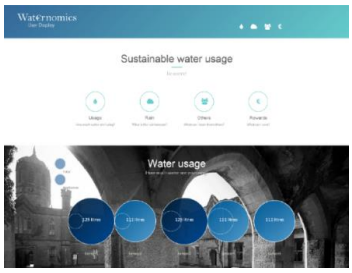


Figure 8-3 Home Screen

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 3: Interactive Digital Signage Kiosk - WATERNOMICS Information Platform

Description: The WATERNOMICS Platform will be available on a dedicated interactive digital signage kiosk. The kiosk will feature a 32" touchscreen display to allow users to interrogate the WATERNOMICS Platform. The kiosk will be installed in the main foyer of the Engineering Building.

Responsibility: The NUIG-Deri WATERNOMICS Team will be responsible for the installation of the kiosk at the Engineering Building.

Deadline: The Interactive Digital Signage Kiosk will be installed in the period February 2016 – April 2016 (M25-M27).

Figure 8-4 Digital Kiosk

Review: The effect of this WEM will be reviewed on a weekly basis for a 2 month period following its introduction.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 4: Interactive Signage at Water Meter Installations

Description: The ultrasonic water meters installed as part of the WATERNOMICS Project are wall-mounted devices installed in publically accessible areas of the building. The meter units are housed in locked enclosures that feature a transparent door through which is it possible to observe the meter readings. During the initial baselining period the enclosures do not have any associated or explanatory signage and the unobtrusive design of the units give no indication of what they are or what their function is. Following the launch of the WATERNOMICS Platform, signage will be posted at each of the newly installed water meters giving some detail about the project and its objectives. The signage will also include a QR code that will link to data about the meter to be accessed by any suitably equipped mobile device.

Figure 8-5 Interactive Signage

Responsibility: The NUIG-Deri WATERNOMICS Team will be responsible for the preparation and installation of the signage and the QR code linkage will be provided by the NUIG WATERNOMICS Team.

Deadline: The Interactive Device Signage will be installed in March 2016 (M26).

Review: The effect of this WEM will be reviewed on a monthly basis following its introduction.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

Objective 2: Promote Education

The key WEMs identified to **Promote Education** with respect to the consumption of water at the Pilot Site, are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is presented in Section 4.3 above.

WEM 5: Water Information Seminars

Description: Water Information Seminars will be held for students and staff as part of the lunchtime seminar series. These seminars will describe the water system at the Engineering Building and the Principal water demands and promote knowledge among staff and students of the role of building occupants in water conservation and responsible water usage. The WATERNOMICS Project, its goals and objectives will also be presented at these seminars. An attendance will be taken at the events.

Responsibility: The NUIG-Deri WATERNOMICS Team will hold and organise the seminars.

Deadline: The first seminar will take place in January 2016 (M24).

Review: The effect of this WEM will be reviewed (i.e. user access numbers) on a weekly basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 6: WATERNOMICS Seminars

Description: Following the launch of the WATERNOMICS Platform, a seminar will be held focusing on the use of the platform for various stakeholders. The seminar will recap on some of the information presented in the Water Information Seminars but will focus more on the use of the WATERNOMICS Platform. This information seminar can be repeated at intervals during the project control period pending the results of the review.

In addition, similar to the proposals at Linate and Thermi, as the project continues a further seminar is proposed to bring together users from the domestic environment (Thermi) and the corporate environment (Linate) to share their experience with staff, students at NUI Galway and potentially local businesses this will link results and experiences from other pilots with new potential end-users

Responsibility: The NUIG-Deri WATERNOMICS Team will hold and organise the seminars.

Deadline: The first seminar will take place in February 2016 (M25).

Review: The effect of this WEM will be reviewed (i.e. user access numbers) on a weekly basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 7: Promote use of WATERNOMICS Platform Data

Description: Staff and Students will be encouraged to use the information gathered by the WATERNOMICS Information System (Platform) to perform analytics and to develop and support research ideas. In addition, the data analytics available on the platform will provide valuable support and reference data. To promote and disseminate the type of data available for download from the WATERNOMICS Platform, a bi-monthly (every 2 months) newsletter will be circulated to staff and students at the Engineering Building giving key statistics from the previous period.

Responsibility: The NUIG-Deri WATERNOMICS Team will prepare and circulate the e-bulletins at two monthly intervals.

Deadline: The first e-bulletin will be circulated in February 2016 (M25).

Review: The effect of this WEM will be reviewed on a two-monthly basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 8: Promote WATERNOMICS Platform for new Apps

Description: The WATERNOMICS Platform will be available to host innovative water information based applications developed by any 3rd party. The applications must be non-commercial and free of any-charge and have a water/WATERNOMICS related focus. The College of Engineering and Informatics at NUIG has a number of Undergraduate and Post-graduate Information Technology Programmes and the course directors here as well as those at the Galway-Mayo Institute of Technology Department of Mathematics & Computing will be contacted to make them aware of the facility. http://www.nuigalway.ie/engineering-informatics/information-technology/courses/ http://www.gmit.ie/programme-discipline/science

In addition, the WATERNOMICS Project has a number of dissemination channels such as twitter https://twitter.com/WATERNOMICS_eu and website http://WATERNOMICS.eu/ where the platform facility will be promoted.

Responsibility: The NUIG-Deri WATERNOMICS Team will be responsible for the promotion of the WATERNOMICS Information System as a platform for developing applications.

Deadline: The promotion will commence in February 2016 (M25).

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

Objective 3: Reduce Consumption

The key WEMs identified to **Reduce Water Consumption** at the Engineering Building are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is as described in Section 4.2 above; simply a measure and review relative to baselining of total and system specific water consumption patterns for given time periods.

WEM 9: Water Consumption Awareness

Description: The successful effect of the measures described above as planned actions towards Objectives 1 & 2 will be to increase the overall awareness of water consumption at the Engineering Building and lead to a change in behaviour and ultimately a reduction in water consumption. The proposed methodology for the measurement of awareness is given in 4.2 above. The water consumption at the pilot will be measured by the existing and new metering in the building.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for the installation of metering and the collection and analysis of data.

Deadline: The specific measures to increase awareness of water consumption are given in Objective 1 above. The measurement of water consumption data in line with the proposed metering plan commenced at the Engineering Building in NUIG in September 2015 (M20).

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 10: Gamification

Description: The WATERNOMICS Platform will facilitate the gamification of water information presentation and dissemination. The success of gamification as a learning and dissemination tool will similar to the above WEMs increase the overall awareness of water consumption at the Engineering Building and lead to a change in behaviour and ultimately a reduction in water consumption. The number of users of the games will be recorded by game sign in which will provide data in relation to the use and users of the game. The water consumption at the pilot will be measured by the existing and new metering in the building.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for the development of the WATERNOMICS Game.

Deadline: The WATERNOMICS Game will be launched on the platform after February 2016 (M25).

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 11: Engagement

Description: The WATERNOMICS Project seeks to engage Pilot Site occupants in the issue of water consumption. This process of engagement is reflected in the WEMs described above and in particular for Objectives 1 & 2. The physical intervention strategies that are often popular as WEMs are generally self-enforcing and passive in terms of user engagement i.e. water saving devices such as Hippo http://www.hippo-the-watersaver.co.uk/ and rainwater harvesting systems. The NUIG-Deri WATERNOMICS Team has developed two physical interventions that require user engagement to effect behavioural change. These innovative physical intervention applications will be trialled at demonstration units at the NUIG Engineering Building during the Pilot Control Period. The demonstration units have two independent sink units one of which is fitted with a physical intervention and one which is not. Students and staff will be invited to use the sink units in pairs and their experience and behaviour will be recorded by questionnaire survey.

Goal Orientated Water Delivery www.vimeo.com/139002337

This concept challenges traditional water delivery

By transforming it into a goal oriented activity. The system components engage with the end users and connect to the water information system via a social network application that allows users to report issues/problems. This concept also facilitates personalisation of water consumption information utilizing blue tooth technology on mobile devices to identify consumers

Figure 8-6 Goal Orientated Water Delivery

Water as a Messaging Medium/ Eco-feedback through water

The developed application gives feedback about consumption (eco-feedback) through the water itself with the philosophy that this is unobtrusive to the interaction of the water consumer but provides a reminder signal that informs of levels of consumption. The concept is based on findings from user research which stated showed that in general users are motivated to save water, and all they need is a reminder in most cases.

Figure 8-7 Messaging With Water

Responsibility: The NUIG-Deri WATERNOMICS Team is responsible for the installation of demonstration units and trialling of the physical intervention techniques.

Deadline: The physical intervention techniques will be trialled after April 2016 (M27).

Review: The effect of this WEM will be reviewed by feedback survey during the trialling period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

4. Improve Operation

The key WEMs identified to **Improve Operation** at the Engineering Building are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is as described in Section 4.2 above. In summary, the success of these WEMs will be measured by a reduction in time to identify faults.

WEM 12: Installation of Additional Metering

Description: In line with the Measurement Frameworks Report D2.2., 8 ultrasonic meters were installed at NUIG Engineering Building in August 2015. An additional three small in-line metres will be installed in October 2015. The meters will provide additional information with respect to specific water usage at the Building. The proposed metering strategy is designed to allow the identification of significant and specific water uses through identifiable flow signatures.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for the installation and commissioning of metering at the NUIG Pilot Site.

Deadline: The measurement of water consumption data in line with the proposed metering plan commenced at the Engineering Building in NUIG in September 2015 (M20). The final three additional meters will be installed in October 2015.

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an ongoing basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 13: Water Network Information

Description: Additional, timely and relevant information regarding the operation of the water system at the NUIG Engineering Building will be collected and analysed by specific applications hosted by the WATERNOMICS Platform. The provision of specific water usage information based on the stakeholder user requirements and KPIs will provide network data to plan upgrades and respond to faults and other unexpected occurrences. In addition, notices regarding water quality events will be

Responsibility: The NUIG-Deri WATERNOMICS Team is responsible for development of the WATERNOMICS Information System Platform and associated applications that will provide the output of water meter and other relevant data analysis.

Deadline: The WATERNOMICS Platform will be launched in January 2016 (M24).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an on-going basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 14: Identification of Faults (M26)

Description: Additional, timely and relevant information regarding a well-operating water system at the NUIG Engineering Building will provide a baseline for the identification of faults or unexpected occurrences. This fault detection facility is currently under development as a methodology and will be automated by a software application hosted by the WATERNOMICS platform

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for development of the WATERNOMICS Information System Platform and associated fault detection application.

Deadline: The WATERNOMICS Platform Fault Detection Application will be launched in March 2016 (M26).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an ongoing basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Development Activities.

WEM 15: Diagnosis of Faults (M26)

Description: Additional, timely and relevant information regarding the function of the water system at the NUIG Engineering Building will provide for the elimination of fault causes and provide a framework for the diagnosis of common faults. This fault diagnosis facility is currently under development as a methodology and will be automated by a software application hosted by the WATERNOMICS platform.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for development of the WATERNOMICS Information System Platform and associated fault diagnosis application.

Deadline: The WATERNOMICS Platform Fault Detection Application will be launched in March 2016 (M26).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an ongoing basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Development Activities.

Table 8-1: List of Selected applications for the NUIG Pilot

App ID	App Name
NEB.1	Manager's Dashboard
NEB.2	Public Display
NEB.3.1	Goal-oriented Accessing Water
NEB.3.2	Physical Consumption Feedback
NEB.4	Wearable Info-centre
NEB.5	Social Feedback and News Aggregator
NEB.7	FDD
NEB.8	Water Saving Calculator (What if scenarios)
NEB-SVC 1	Water Data Analytics Service
NEB.9	Water Retention Period Observation

8.1 WEM Dissemination activities at NUI Galway

Table 8-2 below summarises the dissemination activities associated with the proposed efficiency measures described in the pilot plan.

Table 8-2: Dissemination activities and WEMs at NUI Galway Engineering Building

No	WEM Ref.	Dissemination Aim	Month	Targeted audience				
				Academic/Research Staff @ NUIG	NUIG Students	NUIG Operational or Management Staff	Research Community	Public
01	WEM 01	Public Display of Pilot Specific Water Consumption Data	M27	X	X	X		X
02	WEM 02	Email re Platform Launch	M24	X	X	X	X	
03	WEM 03	Showcase WATERNOMICS Data/Platform	M24	X	X	X	X	
04	WEM 04	Highlight Specific WATERNOMICS Meter Data	M26	X	X	X	X	
05	WEM 05	Presenting water consumption information to engage consumers	M25	X	X	X	X	
06	WEM 06	Present WATERNOMICS Project to create awareness	M26	X	X	X	X	
07	WEM 07	Promote use of WATERNOMICS Platform Data	M26	X	X	X	X	
08	WEM 08	Promote use of WATERNOMICS Platform for App Developers	M26	X	X	X	X	X

09	WEM 11	Promote innovative ideas in water consumption	M27	X	X	X	X	

8.2 Implementing the Pilot Plan Phase 2 – Do

Efficiency Measurement Implementation

The Action Plan outlined above describes the specific WEMs proposed for the NUIG Engineering Building. The programme of implementation of the measures is given in the Gantt chart included in Appendix A of this report.

Meter Installation and Configuration

The installation of 8 Ultrasonic Meters as proposed in D2.2 Measurement Frameworks, Table 8-2, was carried out in August 2015. The meters, cabling and BBBs were successfully installed at the selected locations and transducers fixed on the identified pipes. The meters and BBBs and power sockets were installed in wall mounted enclosures (see Figures below) and the transducer, power and data cabling was provided in surface mounted galvanised steel conduit or hidden in keeping with existing adjacent fittings.

The physical installation work was carried out by an external electrical contractor engaged following a restricted tender process in line with NUIG Procurement Policy. Representatives of VTEC, NUIG Computer Services Department and the NUIG WATERNOMICS Team worked together to complete the installation works in advance of the start of the academic year.

Figure 8-8: Installed Ultrasonic Water Meter at NUIG

Figure 8-9: Installed Water Meter Enclosure at NUIG Office Area

Figure 8-10: Installed Water Meter Enclosure at NUIG Laboratory Area

In addition to the identified meter requirements outlined in D2.2, a further three small BMS-connected water meters will be installed at end-of-line drinking fountains in the Engineering Building. This work is in association with by the NUIG Buildings Office who will oversee the installation and will be carried out in October 2015. The water meter installation details are provided in the Table below for convenience. All of the meters take continuous measurements from the subject water system.

Table 8-3: NUIG Engineering Building Water Metering

No.	Water meter Ref.	Water Usage Description Measurement	Units	Installation Status
1	USF_10 MR.WM.002_CW_US	Complete CWS to building	m^3	Complete August 2015
2	USF_03 CWS9_US	CWS to all Female Showers/Sinks	m^3	Complete August 2015
3	USF_04 CWS3_US	CWS to all Male Showers/Sinks	litres	Complete August 2015
4	USF_05 CWS4_US	CWS to Zinc Canteen	$m^3 \times 10^{-3}$	Complete August 2015
5	USF_06 CWS5_US	CWS to Materials Laboratory	$m^3 \times 10^{-3}$	Complete August 2015
6	USF_07 CSW6_US	CWS to grey water tanks East side	$m^3 \times 10^{-3}$	Complete September 2015
7	USF_08 CWS7_US	CWS to grey water tanks West side	$m^3 \times 10^{-3}$	Complete September 2015
8	USF_09 CWS8_US	CWS to Domestic Hot Water system	$m^3 \times 10^{-3}$	Complete August 2015
9	MWS3	MWS to Water Fountain 3rd Floor Northwest Corner	$m^3 \times 10^{-3}$	Planned October 2015
10	MWS4	MWS to Water Fountain 3rd Floor West Corridor	$m^3 \times 10^{-3}$	Planned October 2015
11	MWS5	MWS to Water Fountain 3rd Floor East Corridor	$m^3 \times 10^{-3}$	Planned October 2015

Data Collection

Water usage data recorded by BMS connected water meters will be collected from the BMS at the Engineering Building and transferred directly to the WATERNOMICS Amazon Web Space. Data from 8 VTEC ultrasonic meters will be transferred from the meter unit processer directly to the Amazon Web Space. This process is described in earlier project reports D2.2 and D3.2.

Data from the VTEC meters is currently available to view and download directly from the meter web site e.g. http://vtec-cloud.com/vl_usf_05.html. Figure 8-11 below shows the output from meter USF_05 CWS4_US.

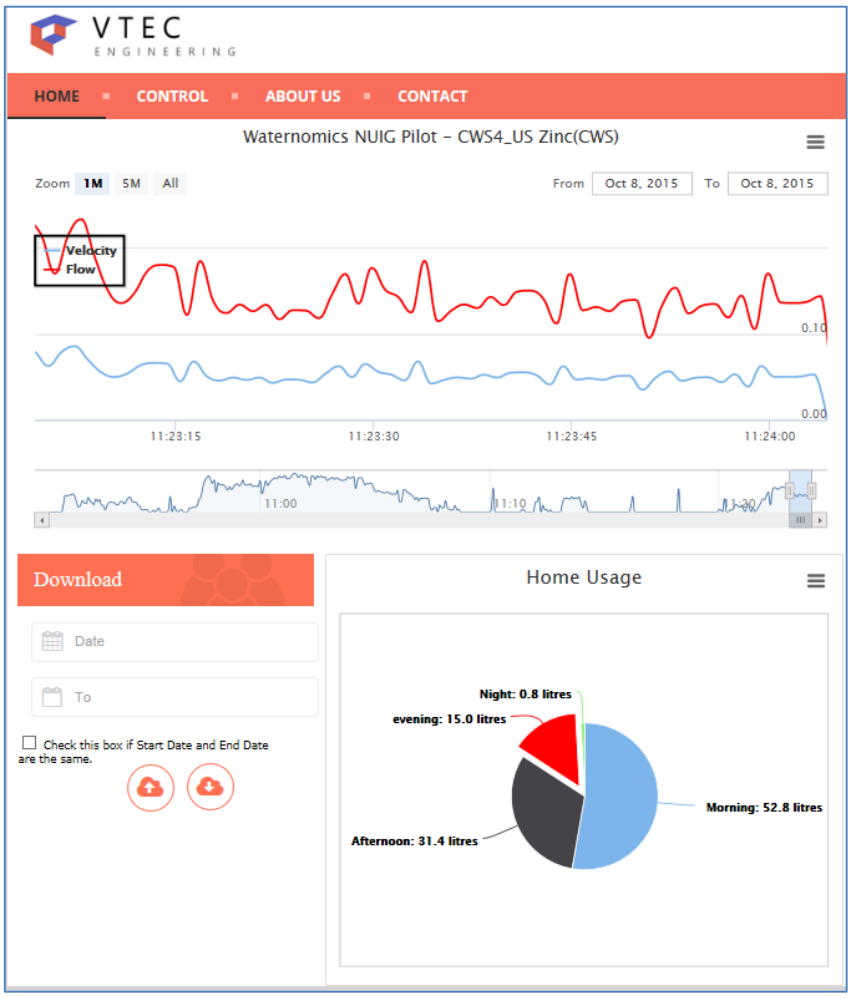


Figure 8-11 Real-time Water Meter Output NUIG

Other data collected as part of the project will be recorded by online questionnaire survey using an application such as www.surveymonkey.com or by interview i.e. in the case of the Physical Intervention Demonstrations. Much of the key data recorded for the NUIG Pilot Site will be collected by the WATERNOMICS Applications.

Water Information System (The WATERNOMICS Platform) Deployment

The WATERNOMICS Platform developed by the WATERNOMICS Project Team will be launched in January 2016 (M24). Dissemination of information regarding the WATERNOMICS platform is described in the Pilot Action Plan outlined in above.

Staff Training

The Water Information Seminars and WATERNOMICS Seminars described in the pilot plan as WEM 5 & WEM 6 will provide information to staff on the operation of the WATERNOMICS Platform, the WATERNOMICS Project and the objectives of implementing a Water Management Program at the NUI Galway Pilot Site.

9 The Pilot Plan - Coláiste na Coiribe

Figure 9-1 following summarises the specific WEMs that are proposed to achieve the each of the pilot specific objectives introduced in Section 5.2 above, for implementing a Water Management Program at the Coláiste na Coiribe Pilot Site.

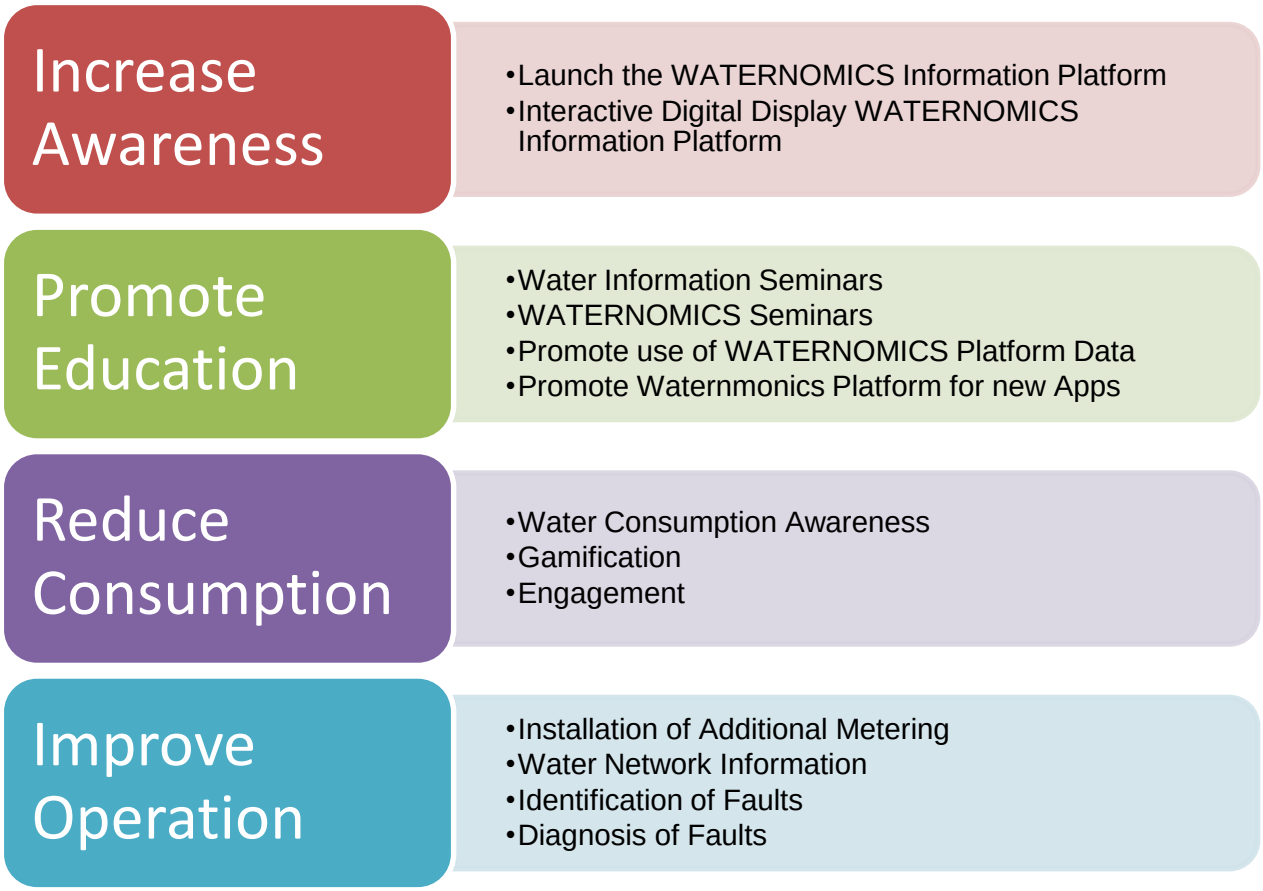


Figure 9-1: Action Plan Summary: Objectives and Associated WEMs

Objective 1: Increase Awareness

The four key WEMs identified to **Increase Awareness** of water consumption at the Pilot Site, are discussed below. As introduced in Chapter 5, to comprehensively determine whether an increase in awareness of water consumption has been achieved among a subject group, a baseline must first be established. As described, it is proposed that in advance of the introduction of any WEMs, sample groups of students from each of the 6 years at Coláiste na Coiribe will be subject to a questionnaire survey. This survey will also be carried out on a similar-sized peer group from another similar secondary school in Galway to establish a control. Following each of the proposed WEMs listed below, the survey questionnaire will be repeated with the exposed students and the control group and in this way the effect of the WEMs can be established.

WEM 1: Launch the WATERNOMICS Platform

Description: Following its launch, the WATERNOMICS Platform will be available to staff and students in Coláiste na Coiribe. The availability of this Water Information Platform will be notified to staff and classrooms by a series of introductory emails that will include a link to a demonstration video.

Responsibility: The NUIG-Deri WATERNOMICS Team will launch the Platform.

Deadline: The WATERNOMICS Platform will be launched in January 2016 (M24).

Review: The effect of this WEM will be reviewed on a monthly basis for the pilot control period.

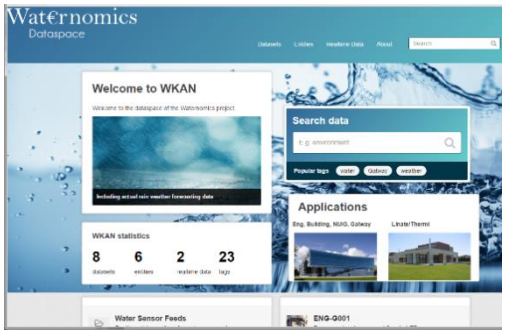


Figure 9-2 WIP Apps Homepage

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 2: Interactive Digital Display WATERNOMICS Information Platform

Description: An interactive 10" touch screen display, Figure 9-3, will be installed in an area close to the main entrance foyer, adjacent to the School's First-Aid or (Seomra Garchabhair). This display will allow access and interaction with the WATERNOMICS Platform.

Responsibility: The NUIG-Deri WATERNOMICS Team will provide the information feed to the public display screen.

Deadline: The public display will initially be launched in the period January 2016 (M24) – March 2016 (M26).

Review: The effect of this WEM will be reviewed on a monthly basis for the pilot control period.

Figure 9-3 Interactive Digital Display

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

Objective 2: Promote Education

The key WEMs identified to **Promote Education** with respect to the consumption of water at the Pilot Site, are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is presented in Section 5.3.1 above.

WEM 3: Water Information Seminars

Description: Water Information Seminars will be held for students and staff as part of the lunchtime seminar series. These seminars will describe the water system at the School Building and the principal water demands and promote knowledge among staff and students of the role of a building's occupants in water conservation and in responsible water usage. The WATERNOMICS Project, its goals and objectives will also be presented at these seminars. An attendance will be taken at the events.

Responsibility: The NUIG-Deri WATERNOMICS Team will hold and organise the seminars.

Deadline: The first seminar will take place in January 2016 (M24).

Interactive Digital Display

Review: The effect of this WEM will be reviewed (by analysing data access numbers) on a monthly basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 4: WATERNOMICS Seminars

Description: Following the launch of the WATERNOMICS Platform, a seminar will be held focusing specifically on the use of the platform for various stakeholders. The seminar will recap on some of the information presented in the Water Information Seminars but will focus more on the use of the WATERNOMICS Platform. This information seminar can be repeated at intervals during the project control period pending the results of the review.

In addition, similar to the proposals at Linate and Thermi, as the project continues a further seminar is proposed to bring together users from the domestic environment (Thermi) and the corporate environment (Linate) to share their experience with staff, students and parent at Coláiste na Coiribe and potentially local businesses this will link results and experiences from other pilots with new potential end-users.

Responsibility: The NUIG-Deri WATERNOMICS Team will hold and organise the seminars.

Deadline: The first seminar will take place in February 2016 (M25).

Review: The effect of this WEM will be reviewed (by analysing data access numbers) on a monthly basis following its introduction.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 5: Promote use of WATERNOMICS Platform Data

Description: Staff and Students will be encouraged to use the information gathered by the WATERNOMICS Platform to perform their own analytics and to develop and support research ideas. In addition, the data analytics available on the platform will provide valuable support and reference data. To promote and disseminate the type of data available for download from the WATERNOMICS Platform, a bi-monthly (every 2 months) update will be circulated to staff and students at Coláiste na Coiribe giving key statistics from the previous period.

Responsibility: The NUIG-Deri WATERNOMICS Team will prepare and circulate the e-bulletins at regular intervals.

Review: The effect of this WEM will be reviewed (by analysing data access numbers) on a two monthly basis following its introduction.

Deadline: The first e-bulletin will be circulated after February 2016 (M25).

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 6: Promote WATERNOMICS Platform for new Apps

Description: The WATERNOMICS Platform will be available to host innovative water information based applications developed by any 3rd party. The applications must be non-commercial and free of any-charge and have a water/WATERNOMICS related focus. The College of Engineering and Informatics at NUIG has a number of Engineering and Information Technology Programmes specifically aimed at secondary school students and the relevant course directors will be contacted to make them aware of the facility and in

particular the involvement of Coláiste na Coiribe with the WATERNOMICS Project. Many of the second level programmes at NUIG are Summer Schools but consideration can be given to developing a short app development programme for Coláiste na Coiribe Students with particular emphasis on launching to the WATERNOMICS Platform.

In addition, the WATERNOMICS Project has a number of dissemination channels such as twitter https://twitter.com/WATERNOMICS_eu and the project website http://WATERNOMICS.eu/ where the platform facility will be promoted to other secondary schools in Galway.

Responsibility: The NUIG-Deri WATERNOMICS Team will be responsible for the promotion of the WATERNOMICS Information System as a platform for developing applications.

Deadline: The promotion will commence in February 2016 (M25).

Review: The effect of this WEM will be reviewed on a twice-monthly basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

3. Reduce Consumption

The key WEMs identified to **Reduce Consumption** of water at the Engineering Building are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is as described in Section 5.3 above; simply a measure of total and system specific water consumption patterns relative to baselining for given time periods.

WEM 7: Water Consumption Awareness

Description: The successful effect of the measures described above as Specific Water Efficiency Measures towards Objective 1: Increase Awareness & Objective 2: Promote Education will be to increase the overall awareness of water consumption at the Engineering Building and lead to a change in behaviour and ultimately a reduction in water consumption. The proposed methodology for the measurement of awareness is given in 5.3 above. The water consumption at the pilot will be measured by the new metering in the building.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for coordinating with the main building contractor regarding the installation of metering to the WATERNOMICS' Project Team requirements and establishment of a suitable data collection system as well as the analysis of the data.

Deadline: The specific measures to increase awareness of water consumption are given in Objective 1: Increase Awareness above. The measurement of water consumption data in line with the proposed metering plan described in D2.2 will commence at Coláiste na Coiribe in October 2015 (M21).

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 8: Gamification

Description: The WATERNOMICS Platform will facilitate the gamification of water information presentation and dissemination. The success of gamification as a learning and dissemination tool will similar to the above specific WEMs increase the overall awareness of water consumption at the Pilot Site and lead to a change in behaviour and ultimately a reduction in water consumption. The number of users of the games will be recorded by game sign in which will provide data in relation to the use and users of the game. The water consumption at the pilot will be measured by the existing and new metering in the building.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for the development of the WATERNOMICS Game.

Deadline: The WATERNOMICS Game will be launched on the Platform in February 2016 (M25).

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 9: Engagement

Description: The WATERNOMICS Project seeks to engage Pilot Site occupants in the issue of water consumption. This process of engagement is reflected in the WEMs described above and in particular for Objective 1: Increase Awareness & Objective 2: Promote Education. The physical intervention strategies that are often popular as WEMs are generally self-enforcing and passive in terms of user engagement i.e. water saving devices such as Hippo http://www.hippo-the-watersaver.co.uk/ and rainwater harvesting systems.

Responsibility: The NUIG-Deri WATERNOMICS Team is responsible for the installation of demonstration units and trialling of the physical intervention techniques.

Deadline: The physical intervention techniques will be trialled after April 2016 (M27).

Review: The effect of this WEM will be reviewed by feedback survey during the demonstration period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

4. Improve Operation

The specific WEMs identified to **Improve Operation** at the Coláiste na Coiribe Pilot are discussed below. The proposed methodology for assessing whether the measures have achieved the objective is as described in Section 2.4.5 above. In summary, the success of these WEMs will be measured by a reduction in time to identify faults.

WEM 10: Installation of Metering

Description: In line with the Measurement Frameworks Report D2.2, 14 water meters were installed at Coláiste na Coiribe in August and September 2015. 6 of these were as per the original building construction project and a further 8 were added by the WATERNOMICS Project. The meters will provide information with respect to specific water usage at the Building. The proposed metering strategy is designed to allow the identification of significant and specific water uses through identifiable flow signatures.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for the installation and commissioning of metering at the NUIG Pilot Site.

Deadline: The measurement of water consumption data in line with the proposed metering plan commenced at the Engineering Building in NUIG in September 2015 (M20). The final three additional meters will be installed in October 2015.

Review: The effect of this WEM will be reviewed on an ongoing basis for the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 11: Water Network Information

Description: Additional, timely and relevant information regarding the operation of the water system at Coláiste na Coiribe will be facilitated by a remote connection from the NUIG Engineering BMS to the building control system being installed at the school. The building control system does not facilitate any archiving or data transfer so a data transfer protocol was developed to allow data from Coláiste na Coiribe to be transferred to NUIG Engineering Building BMS system and from there to the Waternomics Cloud Storage. Data from Coláiste na Coiribe is collected from this space and analysed by specific applications hosted by the WATERNOMICS Platform. The provision of specific water usage information based on the stakeholder user requirements and KPIs will provide network data to plan upgrades and respond to faults and other unexpected occurrences.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for development of the WATERNOMICS Information System Platform and associated applications that will provide the output of water meter and other relevant data analysis.

Deadline: The WATERNOMICS Platform will be launched in January 2016 (M24).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an on-going basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Demonstration Activities.

WEM 12: Identification of Faults

Description: Additional, timely and relevant information regarding a well-operating water system at Coláiste na Coiribe will provide a baseline for the identification of faults or unexpected occurrences. This fault detection facility is currently under development as a methodology and will be automated by a software application hosted by the WATERNOMICS platform

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for development of the WATERNOMICS Information System Platform and associated fault detection application.

Deadline: The WATERNOMICS Platform Fault Detection Application will be launched in March 2016 (M30).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an on-going basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Development Activities.

WEM 13: Diagnosis of Faults

Description: Additional, timely and relevant information regarding the function of the water system at Coláiste na Coiribe will provide for the elimination of fault causes and provide a framework for the diagnosis of common faults. This fault diagnosis facility is currently under development as a methodology and will be automated by a software application hosted by the WATERNOMICS platform.

Responsibility: The NUIG-Deri WATERNOMICS Team are responsible for development of the WATERNOMICS Information System Platform and associated fault diagnosis application.

Deadline: The WATERNOMICS Platform Fault Detection Application will be launched in March 2016 (M30).

Review: The effect of this WEM will be increase information regarding water consumption and its effect will be in this context on an on-going basis over the pilot control period.

Resources: Staffing assignments are provided in the Project DOW to complete Development Activities.

9.1 WEM Dissemination activities at Coláiste na Coiribe

Table below summarises the dissemination activities associated with the proposed efficiency measures described in the pilot plan.

Table 9-1: Dissemination activities and WEMs at Coláiste na Coiribe

No	WEM Ref.	Dissemination Aim	Month	Targeted audience				
				Teaching Staff @ Coláiste na Coiribe	*Students @ Coláiste na Coiribe*	Operational or Management Staff	Research Community	Public/Parents
01	WEM 01	Email re Platform Launch	M24	X	X	X		X
02	WEM 02	Showcase WATERNOMICS Data/Platform	M24	X	X	X		X
03	WEM 03	Presenting water consumption information to engage consumers	M25	X	X	X		X
04	WEM 04	Present WATERNOMICS Project to create awareness	M26	X	X	X		X
05	WEM 05	Promote use of WATERNOMICS Platform Data	M26	X	X	X	X	X
06	WEM 06	Promote use of WATERNOMICS Platform for App Developers	M26	X	X	X	X	X

07	WEM 09	Promote innovative ideas in water consumption	M27	X	X	X		

9.2 Implementing the Pilot Plan Phase 2 – Do

Efficiency Measurement Implementation

The Action Plan outlined in Section 2.4.7 above describes the specific WEMs proposed for Coláiste na Coiribe. The programme of implementation of the measures is outlined in the Gantt chart given in Appendix A of this report.

Meter Installation and Configuration

The installation of 14 electromagnetic and turbine meters at Coláiste na Coiribe was carried out in September and October 2015. The 8 meters that were additional to the original M&E design for the school building are described in D2.2 Measurement Frameworks, Table 12. The installation work was carried out by the main building contractor responsible for the construction of the school building. A specialist building control company www.sygma.com set up a Cylon www.cylon.com building control system at the site to which all of the meters are connected. Sygma representatives are currently working with members of the NUIG WATERNOMICS Project Team to finalise the connection of the Coláiste na Coiribe control system to the NUIG Engineering Building BMS.

Figure 9-4 Control Panel CnaC

Figure 9-5 CWS Meter

Figure 9-6 MWS Meter

The water meter installation details are provided in Table 5.3 below for convenience. All of the meters take continuous measurements from the subject water system and the results are logged in daily, weekly and monthly usage rates and cumulative consumption.

Table 9-2: Proposed Water Metering at Coláiste na Coiribe

No.	Water meter Ref.	Water Usage Description Measurement	Units	Installation Status
1	WM001	Mains Water Inflow	m^3	Complete August 2015

2	WM002	Mains Water into Cold Water Tank	m^3	Complete August 2015
3	WM003	Mains Water into Rainwater Tank	litres	Complete August 2015
4	WM004	Cold Water Gravity Supply from Tank	litres	Complete August 2015
5	WM005	Rainwater from U/G Collection Tank to Rainwater Header	litres	Complete August 2015
6	WM006	Calorifier Cold Water Feed	litres	Complete September 2015
7	WM007	Rainwater Gravity Feed from Tank	litres	Complete September 2015
8	WM008	Cold Water Male Bathrooms Block 1 Ground & 1st Floor	litres	Complete August 2015
9	WM009	Cold Water Female Bathrooms Block 1 Ground & 1st Floor	litres	Complete September 2015
10	WM010	Cold Water Male Bathrooms Block 1 2nd Floor	litres	Complete September 2015
11	WM011	Cold Water Female Bathrooms Block 1 2nd Floor	litres	Complete September 2015
12	WM012	Cold Water Supply to Block 3 Showers	litres	Complete September 2015
13	WM013	Cold Water Block 2 Home Economics Room	litres	Complete September 2015
14	WM014	Mains Water Supply to Staffroom Block 1 2nd Floor	litres	Complete September 2015

Data Collection

Water usage data recorded by the water meters at Coláiste na Coiribe are collected by the buildings control system which allows limited storage. The control system will be remotely accessible by the NUIG BMS which will collect data from the 14 meters at Coláiste na Coiribe for transfer to the WATERNOMICS Amazon Web Space. This process is described in earlier project reports D2.2 and D3.2.

Other data collected as part of the project will be recorded by online questionnaire survey using an application such as www.surveymonkey.com or by interview i.e. in the case of the Physical Intervention Demonstrations. Much of the important data recorded for the pilot will be collected by the WATERNOMICS Applications.

Water Information System (The WATERNOMICS Platform) Deployment

The WATERNOMICS Platform developed by the WATERNOMICS Project Team will be launched in January 2016 (M26). Dissemination of information regarding the WATERNOMICS platform is described in the Action Plan outlined in Section 2.4.7.

Staff Training

The Water Information Seminars and WATERNOMICS Seminars described in the pilot plan as WEM 3, WEM 4 & WEM 5 will provide information to staff on the operation of the WATERNOMICS Platform, the WATERNOMICS Project and the objectives of implementing a Water Management Program at the site.

10 The Next Phases – Check & Act

10.1 Phase 3 - Check

Following the Implementation or "Do Phase", the Check Phase of the WATERNOMICS Methodology provides a systematic 'review and react' process to monitor the efficacy of water management interventions. This phase involves inspections, functional performance testing, data trending and analysis.

The extensive monitoring systems implemented at the Pilots will provide regular and recent or real-time data to the WATERNOMICS Applications for analysis. These data analysis applications will provide key results in terms of water consumption, retention time, user access etc. in useful and easily assimilated formats. This analysis will facilitate the easy detection of unexpected patterns or events i.e. high levels of water consumption or other unexplained trends. Specific applications based on the identified user and stakeholder requirements will make present relevant and timely data analysis to platform users. In particular, this 'always-on' availability of Water Network Information will facilitate early detection of inefficient or unsatisfactory operations

In addition, data analysis in the form of leak detection and fault detection and diagnosis will also be carried out at the pilots. Audio-based leak detection sensors being developed as part of the WATERNOMICS Project will be used to conduct physical leak detection measurements at the pilots. In particular, at the Linate Pilot site, it is proposed to development a hydraulic model of the overall water network implementing leakages scenarios and comparing the real measurement data gained from the water sensors installed in the network with the ones obtained from the model in every leakages scenario in term of water flow and pressure. The comparative analysis will identify likely areas of suspected leakage.

The fault detection and diagnosis applications being developed as part of the WATERNOMICS Project are both rule based and analytical. The applications will allow the early detection and diagnosis of faults such as network operation at sub-optimal pressures, a stuck toilet or faucet, or a sudden leak which creates an abnormal data signature.

In terms of meeting the Project Specific Objectives, the methodology by which the success of these will be measured is outlined in detail for each pilot in Sections 2.3, 3.3, 4.3 and 4.3 of this report.

Program Analysis

The intent of the program analysis activity is to determine if all previous actions are complete and functional. In the pilots it will be performed in the form of a WEM checklist, status table or regular reporting schedule (e.g. bi-monthly internal audits) recording the status of the Program.

The WATERNOMICS Platform will include this facility as operational dashboard application showing the status of measureable KPIs, Project Specific Objectives and to allow the assessment of the effect of particular interventions. Its aim is to assess the functionality of the Water Management Program its WEMs, objectives / targets and to inform the development of new measures for optimizing water management. The Program Analysis facility is intended not only as a control measure but as an opportunity to further Increase Awareness of issues regarding the consumption of water and water network problems. In this regard, a program analysis may also contain a description of follow-up activities, monitoring and measurement of results, as well as a description of responsibilities.

The Program Analysis report actual progress comparative to a Water Management Program's planned activities.

Assess Performance

The assess performance activity is the execution of the calculation methods and adjustments established in the measurement & verification plan from the Plan Phase plus the determination of performance related to any measureable KPIs or objectives not part of these calculations. In the pilots the verification be carried out principally through the evaluation of measureable KPIs and Project Specific Objectives and automated by the Water Information System – KPIs dashboard. Any Significant deviations in performance indicated will require a detailed study on the measurement data in order to understand the type of measures to implement in the Water Management System to counter these deviations. In the case of significant deviations in the measurement of water consumption, Checking and calibration of equipment will be recommended.

The WATERNOMICS Teams responsible for each pilot will develop a schedule of planned evaluations (likely to be monthly or bi-monthly or quarterly) to evaluate WEMs implementation and check the effectiveness of the system in achieving the Project Specific Objectives with particular attention to WEMs introduced in the last period.

Find and Fix

The Fault Detection and Diagnostics (FDD) application being developed as part of the WATERNOMICS Project fulfils much of the Find and Fix aspect of the Check Phase.

In the Commercial and Public/Mixed Use Pilots, an automated system of fault detection based on an innovative algorithm “ADWICEi” (Anomaly Detection With fast Incremental Clustering) will be applied. This FDD task is under development and will be the subject of a later Project Deliverable D4.2 (Burbeck et al., 2007), (Raciti et al., 2012) and (Racti, 2013).

In brief, by modelling the water system and selecting the best set of parameters that characterize the operational conditions (such as flow rate, pressure, energy consumption for pumps system, ground water level for the wells, etc.) assuming normal operation, i.e. absence of problems (leaks, faults, etc.) the facility will allow identification of faults in a complex water network. The algorithm will automatically perform a comparison between the base line with the operational values observed by the water sensors installed in the network in real time. When baseline data and measured data don’t match the algorithm considers the data point as an outlier and an alert is generated.

ADWICE algorithm will be used in two different ways:

1) To check system faults: this could be developed by knowing some parameters of the normal operation such as output pressure/ energy consumption. If we know the normal operation value of these parameters when one of these or all change in a strange way there could be a fault of the system and ADWICE could send an alarm to point it out.
2) Using the hydraulic model of the water network, if we know the normal (without leakages) operation values for each line and node (flow rate and pressure) and we obtain form water meters different values from the normality than there could be a leak in the system and ADWICE could send an alarm showing which area of the water network could be interested by the problem.

The ability to detect faults brings added value to a Water Management System by increasing awareness of the role of system faults in (1) increasing costs and (2) causing meter problems at the consumer level and (3) contributing to higher water consumption rates. The reasons for faults can include equipment over or under dimensioning, equipment malfunction, pipe blockages, leaks, behavioural errors, procedural errors, etc. Detecting and diagnosing faults at the earliest possible stage can lead to maintenance, repairs, savings well beyond those associated with only water savings as well as taking actions to eliminate the cause of the problems.

Document Progress

At each of the pilot sites, this activity will be actioned by the preparation of a final report to the pilot management and interested parties in the organisation. At pilots where review workshops have been held with users and stakeholders, the report will include feedback from those invited to participate. The role of the final report is to present outcomes, explain deviations and non-conformity and to identify possible improvement measures. It also facilitates user awareness about both the targets achieved and the deviations registered to avoid the problems and help to decide corrective actions.

For effectively gather feedback and provide dissemination channels within the pilots, where relevant a specific communication strategy may be developed for the WATERNOMICS Project within the organization. An internal communication procedure will include how staff members are made aware of water issues, how decisions are made or information is disseminated to staff etc. The communication procedure also will cover the process in responding to comments and suggestions by contractors working for or on behalf of the organization. Methods for communication include, for example: meetings, teleconferences, briefings, e-mails, posters, memos, etc.

10.2 Phase 4 – Act

At each Pilot Site, the WATERNOMICS Team together with the primary stakeholder/manager/householder will be given the opportunity to review the performance of the Water Management Program and its effectiveness at meeting the Pilot Specific Objectives. The focus of the meeting will be the final report prepared for the Pilot by the responsible WATERNOMICS Team.

Institutionalize Changes

As described in the WATERNOMICS Methodology, where a particular measure has proved successful it can be considered for inclusion into company policy, household routine or facility protocol, thereby institutionalizing the change. In addition, a successfully trialled measure may be considered suitable to extend to other geographic or functional areas of the pilot and become corporate policy or similar. Institutionalizing change in particular in a large organization but also at a local level in households is dependent on the commitment of management / householders. The WATERNOMICS Team will work with the pilots to support their efforts to make permanent any successful measures at the pilots. Conversely, WEM's that have not proved effective or successful, will be evaluated by the WATERNOMICS Team and many result in a revised strategy as described below in Evaluate and Adjust Strategy.

Close Appropriate Water Efficiency Measure

Being an iterative methodology, it is important that when developing and implementing a Water Management Program that suitable points are identified for assessment, change and progression. This provides for the planned closure of a WEM to facilitate reporting on progress. At each pilots, the end of the pilot control period will mark the closure of many of the WEMs and the final reporting described above will recommend or otherwise these for permanent inclusion.

Evaluate and Adjust Strategy

For WEMs that do not close, the "Act" phase implemented corrective actions and/or adjusts strategy to realign the WEMs to the expected targets. At each of the pilot sites, the WATERNOMICS Team will work with the pilot management/stakeholders to fully evaluate the program strategy and identify any corrective actions. The program plans presented in in this report, incorporate opportunities for the continuous assessment of performance of WEMs during the Pilot Control.

Communicate Progress

As outlined in the WATERNOMICS Methodology, to fully realize the less obvious benefits of implementing a successful Water Management Program, relevant stakeholders and, in the case of a corporate or public body, the general public must be made aware of the measures undertaken. The dissemination of the project and its results will be the subject of a later project deliverable.

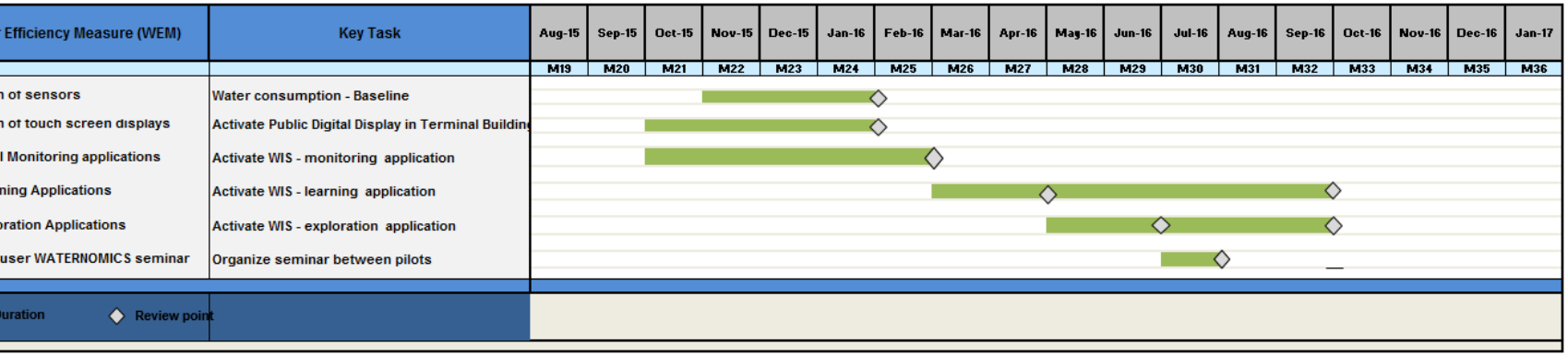
Determine Next Actions

For each of Pilots sites, the WATERNOMICS Team will recommend with appropriate justification from the analysis of results the adoption of certain successful measures and the exclusion or revision of others this setting each pilot on course to enter a new PDCA cycle where; constantly reviewing and revising the system in a continuous improvement loop.

Appendix A – Pilot Programmes

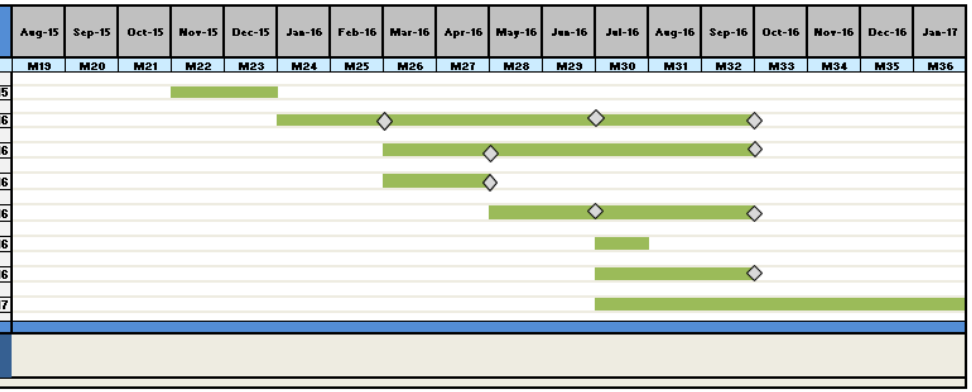
Linate Pilot - Pliot Plan Programme

WEM ID	Water Efficiency Measure (WEM)	Key Task
WEM 1	Installation of sensors	Water consumption - Baseline
WEM 2	Installation of touch screen displays	Activate Public Digital Display in Terminal Buildin
WEM 3	WIS - initial Monitoring applications	Activate WIS - monitoring application
WEM 4	WIS - Learning Applications	Activate WIS - learning application
WEM 5	WIS - Exploration Applications	Activate WIS - exploration application
WEM 6	Open End-user WATERNOMICS seminar	Organize seminar between pilots



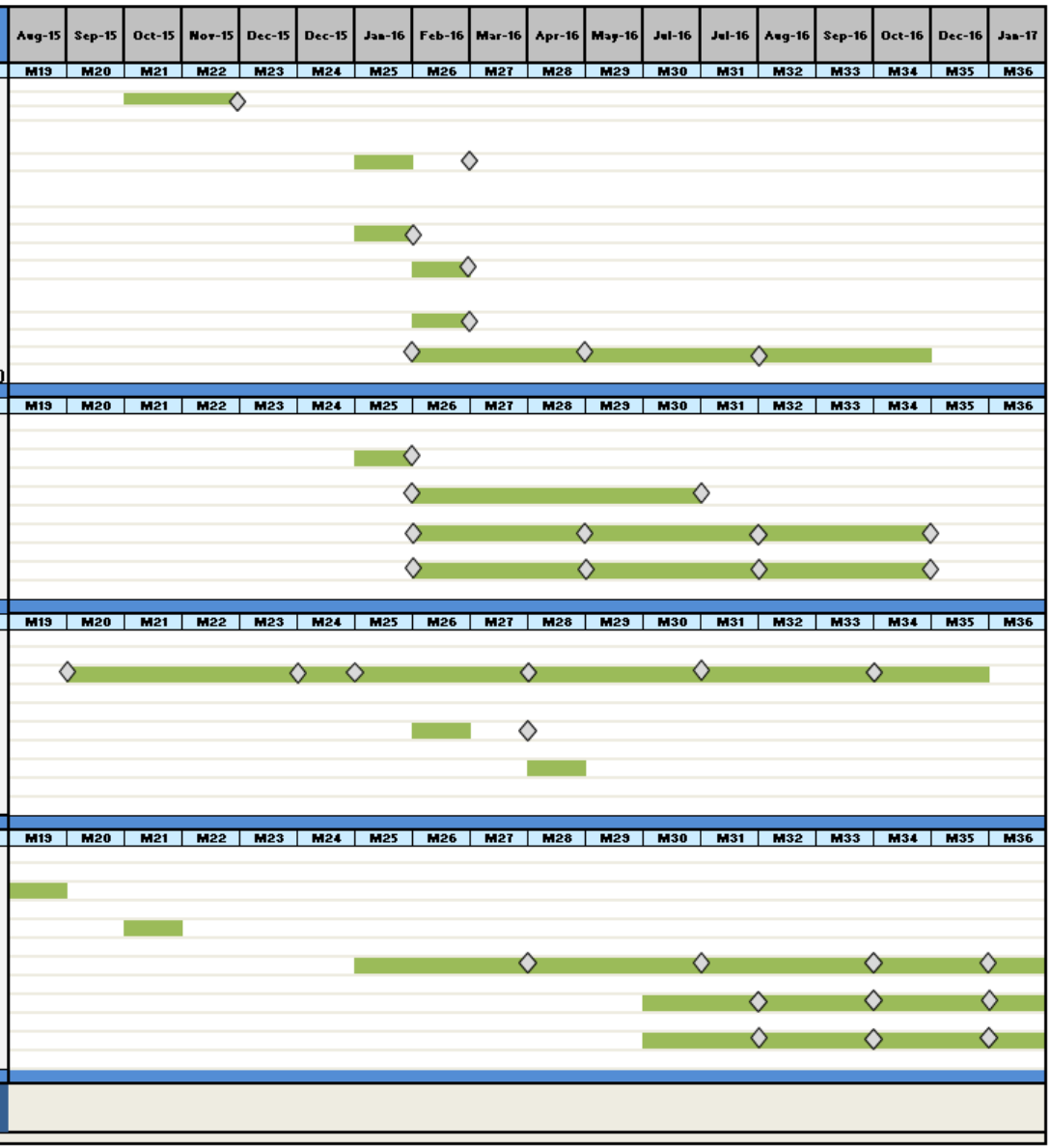
Thermi Pilot - Pilot Plan Programme

Activity ID	Water Efficiency Measure (WEM)	Start	End
WEM 1	Installation of sensors	01 November 2015	31 December 2015
WEM 2	Introduction of WATERNOMICS Applications Platform and initial Monitorir	01 January 2016	01 October 2016
WEM 3	Introduction of WATERNOMICS Learning Applications	01 March 2016	01 October 2016
WEM 4	In-school training program	01 March 2016	01 May 2016
WEM 5	Introduction of WATERNOMICS Exploration Applications	01 May 2016	01 October 2016
WEM 6	Open End-user WATERNOMICS seminar	01 July 2016	01 August 2016
WEM 7	Introduction of WATERNOMICS Gaming Applications and Gamificaiton fea	01 July 2016	01 October 2016
WEM 8	WATERNOMICS public data to be linked with the municipality website	01 July 2016	31 January 2017

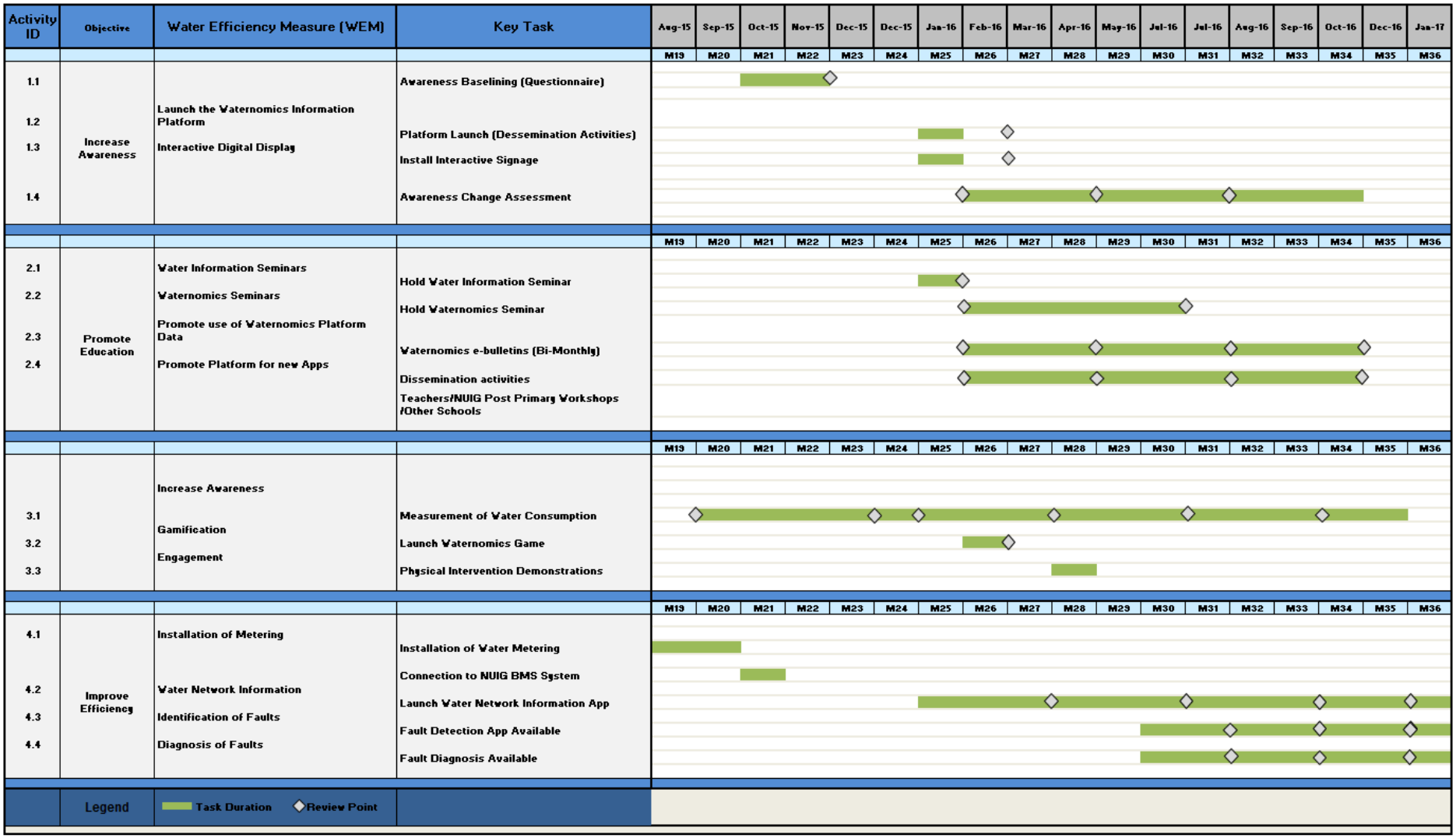


NUIG Engineering Building Pilot Site - Pilot Plan Programme

Activity ID	Objective	Water Efficiency Measure (WEM)	Key Task
1.1	Increase Awareness		Awareness Baselining Survey
1.2		Public Display Relevant Water Consumption Data	Activate Public Digital Display
1.3		Launch the WATERNOMICS Information Platform	Platform Launch (Dissemination)
1.4		Interactive Digital Signage Kiosk	Install Digital Signage Kiosk
1.5		Interactive Signage at Water Meter Installations	Install Interactive Signage
1.6			Awareness Change Assessment (Intermittent Surveys)
2.1	Promote Education	Water Information Seminars	Hold Water Information Seminar
2.2		WATERNOMICS Seminars	Hold Waternomics Seminar
2.3		Promote use of Platform Data	Waternomics e-bulletins
2.4		Promote Platform for new Apps	Dissemination Activities
3.1		Water Consumption Awareness	Measurement of Water Consumption
3.2		Gamification	Launch Waternomics Game
3.3		Engagement	Physical Intervention Demos
4.1	Improve Efficiency	Installation of Additional Metering	Installation of Ultrasonic Metering
4.2		Water Network Info - Platform	Installation of Additional BMS Meters
4.3		Identification of Faults	Launch Water Network Information
4.4		Diagnosis of Faults	Fault Detection App Available
			Fault Diagnosis App Available
	Legend	Task Duration / Review Point	



Coláiste na Coiribe Pilot - Pilot Plan Programme



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