(Projects submitting final reports after 1 January 2014 must use this format.)

LIFE Project Number

<LIFE08 ENVIT000390>

FINAL Report

Covering the project activities from 01/03/2010 to 31/10/2013

Reporting Date

<28/02/2014>

LIFE+ PROJECT NAME or Acronym

<ECOMAWARU>

Project Data

Project location	Municipality of Varese Ligure
Project start date:	<01/03/2010>
Project end date:	<28/02/2013> **Extension date:** <31/10/2013 >
Total Project duration (in months)	<44> months (including **Extension of** <8> **months**)
Total budget	960.122 €
Total eligible budget	942.372 €
EU contribution:	471.186 €
(%) of total costs	49%
(%) of eligible costs	50%

Beneficiary Data

Name Beneficiary	Comune di Varese Ligure
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Project Website	www.ecomawaru.it

1. List of contents

This document is the final technical report of the LIFE + Project "ECOMAWARU" and aims at providing a detailed account of the activities undertaken with respect to the objectives, actions and work plan envisaged in the project.

The report is organized in the following chapters:

Executive SUMMARY: Brief description of the project objectives, actions and means involved and final results of the project;

INTRODUCTION: Description of background, problems and objectives, with hypotheses to be demonstrated/verified by the project through technical/methodological solutions, expected results and environmental benefits;

ADMINISTRATIVE part: Description and evaluation of the management system. The chapter is divided into two sections. The first section includes a schematic presentation of project-phases, activities per phase and planning; Presentation of coordinating and associated beneficiaries and project-organization (organization chart: functions and actions, persons and companies). The second section provides a description of the progress stages of the project including the problems encountered and the significant deviations from the project stages foreseen in the proposal. Furthermore, the communication between the project beneficiaries and the Commission/Monitoring team is illustrated.

TECHNICAL part: Description of the technical progress of the project, the dissemination activities together with the evaluation of the project implementation and the analysis of long-term benefits. The chapter is divided into four sections. The first section reports the description of the detailed techniques, technology or methodology for each developed action. In addition, activities and outputs are described for each action in quantifiable terms compared with the objectives and outputs as stated in the Plan. Also, lists of deliverables (available information, handbooks, videos, publications, handouts, leaflets etc.) are described together with the major encountered problems/drawbacks. The second section illustrates the dissemination objectives and the activities carried on among different classes of recipients, the web portal, organization of workshops and participation to relevant conferences and publications. The third section describes the methodology applied for the project implementation and the results are compared against objectives. In particular, the relevance and the visibility of each achieved results is examined on both short and long-term period. Finally the forth section analyses qualitatively and quantitatively the long-term benefits in terms of environmental benefits (reduction of emissions), relevance and potential implementation of national and regional legislative framework, transferability, reliability and demonstration value of the project.

Comments on the financial report: Description of the incurred cost, the accounting system and the allocation of the costs per action

2. Executive Summary (maximum 5 pages)

The general objective of the ECOMAWARU project deals with the environmental protection of local waters (springs, wells, water courses) in the Municipality of Varese Ligure, mainly focusing on the problems related to the management of storm water and wastewater. The first objective of the ECOMAWARU project is to demonstrate the feasibility, reliability and efficiency of the phytodepuration technique with micro algae as a tertiary treatment for wastewater management. Secondly the project aims at providing a base of knowledge that can be integrated within the local regulation in order to support the spreading of "green" technologies such as phytodepuration techniques to a sustainable approach in terms of integrated water cycle management. Finally the project aims at transferring the basic knowledge on design, installation, maintenance, management and control procedures of the phytodepuration system using micro algae, involving different targeted audiences.

The Project involves the Municipality of Varese Ligure who is in charge of managing the waste water treatments plant of Varese Ligure and San Pietro Vara as well as authorizing storm water discharges and waste water discharges at small scale (scattered houses). In addition the project involves DICCA as scientific consultant in the framework of integrated water cycle management and in particular concerning the phytodepuration technique.

In the following section, the main actions and results of the project are summarized.
The first phase of the project deals with a review of the scientific literature concerning the phytodepuration techniques for the wastewater and storm water runoff treatment in rural areas. Furthermore data regarding the management of wastewater and storm water discharges and the related state of degradation of runoff quality particularly focusing on the impact of the main infrastructure of the urban environment are collected to be implemented on a GIS platform.
At the same time a survey is carried out in order to select three experimental sites and install two prototypal plants in the Municipality of Varese Ligure:

1. a closed microalgae photobioreactor (pilot scale), installed at the wastewater treatment plant of S. Pietro Vara (500 EI) in order to refine a fraction of the treated effluent;
2. an open photobioreactor (pond), installed in Le Pezze in order to refine the treated effluent from an Imhoff tank of a farmhouse (10EI);
3. two storm water monitoring stations, installed at the municipal waste depot in the Baghino hamlet, in order to characterize the storm water runoff at the inlet and outlet sections of the existing treatment system (on-line tank).

The second phase of the project concerns the selection of microalgae, the design, construction and installation of the prototypal phytodepuration plants and storm water runoff monitoring stations. As for the selection of microalgae, water samples are collected at the experimental sites. The autochthonous algal biomass is selected in the effluent of the San Pietro Vara wastewater treatment plant. The developed biomass has been inoculated in the prototypal phytodepuration plants thus resulting in an heterogeneous biomass including different species of the algal cells, protozoa and small metazoan.

The designing and realization of the prototypal closed system (photobioreactor) were carried out step by step in order to identify the optimal configuration for the process (horizontal or vertical module, feeding in series or in parallel, degassing capacity, etc.).

The definitive photobioreactor configuration consists of two vertical modules, each one composed by 20 Plexiglas tubes placed in parallel, a recycling tank, a settling tank, pumps for recycling and feeding. The open microalgae system (pond) consists of two rectangular fibreglass tanks connected in series with a total capacity of 4200 l, two photovoltaic panels to provide energy to a recycling pump.

The phytodepuration plants monitoring activity has been carried out between June 2011 and September 2013. Two samples (inlet and outlet) for each plant has been collected weekly for a total of 228 samples analyzed for a total of 1824 analysis.

As for storm water monitoring stations, the monitoring campaign has been carried out between December 2011 and November 2012 in order to characterize untreated (VARESE-IN) and treated (VARESE-OUT) storm water runoff quality by collecting 19 rainfall-runoff events. In particular 153 composite samples corresponding to 612 storm water runoff samples collected at the VARESE-IN station while 158 composite samples corresponding to 632 storm water runoff samples collected at the VARESE-OUT station have been analyzed.

The ECOMAWARU project fully achieved its main objectives in demonstrating the performances of the prototypal phytodepuration systems and the storm water traditional treatment system. The analytical programme allows to verify that the microalgae phytodepuration treatment systems are efficient in removal of N and P, although the efficiency is strongly affected by the seasonality. The biomass produced by the two prototypal systems is easy to agglomerate and settle; therefore specific systems to separate the biomass from the liquid medium are not necessary. Regarding the storm water runoff monitoring programme carried on at the inlet and outlet sections of a traditional treatment system (on-line tank), results demonstrate that the untreated pollutant load is limited in particular in terms of heavy metals. The comparison between the untreated and treated pollutant load reveals a limited abatement of the acute concentration values (good removal efficiency is observed only for TSS, Pb and HC).

The last phase of the project concerns the drafting of a technical manual for the design, construction and management of microalgae phytodepuration systems. Furthermore a proposal to be included in the Municipal building code concerning the phytodepuration techniques has been elaborated.

To complement this working effort and to ensure wide exploitation of the results dissemination to different classes of recipients has been developed in various forms. In particular a web portal has been implemented (www.ecomawaru.it) and meetings organized within the framework of an existing and successful professional training activity background.

In the following table, the deliverables due for each action, together with the occurrence they had been reported to the European Community have been summarized.

ACTION	Deliverable	Planned	Actual	Delivery to EC with
1	D1: Technical report on the actual microalgae practices	30/06/2010	30/06/2010	Inception Report
2	D2: Technical report on system specifications	30/09/2010	30/09/2010	Inception Report
	U2.: Specification Update on the "monitoring campaign"	31/03/2011	31/03/2011	Mid-term. Report
3	D3.A: Technical report on preliminary database for the GIS platform	30/06/2011	30/06/2011	Mid-term. Report
	D3.B: Technical report on the GIS platform implementation	30/09/2012	30/09/2013	Final Report
4	D4.1 Technical report on sites selection	30/09/2010	30/09/2010	Inception Report
	D4.2 Technical report on microalgae selection	31/12/2010	31/12/2010	Mid-term Report
	D4.4 Technical report on systems as installed	30/06/2011	30/06/2011	Mid-term Report
5	D5 Technical report on the collected data during the monitoring campaign	30/09/2012	30/09/2013	Final Report
6	D6.1: Technical report on the achieved results	28/02/2013	31/10/2013	Final Report
	D6.2: Technical report on the microalgae and final effluent reuse	28/02/2013	31/10/2013	Final Report
7	D7.1: Technical report on the draft proposal to be included in the Municipal Building Code	28/02/2013	31/10/2013	Final Report
	D7.2: Report on the technical handbook	28/02/2013	31/10/2013	Final Report
8	D8.A Technical report on the design of the project logo	30/09/2010	30/09/2010	Inception Report
	D8.B Technical report on informative brochures	31/12/2011	31/12/2011	Final Report
	D8.C Press release	28/02/2013	31/10/2013	Final Report
	D8.D Layman's report	28/02/2013	31/10/2013	Final Report
9	D9.1A: Mid Term report on related meeting minute	31/12/2011	31/12/2011	Final Report
	D9.1B: Final report related meeting minute	28/02/2013	31/10/2013	Final Report
	D9.2: Technical report on the Monitoring Protocol	31/12/2010	31/12/2010	Final Report
	U9.2: Update of the Technical report on the Monitoring Protocol	28/02/2013	31/10/2013	Final Report

Table 1 List of the deliverables due for each action, together with the occurrence they had been reported to the European Community.

3. Introduction (1 page)

This project deals with the environmental problem of the receiving water bodies quality. In according to directive 2000/60/CE, this demonstration study intends to improve the water quality in order to achieve the "good ecological state" of receiving water bodies. In particular, it concerns the application of "green" technologies such as phytodepuration solutions with micro algae in the treatment process of civil effluents of rural areas.

The ECOMAWARU project demonstrates the feasibility, reliability and efficiency of using the phytodepuration technique with micro algae as a tertiary treatment for the civil effluents of rural settlements in the municipality of Varese Ligure. Because of the high number of hamlets and of the economic feasibility, the area of Varese Ligure is not completely served by a public sewer system. As for the scattered houses (rural areas), the entire wastewater effluent is treated by using phytodepuration with micro algae (pond), while as for the urban catchment area, a portion of the wastewater outflow from the municipal treatment plant is conveyed to the "green" tertiary treatment (photobioreactor). Note that the phytodepuration technique with micro algae is a land-saving solution compared with other phytodepuration techniques.

The main expected results of this project are summarized as follows:

1. the development of a water and wastewater management scheme adopting phytodepuration with micro algae;
2. the implementation of two prototypal treatment plants, an open photobioreactor (pond) and a closed photobioreactor (photobioreactor), at two different spatial scales;
3. the organization of a comprehensive data base including the biomass characteristics, the quality (chemical physical parameters) of storm water and wastewater influent and effluent in the area of Varese Ligure;
4. the elaboration of a draft proposal regarding the use of phytodepuration technique to be included in the Varese Ligure Municipal Building Code in force;
5. the drafting of a handbook containing the technical documentation about design installation, maintenance and management of the phytodepuration system focusing mainly on micro algae.

The main environmental benefits of this project are: the improvement of the water quality of receiving water bodies; the energy conservation of the prototypal treatment plants with respect to the traditional treatment plants; the no use of chemical additives in the treatment process and the reduction of carbon footprints due to the use of photosynthetic process.

As for the no use of chemical additives, note that the traditional tertiary treatments (especially for Phosphorous removal) generally use chemical additives, with the consequent production of a sludge that must be treated and disposed while the "green" tertiary treatment with micro algae does not use any type of chemical additives and allows to obtain a high value product that can be reused, such as micro algal biomass. Finally, the developed technologies are ecological friendly, easy to implement in the rural existing realities and sustainable in terms of integrated water cycle (zero disposal production).

4. Administrative part (maximum 3 pages)

4.1 Description of the management system

The ECOMAWARU project under the supervision of the municipality of Varese Ligure acting as coordinating beneficiary and DICCA as associated beneficiary was positively concluded. The proper functioning of the partnership, characterised by a spirit of collaboration and complementarity of skills, allowed that the implementation of the foreseen actions were concluded with linearity.

The project can be divided in five main phases which form part of the 9 project actions:

1 phase "**Studies and surveys of the territory**" includes :

Action 1 *"State of the literature"*: Detailed analysis of the literature on the current uses of microalgae; **Action 3** "*Analysis of the territory":* detailed investigation on the wastewater and storm water management in the municipality of Varese Ligure. The data collected was implemented in a GIS platform;

2 phase "**Planning**" includes :

Action 2 *"Specifications"*: definition of the general architecture and technical specifications relating to the experimental activities. **Action 4** *"Planning, construction, installation and management of micro phytodepuration systems"*: with the corresponding 4 sub-actions led to the selection of sites, the identification of the autochthonous microalgae, the design and the realization and fully operational tests of two prototypal plants and two storm water monitoring stations;

3 phase **"Testing"** includes:

Action 5 *"Monitoring campaign"*: led to data collection, samples collection and laboratory tests performing.

4 phase "**Analysis of the results and their potential practical uses**" includes:

Action *6* *"Analysis of the results"* with the corresponding two sub actions, led to the validation and elaboration of the data collected during the monitoring programme and the definition of the procedure for the biomass reuse. **Action 7** *"Set of rules and technical documentation"* with the corresponding 2 sub-actions led to the collection of national and European regulations in the field of wastewater and storm water management, the drafting of a proposal to be included in the municipal building regulations act and the drafting of a manual (handbook) on good practices and processes of "green technique" for wastewater management.

5 phase "**Communication and project management**" includes :

Action 8 *"Dissemination"*: led to the organization of three informative events, drafting of informative materials (posters, Layman's report, CD, web site…) the setting-up of information points (bulletin board and Kiosk in the town hall). **Action 9** *"Project management and monitoring"* with the corresponding 2 sub-actions was devoted to actions related to the management and monitoring of the project.

During the development of the project the coordinating beneficiary , Project Leader, filled the role of being responsible for the overall management of the partnership, therefore taking on the responsibility of all technical and financial aspects of the project, and also the responsibility of the documents regarding the management of the project (monitoring protocol, report on the application of the monitoring protocol, report on related meeting minute) and all communications with the European Commission.

In addition to activities purely related to the project management (action 9), the coordinating beneficiary was also the Action Leader of action 3 and action 8.

The associates beneficiary initially represented by the Department of Chemistry and Engineering (DICheP) now Department of Civil Engineering, Chemistry and Environment

(DICCA) (communicated to the European Commission by the coordinating beneficiary on the 15.06.2012) undertook the role of the scientific leader. This role saw the programming and the realization of the actions with more scientific content: action 1, 2, 4, 5, 6 and sub action 7.2. In addition to these more specialized actions DICCA worked on the realization of Action 8 "Dissemination".

The implementation of the project was also able to rely on the figure of a project manager who provided assistance throughout the project implementation. The role of the project manager was first covered by the Engineer Mr. Coniglio and later with the assignment in June 4, 2012 by the Company Srl A4 (Communication was made to the European Commission of the coordinating beneficiary of 15.06.2012).

A summary of the reference person for each action:

Action 1: Action leader DICCA person of reference: Prof. Rovatti;

Action 2: Action leader DICCA person of reference: Prof. Rovatti;

Action 3: Action leader COVA person of reference: Massimo Serventi with the Prof. Mauro Rovatti (DICCA);

Action 4: Action leader DICCA person of reference: Prof. Rovatti;

Action 5: Action leader DICCA person of reference: Prof. Rovatti;

Action 6: Action leader DICCA person of reference: Prof. Rovatti;

Action 7.1: Action leader COVA person of reference: Massimo Serventi;

Action 7.2: Action leader DICCA person of reference: Prof. Rovatti;

Action 8: Action leader COVA person of reference: Michela Marcone

Action 9: Action leader COVA person of reference: Michela Marcone

Secretary of the project: Cristina De Paoli (COVA).

The implementation of each of the actions listed above as well as having benefitted from the joint action of the partners was able to count on the workgroup made available by the two structures.

In addition to the activities carried out individually by each partner in relation to each action, the shared actions of monitoring and planning of the project, the countless and constant phone calls and emails made between the working groups, the project also provided great opportunities for interaction and exchange. The detailed list of the official meetings held during the project is reported in the deliverables D9.1A: Mid Term report on related meeting minute and D9.1B: Final report related meeting minute

In addition to the meetings of the partnership, there also took place workshop foreseen in the project proposal: the local workshop, held in Varese Ligure April 13, 2011, the regional conference held in Genoa March 12, 2012 and the national conference held in Genoa on 24 January , 2014.

During its development, the project was in line with the objectives and expected results defined in the proposal and later confirmed in the Grant Agreement. However, during the implementation of the project the severe floods that hit the provinces of La Spezia and Genoa in October 2011 made it necessary to request an extension of time in order to carry out the planned activities.

The request for a postponement of the deadline of the project was formally made by the Coordinating Beneficiary. The European Commission approved the request of the municipality of Varese Ligure setting the new deadline for the project to 31/10/2013. The approval was notified to the municipality of Varese Ligure on 20/12/2012. Together with the communication of the postponement approval the amendment to its original grant agreement was sent to the Coordinating Beneficiary.

The partnership agreement between DICCA and COVA was approved by COVA on 10

June 2010. The agreement once approved by a deed from the town hall was signed and sent as an attachment to the Inception Report 30.10.2010.

4.2 Evaluation of the management system

The streamlined partnership and the complementary expertise of the partners were key factors in facilitating relationships and in maintaining a clear division of roles and functions. These elements were fundamental to the success of the project.

The Project Leader with the collaboration of the associated beneficiary and the project manager kept a careful management of the partnership to ensure compliance with work programs, early detection of potential problems and possible solutions and to ensure the quality of products and the results of the project.

The sustainable approach adopted by the municipality of Varese Ligure aiming at the environmental protection and expertise of DICCA in wastewater and storm water control and management allowed the partnership to address and pursue the objectives set by the project.

The environmental sensitivity combined with the scientific expertise of the partnership ensured a good cooperation in the development and conclusion of Action 8 wherein the Municipality of Varese worked as implementer, while DICCA provided its expertise in the definition of the scientific content of the informative material (articles and publications) and in the management of specialist media relations and stakeholders. The success of the project was also guaranteed by the collaboration and experience that DICCA made available to the partnership in the implementation of the Action 9 "Project management and monitoring."

The efficiency in the management of the partnership and the planning of activities allowed to minimize the difficulties caused by the flooding that occurred in October 2011 in the provinces of La Spezia and Genoa. The inconveniences which arose from these events led to delays in the completion of the prototypal system, mainly as for the pond, and consequently in the accomplishment of all actions related to it. Due to this it emerged the need to request the postponement and the consequent change in the original grant agreement. The approved variation therefore determined the postponement of the deadline for the project from 28 February to 31 October 2013.

During the project development communications with the Commission and the Monitoring team occurred and, further to the official occasions of the monitoring meetings, contacts were also maintained through: submission of inception report, mid-term report, request of postponement and progress report intervened other exchanges of a more technical nature. With the technical and financial desk officer there were exchanges regarding requests for explanations and clarifications of purely technical and managerial nature.

During the project development continuous and constant contact with the Monitoring Team was maintained through Dr. Agnese Roccato. In between the monitoring visits a constant flow of timely information on the state of progress of the project, the difficulties encountered and the solutions adopted to specifications was maintained.

5. Technical part (maximum 50 pages)

5.1. Technical progress, per task

Action 1 **State of the literature**

Planned Duration	01/03/2010 – 30/06/2010
Actual Duration	01/03/2010 – 30/06/2010
Responsibility	DICCA
Objectives	Literature review concerning phytodepuration plants
Milestone	✓ 30/09/2010 Reporting Deliverable D1.
Deliverables	✓ 30/06/2010 D1.: Technical Report on the actual microalgae practices
Progress Indicators	Setting up of the design parameters, climatic and environmental variables

The action was devoted to a literature research in order to identify and define the main process parameters and the climatic and environmental variables affecting the phytodepuration with microalgae.

In the literature there is a large amount of studies and research on microalgae, however, almost all relating to the production of algal biomass.. The algal biomass in fact can be used in various fields: pharmaceutical and cosmetology, aquaculture, agricultural sectors as bio fertilisers, etc. In recent years, many efforts have been made, even on an industrial scale, to extract biofuel from algae by economically viable processes.

The microalgae treatments of the wastewater performed on the field were not employed, but only laboratory tests have been carried out.

The wastewater treatments by microalgae are all aimed to the algal biomass production, so they have been carried out not in order to treat the wastewater, but in order to provide nutrients for the algal growth. The purchase of salts of nitrogen and phosphorus required for the growth of algae is one of the higher production costs of biomass.

The main process parameters, from the close examination of national and international scientific literature involved in the microalgae biomass growth are: nitrogen and phosphorous concentration and their concentration ratio, availability of CO_2, temperature, light, pH.

About temperature the microalgae productivity normally decreases at low temperatures. It has been observed that the removal efficiency doubled when the temperature increases from 25 to 30 °C. However it has been demonstrated that a cold-adapted cyanobacteria strain was suitable for nutrient removal at an average temperature of 10-15 °C.

About light the sunlight intensity greatly varies during the day and during the year. A careful photobioreactor design must avoid excessive damage of the photosynthetic apparatus (photo-inhibition) by distributing the light irradiation onto a larger surface. Therefore periodical absence of light or periods of low light intensity cause a halt or a strong reduction

of photosynthesis. However photosynthesis and nutrients removal normally resume once light is available again. Phytodepuration plants are therefore designed to cope with natural diurnal or seasonal light intensity fluctuations by, for instance, increasing the hydraulic retention time in the system.

In the following, the main types of plants are reported, as gathered from survey in scientific literature:

- for open system (pond) the main types currently in use are big ponds, tanks, circular ponds and raceway ponds. The selection of the specific types is influenced by specific requirements, intrinsic properties of the employed microalga as well as local climatic conditions and costs of land and water
- for closed system (photobioreactor) the available configurations are numerous, but they usually can be classified into two types: tubular devices or flat panels. Then these systems can be also categorized according to the orientation of tubes or panels, the mixing mechanism, the light supplying systems, the materials employed for construction and the methods for nutrients supplying.

A very important information is about the evaluation of the surface-volume ratio, in order to evaluate the required surface for the plant installation and the related installation cost.

The information obtained during the evaluation of the main process parameters has been used to define critical points and possible solutions about microphytodepuration technique applied in Varese Ligure territory.

The deliverable D.1 "*Technical report on the microalgae practices*" describes in detail the activities and the results obtained

The activities have been performed by DICCA.

Action 2 **Specification**

Planned Duration	01/03/2010 – 31/03/2011
Actual Duration	01/03/2010 – 31/03/2011
Responsibility	DICCA
Objectives	Definition of specifications for each project component
Milestone	✓ 31/03/2010 Technical meeting of beneficiaries for activities scheduling ✓ 30/09/2010 Reporting Deliverable D2. ✓ 28/09/2011 Reporting Deliverable U2.
Deliverables	✓ 30/09/2010 D2: Technical Report on system specifications ✓ 31/03/2011 U2: Specification update on the monitoring campaign
Progress Indicators	Compilation and update of the technical schedules and reports.

The action was devoted to the specification of the procedures for data collection and validation and for the management, maintenance and monitoring of the pilot plants.

A standard data collection procedure was defined with the goal of producing a data base thus allowing both project partners and different types of involved subjects to rapidly update and/or look through the data.

Specifications for each activity i.e laboratory tests and monitoring were further provided in the form of technical notes divided by tasks, covering functionality, structure, sensor installation schemes, input/output characteristics, required data acquisition software, standard procedures for the testing and performance evaluation of different components.

The project specifications include protocols concerning the GIS platform development.

The project specifications dealing with the monitoring campaign illustrate the basic requirements of the monitoring gauge stations, the data acquisition software and the analytical methodologies with respect to the each monitored parameter.

The required information has been reported in the "*Technical Report on System Specifications*" Deliverable D2.

The project specifications have been updated with information concerning the site selection, the design and the realisation of the pond pilot site.

The activities have been performed by DICCA with the technical support of COVA.

Action 3 **Analysis of the territory and the present management**

Planned Duration	01/07/2010 – 30/09/2012
Actual Duration	01/03/2010 – 30/09/2013
Responsibility	COVA
Objectives	Implementation of a GIS platform concerning the management and treatment of wastewater effluents and storm water runoff
Milestone	✓ 28/09/2011 Reporting Deliverable D3.A ✓ 31/12/2011 Water management database for the implementation of the GIS platform ✓ 30/09/2013 Activation of the GIS platform ✓ 28/02/2014 Reporting Deliverable D3.B
Deliverables	✓ 31/06/2011 D3.A: Technical report on preliminary database for the GIS platform ✓ 30/09/2011 D3.B: Technical report on the GIS platform implementation
Progress Indicators	Collection, organization and validation of available data. Collection of data from the public authorities and local communities Implementation of data on the GIS platform

The action was devoted to the survey and acquisition of data regarding the management of wastewater and storm water discharges and the related state of degradation of runoff quality particularly focusing on the impact of the main infrastructure of the urban environment. The final object is to implement the collected data on a GIS platform.

The collected informations and the implemented GIS platform have contributed to complete the level of knowledge relating to the management of water and wastewater in the territory of the Municipality of Varese Ligure.

The architecture of the data base regarding the management and treatment of wastewater effluents and storm water runoff and the protocol for the survey and acquisition of data were described in the *"Technical report on preliminary database for the GIS platform"* Deliverable D3.A.

The summary of the data collected and the description of the GIS platform concerning the management and treatment of wastewater effluents and storm water runoff were reported in the *"Technical report on the GIS platform implementation"* Deliverable D3.B.

The collected data refer to the layout of the sewer and storm water drainage networks, to the technical characteristics of the waste water treatment system (Waste water treatment system and Imhoff tank) and to the main characteristics of the receiving water bodies. The data have been collected from public authorities acting on the territory and from the local community.

The implemented GIS platform examines information (feature or tabular attributes) based on user-selected criteria and displays only those records that satisfy the criteria.

As for the sewer network the following information are available:

- Layout of the sewer network;
- Technical details for each pipe (Depth of the laying, Material, Size in mm, Cross section shape, Water Typology and Construction Year).

As for the local treatments the following information the following information are available:

- Details for each building/settlement (owner, hamlet name, address, building typology, authorization number and data);
- Technical details for treatment system (Typology of treatment system, geometry data, Water Typology and Construction Year);
- Technical details for each pipe (Depth of the laying, Material, Size in mm, Cross section shape, Water Typology and Construction Year);
- Technical details for the receiving body (Depth of the laying, Material, Size in mm, Cross section shape, Water Typology and Construction Year).

As for the storm water drainage network the following information the following information are available:

- Layout of the drainage network;
- Technical details for each pipe (Depth of the laying, Material, Size in mm, Cross section shape, Water Typology and Construction Year).

The activities have been performed by COVA with the technical support of DICCA.

Action 4 Planning, construction, installation and management of microphytodepuration systems

This action has been divided in four sub-actions:

- 4.1 Sites selection for micro phytodepuration systems installations
- 4.2 Microalgae selection
- 4.3 Designing and realization
- 4.4 Installation and field testing

Action 4.1 Sites selection for micro phytodepuration systems installations

Planned Duration	01/04/2010 – 30/09/2010
Actual Duration	01/04/2010 – 30/09/2010
Responsibility	DICCA
Objectives	Selection of three sites for the installation of the two prototypal plant (photobioreactor and pond) and the storm water monitoring station
Milestone	✓ 30/09/2010 Reporting Deliverable D 4.1.
Deliverables	✓ 30/09/2010 D4.1. Technical Report on Sites selection
Progress Indicators	Selection of the three installation sites

The action was devoted to the selection of the sites for the prototypal micro phytodepuration systems and storm water monitoring stations.

In the course this action several site inspections were carried out in the territory of Varese Ligure after that an evaluation board of the various sites under investigation was developed. The result was the selection of the sites where the closed microalgae photobioreactor, open microalgae photobioreactor (pond) and the storm water monitoring stations have to be installed. The selected site for the installation of the closed photobioreactor (hereinafter named photobioreactor) was the municipal wastewater treatment plant of S. Pietro Vara in the no longer used sludge-filter bed, while the selected site for the installation of the open photobioreactor (hereinafter named pond) was a farmhouse at Le Pezze. This farmhouse is composed by isolated scattered houses, at a distance of 7 Km from Varese Ligure. The sewage coming from the farmhouse is pre-treated in an Imhoff tank.

The selected site for the installation of the storm water monitoring stations was the municipal waste depot in the Baghino hamlet, in particular the selected catchment is the asphalt apron that has an extension of about 230 m^2. The area is employed to handle and storage recyclable and non-recyclable urban waste, the storm water runoff is conveyed by a separate drainage network to an on-line tank (traditional treatment system).

The evaluation boards and the acquired information through the on-site inspections have been presented to EU in the deliverable D. 4.1"*Technical Report on Sites selection*".

The activities have been performed by DICCA.

Action 4.2 Microalgae selection

Planned Duration	01/04/2010 – 31/12/2010
Actual Duration	01/04/2010 – 31/12/2010
Responsibility	DICCA
Objectives	Implementation of database containing all the information about the different algae species and inoculation of a sufficient quantity of the microalgal biomass in the two phytodepuration systems
Milestone	✓ 31/12/2010 Selection of the optimal micro-algal biomass ✓ 28/09/2011 Reporting Deliverable D 4.2.
Deliverables	✓ 31/12/2010 D4.2.: Technical Report on microalgae selection
Progress Indicators	Selection of the optimal micro-algal biomass

The action was devoted to the quantitative and qualitative evaluations of autochthonous algal biomass to be used as inoculum for the phytodepuration plants.

The objectives have been achieved through the completion of the following activities:

- the collection of water samples at the site selected;
- the analytical characterization of collected samples at DICCA laboratories.

The algae growth has been identified by microscopic analysis and the algal species have been recorded in a photographic database. The selected heterogeneous biomass includes different species of the algal cells, protozoa and small metazoan. The predominant species were Chlorophyceae and Cyanophyceae; according to the weather conditions the two algal classes took turns in the culture as shown in the Table 2.

Months	**Algae**	
	Chlorophyceae	***Cyanophyceae***
April 2010	so many	not many
May 2010	so many	not many
June 2010	not many	so many
July 2010	not many	not many
August 2010	not many	so many
September 2010	so many	not many
November 2010	so many	not many
December 2010	so many	not many

Table 2 Summary of algal culture.

All information about the microalgae selection and identification has been reported in the Deliverable D 4.2 "*Technical Report on microalgae selection*". The activities have been performed by DICCA.

Action 4.3 Designing and realization

Planned Duration	01/07/2010 – 31/03/2011
Actual Duration	01/07/2010 – 31/03/2011
Responsibility	DICCA
Objectives	Executive design and realization of the plants: closed system (photobioreactor), open system (pond) and the two storm water monitoring stations
Milestone	-
Deliverables	-
Progress Indicators	Design of two prototypal plants (photobioreactor and pond) and storm water monitoring stations

The action was devoted to the designing and realization of the two prototypal plants (photobioreactor and pond) and the storm water monitoring stations.

The designing and realization of the photobioreactor were carried out step-by-step in order to identify the optimal configuration for the process (horizontal or vertical module, feeding in series or in parallel, degassing capacity, lighted surface volume ratio, etc.).

The definitive photobioreactor configuration consists of:

- two vertical modules, each one composed by 20 Plexiglas tubes placed in parallel (internal diameter 44 mm, external diameter 50 mm, height 2 m);
- a recycling tank with 500 l capacity;
- a recycling centrifugal pump;
- a feeding electric pump;
- a discharge tank with 300 l capacity.

The definitive photobioreactor has been installed in the non longer used sludge draining bed of the municipal wastewater treatment plant of San Pietro Vara.

The sewage coming from the farmhouse of Le Pezze is pre-treated by a grease and oil interceptor tank and by an Imhoff tank.

The open microalgae system (pond) consists of:

- two rectangular fibreglass tanks connected in series (width 1 m, length 4.2 m, height 0.5 m) with a total volume of 4200 l
- a recycling DC pump from the second tank to the first one (24 V, 4.05 A max, Q = 13.2 l/min, H = 3.1 bar)
- two photovoltaic panels (width 990 mm, length 1600 mm, 220 Wp) to provide energy to the recycling pump (140 A max).

The pond has been installed at Le Pezze.

The two storm water monitoring stations have been installed at the inlet and outlet sections of the existing treatment system (on-line tank) at the municipal waste depot in order to characterize the untreated and treated storm water runoff. Each storm water monitoring

station has to be equipped with a flow-meter to obtain continuous flow rate measurements. As for quality aspects, each gauge station has to be equipped with an automatic sampler (12 glass bottles with a capacity of 950 ml. each) to collect runoff water Furthermore the monitoring stations have to be equipped with a rain gauge to measure in-situ rainfall data.

The information about designing and realization has been reported in the Deliverable D4.4 "*Technical report on systems as installed*".

The activities have been performed by DICCA with the technical support of COVA.

Action 4.4 Installation and field testing

Planned Duration	01/09/2010 – 30/06/2011
Actual Duration	01/09/2010 – 30/09/2013
Responsibility	DICCA
Objectives	Installation and field testing of the plants: closed system (photobioreactor), open system (pond) and the storm water monitoring station.
Milestone	✓ 30/06/2011 Installation of the open system (pond), the closed system (photobioreactor) and the storm water runoff monitoring station. ✓ 28/09/2011 Reporting Deliverable D.4.4.
Deliverables	✓ 30/06/2011 D 4.4 Technical report on systems as installed.
Progress Indicators	Field testing for the open system (pond), the closed system (photobioreactor) and the storm water runoff monitoring stations

The action was devoted to the installation and the field testing of the two prototypal plants (closed system – photobioreactor and open system – pond) and the storm water monitoring stations.

The installation and field testing of the closed system (photobioreactor) have been done on different plant configurations. All the plant configurations of the photobioreactor have been installed at San Pietro Vara wastewater treatment plant (see Figure 1).

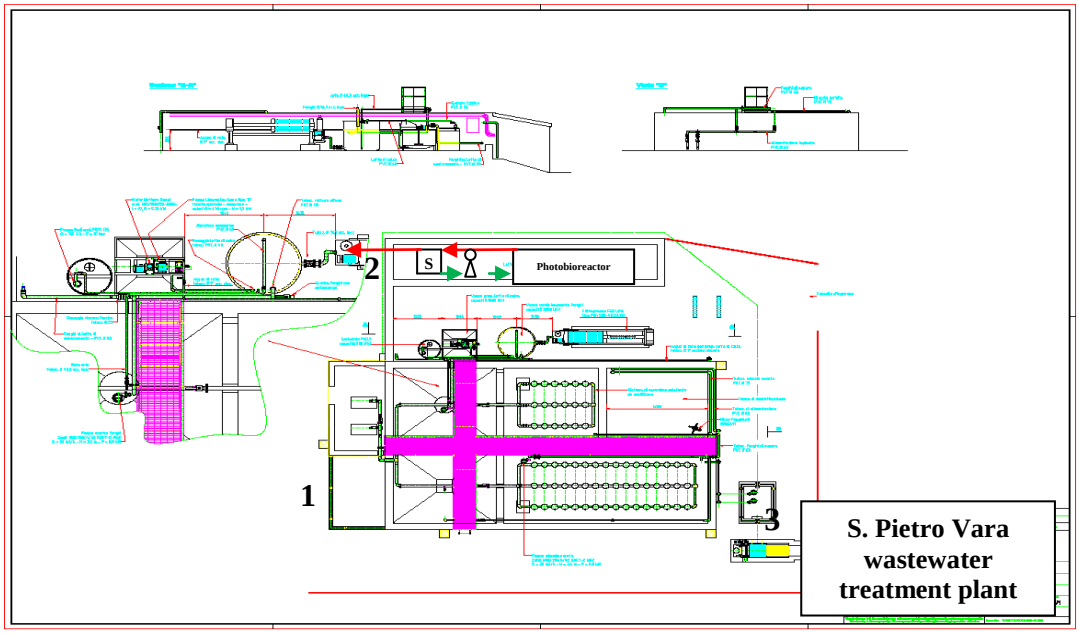

Figure 1 San Pietro Vara Municipal wastewater treatment plant

The first photobioreactor configuration (see Figure 2) was installed nearby the footbridge near the oxidation tank of the wastewater treatment plant. It was composed by 12 Plexiglas horizontal tubes (internal diameter 41 mm and height 2 m) and a recycling vessel in fibreglass (width 53 cm, depth 53 cm and height 70 cm). The tubes were positioned in horizontal way. The tubes were connected together by PVC coupling sleeves: the upper and the lower tubes of the photobioreactor were connected with the recycling vessel. The circulation of the wastewater in the photobioreactor was operated by a centrifugal pump (IWAKI Mo-40RM, 65 W, H max = 45 m and Q max = 52 l/min). The photobioreactor was filled with the outflow from the wastewater treatment plant and with an algal inoculum taken from the batch culture in DICCA laboratory. This process was discontinuous, in fact the plant is weekly discharged of about 30 % of the liquid volume. This blowdown was discharged in the denitrification tank of the wastewater treatment plant, whereas the photobioreactor was reintegrated (30 %) with the effluent from the wastewater treatment plant.

Figure 2 First photobioreactor configuration

The second photobioreactor configuration was installed in the final location such as it is shown in the Figure 3. It consisted of 2 modules, the first composed by 10 Plexiglas vertical tubes fed in parallel (internal diameter 60 mm, external diameter 70 mm and height 85 cm), the second, connected in series to above module, composed by 12 Plexiglas horizontal tubes fed in series (internal diameter 41 mm, external diameter 50 mm and height 2 m), a recycling vessel with a volume of 500 l and a recycling centrifugal pump GRUNDFOS CR32 (1.5 KW, Q = 32 m^3/h, H = 25 bar). This configuration has been chosen in order to evaluate the performance of the different horizontal or vertical systems, in the same operating conditions: fed and recycling flow rate, solar radiation, air and water temperature.

Figure 3 Second photobioreactor configuration

The definitive photobioreactor configuration is shown in Figure 4.

Figure 4 Definitive photobioreactor configuration

The area occupied by the definitive photobioreactor configuration is 5.4 m^2, the total capacity is 0.952 m^3. The photobioreactor is fed (S) with the final effluent of S. Pietro Vara wastewater treatment plant (1), the effluent from the photobioreactor is piped in the no longer used sludge draining bed (2), and from here in the feed sump (3).

The open photobioreactor (pond) is installed at Le Pezze. The area occupied by the pond is 8.5 m^2.

Figure 5 Open photobioreactor (pond)

The monitoring stations of storm water runoff are installed upstream (hereinafter named VARESE-IN) and downstream (hereinafter named VARESE-OUT) the existing treatment system, in order to analyse both treated and untreated storm water runoff quality. A tipping-bucket rain gauge (with a bucket capacity equal to 0.2 mm) has been installed on the rooftop of the office and connected directly to the automatic sampler. Because of the dimensions of the drainage network, the VARESE-IN station was installed downstream just before the inlet in the tank. The pipe was equipped with the flow-meter consisting in an area-velocity sensor and with the intake suction line of the automatic sampler. The VARESE-OUT station was equipped with the intake suction line, the area-velocity sensor and the triangular weir located at the outlet section of the tank. The automatic samplers corresponding to the stations VARESE IN and VARESE OUT were placed into the office that is located in the first apron

of the Municipal Waste Depot just in front of the storm water tank. Finally, a workstation was placed into the office, connected to the automatic samplers in order to retrieve data and modify the auto-sampler operational rules. Note that, before installation, both the rain gauge and the triangular weirs have been properly calibrated by DICCA according to the international standards/guidelines.

VARESE-IN and VARESE-OUT gauge station were activated on June 20th 2011. A first phase of testing has been carried on for about three months.

The information about the installation and field testing of the plants has been reported in the Deliverable D4.4 "*Technical report on systems as installed*".

The activities have been performed by DICCA with the technical support of COVA.

Action 5 **Monitoring campaign**

Planned Duration	01/01/2011 – 30/09/2012
Actual Duration	01/01/2011 – 30/09/2013
Responsibility	DICCA
Objectives	The acquisition and collection of water quality-quantity data observed at the phytodepuration plants (inlet and outlet) and the storm water monitoring station.
Milestone	✓ 30/09/2013 Implementation of the water quality database; ✓ 28/02/2014 Reporting Deliverable D5.
Deliverables	✓ 30/09/2013 D5: Technical Report on the collected data during the monitoring campaign
Progress Indicators	Compilation of the two data base (wastewater and storm water) containing raw quality data observed during the monitoring campaign

The action was devoted to the collection (acquisition and storage) of quality- quantity data in order to evaluate the performance of prototypal phytodepuration plants: the open system (pond) and the closed system (photobioreactor).
In particular the collected data were:

- biomass data: concentration, classes, elemental composition;
- quality data of phytodepuration plants (inlet and outlet): $N\text{-}NH_4$,$N\text{-}NO_3$, $N\text{-}NO_2$,$P\text{-}PO_4$, COD, SST, pH,T, chl-a (traditional way);
- the CO_2 concentration in gaseous emission from the biological oxidation tank (S. Pietro Vara plant), in the event of having to dose carbon dioxide to photobioreactor;
- pH, OD, NO_3, NH_4, Chl-a, T and turbidity using two multiparameters probes (the first one for photobioreactor and the other for pond) that transmitted the parameters via sms (remote way) at DICCA laboratory;
- quantity and quality data to characterize storm water runoff at the inlet and outlet sections of the traditional treatment system (first flush tank).

The Table 3 and Table 4 show the samples number (inlet and outlet) of the two prototypal plants during the monitoring activity using the traditional method.

Pond (inlet and outlet)		Parameters				
Time	Sampling	pH/T	TSS/chla	COD	$P\text{-}PO_4$	$N\text{-}NH_4/NO_3/NO_2$
September 2012	4	X	X	X	X	X
October 2012	4	X	X	X	X	X
November 2012	4	X	X	X	X	X
December 2012	3	X	X	X	X	X
January 2013	4	X	X	X	X	X
February 2013	4	X	X	X	X	X
March 2013	4	X	X	X	X	X
April 2013	4	X	X	X	X	X
May 2013	5	X	X	X	X	X
June 2013	4	X	X	X	X	X
July 2013	4	X	X	X	X	X
August 2013	5	X	X	X	X	X
September 2013	4	X	X	X	X	X

Table 3 The inlet and outlet water collected during the monitoring campaign and the corresponding analysed parameters. During September 2012 there was the "*start-up*" of the plant.

Photobioreactor (inlet and outlet)		Parameters				
Time	Sampling	pH/T	TSS/chla	COD	$P\text{-}PO_4$	$N\text{-}NH_4/NO_3/NO_2$
[(1)]June 2011	4	X	X	X	X	X
[(1)]July 2011	4	X	X	X	X	X
[(1)]August 2011	4	X	X	X	X	X
[(1)]September 2011	4	X	X	X	X	X
Stop						
[(2)]March 2012	4	X	X	X	X	X
[(2)]April 2012	4	X	X	X	X	X
([2)]May 2012	4	X	X	X	X	X
[(2)]June 2012	4	X	X	X	X	X
[(2)]July 2012	4	X	X	X	X	X
Stop						
[(3)]September 2012	4	X	X	X	X	X
[(3)]October 2012	4	X	X	X	X	X
[(3)]November 2012	4	X	X	X	X	X
[(3)]December 2012	3	X	X	X	X	X
[(3)]January 2013	4	X	X	X	X	X
[(3)]February 2013	4	X	X	X	X	X
[(3)]March 2013	4	X	X	X	X	X
[(3)]April 2013	4	X	X	X	X	X
[(3)]May 2013	5	X	X	X	X	X
[(3)]June 2013	4	X	X	X	X	X
[(3)]July 2013	4	X	X	X	X	X
[(3)]August 2013	5	X	X	X	X	X
[(3)]September 2013	4	X	X	X	X	X

Table 4 The inlet and outlet water collected during the monitoring campaign and the corresponding analysed parameters. (1) the samples collected during the monitoring of plant nickname the first horizontal plant, (2) the samples collected during the monitoring of the plant nickname in the final placed, (3) the samples collected during the monitoring of the definitive plant, in the month of September 2012 there was the "*start-up*" of the plant.

The samples have been collected weekly for a total of 228 and the analysis have been done in DICCA chemical laboratory, for a total of analysis equal to 1824.

The analysis carried out by the multiparameter probes are shown in Table 5 and Table 6.

Pond (outlet)		Parameters (remote method)				
Time	Sampling	pH/T	turbidity	OD	chla	N- NH_4/N-NO_3
August 2013	294	X	X	X	X	X
September 2013	552	X	X	X	X	X

Table 5 The parameters transmitted by telemetry unit

Photobioreactor (outlet)		Parameters (remote method)				
Time	Sampling	pH/T	turbidity	OD	chla	N- NH_4/N-NO_3
[(1)]August 2013	476	X	X	X	X	X
September 2013	667	X	X	X	X	X

Table 6 The parameters transmitted by telemetry unit

From April 2012 to September 2013, it has been collected 36 samples of gas emission from wastewater oxidation tank in order to detect the CO_2 concentration.

As for the storm water runoff characterization, the monitoring program is activated based on a selected flow rate threshold and the sampling frequency is equal to 5 minutes. The automatic sampler is equipped with 12 bottles, and each one is filled with 5 uniform time-paced samples of 200 ml (composite sample) thus resulting in a maximum of 60 samples for rainfall event monitored at each station. The sampling programme is automatically stopped when the flow rate is below the selected threshold value; at the end of the rainfall event the runoff samples are immediately delivered to the chemical laboratory. The investigated physic-chemical parameters are the following: pH, total suspended solids (TSS), chemical oxygen demand (COD), heavy metals in dissolved form (Zn , Cu and Pb) and total hydrocarbons (HC) .

The monitoring campaign has been carried out between December 2011 and November 2012 in order to characterise untreated (VARESE IN) and treated (VARESE OUT) storm water runoff quality by collecting a significant number of rainfall-runoff events. During the monitoring campaign that lasted a complete hydrologic year, 19 rainfall-runoff events characterized by different hydrologic conditions have been collected thus allowing to evaluate the treatment efficiency of the on-line tank at the site of concern.

Table 7 and Table 8 summarize the rainfall runoff events that have been monitored at VARESE –IN and VARESE OUT pilot sites in order to characterize the untreated (INlet) and the treated storm water runoff (OUTlet) respectively. In addition the tables report the chemical-physical laboratory testing performed by DICCA.

VARESE-IN		Parameters				
Rainfall Event	Samples	pH	TSS	COD	HC	Metals (Pb, Cu, Zn)
02/12/2011	12	X	X	X	X	X
03/12/2011	12	X	X	X	n.a.	X
2-3/01/2012	7	X	X	X	X	X
03/04/2012	4	X	X	X	X	n.a.
05/04/2012	11	X	X	X	X	X
7-8/04/2012	4	X	X	X	n.a.	X
15/04/2012	7	X	X	X	X	X
18-19/04/2012	11	X	X	X	X	X
20-21/05/2012	12	X	X	X	X	X
26/08/2012	12	X	X	X	X	X
1-3/09/2012	7	X	X	X	X	X
24/09/2012	2	X	X	X	X	X
25-26/09/2012	6	X	X	X	X	X
29/09/2012	6	X	X	X	X	X
11/10/2012	12	X	X	X	X	X
15/10/2012	12	X	X	X	n.a.	X
26/10/2012	12	X	X	X	X	X
10/11/2012	12	X	X	X	X	X

Table 7 Rainfall-runoff event analysed after the validation of the monitoring campaign and the corresponding analysed parameters at VARESE IN gauge station. (n.a. = not available due to the failure of the laboratory equipment).

VARESE-OUT		Parameters				
Rainfall Event	Samples	pH	TSS	COD	HC	Metals (Pb, Cu, Zn)
02/12/2011	12	X	X	X	X	X
03/12/2011	12	X	X	X	n.a.	X
2-3/01/2012	12	X	X	X	n.a.	X
03/04/2012	-	-	-	-	-	-
05/04/2012	3	X	X	X	n.a.	X
08/04/2012	12	X	X	X	X	X
15/04/2012	12	X	X	X	X	X
18-19/04/2012	12	X	X	X	X	X
20-21/05/2012	6	X	X	X	X	X
26/08/2012	10	X	X	X	X	X
1-3/09/2012	6	X	X	X	X	X
24/09/2012	2	X	X	X	X	X
25-26/09/2012	7	X	X	X	X	X
29/09/2012	5	X	X	X	X	X
11/10/2012	12	X	X	X	n.a.	X
15/10/2012	12	X	X	X	n.a.	X
26/10/2012	12	X	X	X	X	X
10/11/2012	12	X	X	X	X	X

Table 8 Rainfall-runoff event analysed after the validation of the monitoring campaign and the corresponding analysed parameters at VARESE OUT gauge station. (n.a. = not available due to the failure of the laboratory equipment).

All information about the monitoring activity has been reported in the "*Technical Report on the collected data during the monitoring campaign*" Deliverable D5.

The activity has been performed by DICCA with the technical support of COVA.

Action 6 **Analysis and assessment of the rules**

The Action 6 is divided into two sub-actions:

- Action 6.1 "Analysis of the result"
- Action 6.2 "Reuse"

In the following sub-sections the Action 6.1 and Action 6.2 are described respectively.

Action 6.1 **Analysis of the results**

Planned Duration	01/07/2011 – 28/02/2013
Actual Duration	01/07/2011 – 31/10/2013
Responsibility	DICCA
Objectives	Implementation of a data base containing the quality-performance indexes and the biomass growth indexes
Milestone	✓ 31/10/2013 Issuing of the evaluating deliverable for the analysis of results action ✓ 28/02/2014 Reporting Deliverable D6.1.
Deliverables	✓ 31/10/2013 D 6.1: Technical Report on the achieved results
Progress Indicators	Compilation of data base containing the quality-performance indexes and the biomass growth indexes.

This action aims at evaluating the efficiency in terms of pollutant load abatement and at assessing the potential implementation of the phytodepuration plants.

In particular the collected data have been elaborated in order to identify the quality performance indices:

1. the nutrient and organic pollution removal
2. the algal growth
3. the discharge rules established by Italian and Regional Laws
4. the flexibility against organic and nutrients load variations
5. the simplicity of management and maintenance

The first index refers to the ability to remove nitrogen, phosphorus and the organic pollution (COD) using solar energy alone and without the use of chemicals.

The second index refers to the production of biomass that can be used for energy production (biogas / biodiesel), chemicals, animal feed, or as it is as a soil conditioner.

The third index refers to the water discharges that must meet the pollutant concentration limits imposed by law.

The fourth index refers to the system that must be able to withstand variations of nutrient concentrations without collapsing or, even worse, to increase the pollution of the water.

The fifth index refers to the identification of the control and maintenance required to keep the plants at full efficiency.

The obtained results have been illustrated in detail in the deliverable D 6.1 "*Technical Report on the achieved results*".

Another result has been the implementation of an electronic data base containing the quality-performance indexes describing the efficiency in nutrients removal rates and the biomass growth indexes.

The main results obtained from the closed system (photobioreactor) have been: the range of removal obtained of 50% for COD; 60% for N; 50% for P. Results of the Table 7 indicate that the effluent (outlet) of phytodepuration is generally very low and met the quality standards required by law (Annex 5 – Italian Law 152/06 according to the EC Dir. 91/271).

Parameter	$N\text{-}NH_4$ [mg/l]		$P\text{-}PO_4$ [mg/l]		COD [mg/l]	
value	*inlet*	*outlet*	*inlet*	*outlet*	*inlet*	*outlet*
mean	4.12	1.11	0.22	0.10	22.00	15.14
sd	1.80	0.56	36.28	29.22	14.09	3.58
median	3.94	0.95	0.20	0.09	23.00	15.00

Table 9 The concentration values (mean, standard deviation and median) observed at the inlet and outlet section of the photobioreactor.

The biomass concentration was between the values of 10 and 110 mg/l, the values are compatible with the characteristics of influent.

The algal species dominating the system were Chlorophyceae (90%) mainly autotrophic and the average elemental composition of biomass was: C = 45.52 %, H = 4.51 %, N = 4.51 %, P =2.43%, K= 1.1 % and S = 0.10 %.

The main results obtained from the open system (pond) have been: the range of abatement obtained are: 50% for COD; 52% for N; 47% for P. Results of the Table 8 indicate that the effluent (outlet) of phytodepuration is generally very low and met the quality standards required by law (Annex 5 – Italian Law 152/06 according to the EC Dir. 91/271).

Parameter	$N\text{-}NH_4$ [mg/l]		$P\text{-}PO_4$ [mg/l]		COD [mg/l]	
value	*inlet*	*outlet*	*inlet*	*outlet*	*inlet*	*outlet*
mean	50.53	30.77	3.77	1.51	158.91	75.34
sd	18.05	12.14	2.20	0.42	32.75	12.62
median	44.67	27.05	3.35	1.40	157.95	73.72

Table 10 The concentration values (mean, standard deviation and median) observed at the inlet and outlet section of the pond with respect of water quality constituents ($N\text{-}NH_4$, $P\text{-}PO_4$ and COD) evaluated across the whole monitoring campaign.

The biomass concentration of the pond was between the values of 51 and 510 mg/l, the values are compatible with the characteristics of influent. The algal species dominating are the Cyanophyceae, mainly heterotrophic and the average elemental composition of biomass was: C = 40.52 %, H = 5.70 %, N = 5.39 %, P =5.21%, K= 6.49 % and S = 0.20 %.

Parameter	photobioreactor		pond	
value	*biomass [mg/l]*	*chll-a [mg/l]*	*biomass [mg/l]*	*chll-a [mg/l]*
average	49.23	1.42	237.62	14.29
minimum	10.00	0.02	51.00	1.80
maximum	110.00	4.50	510.00	45.90

Table 11 The characteristic of algal biomass.

The storm water monitoring campaign provides the assessment of pollutant load discharged by storm runoff in drainage system equipped with on-line first flush tank. By comparing the pollutant load associated with untreated storm runoff (VARESE IN gauge station) and the one associated with treated storm runoff (VARESE OUT gauge station), the treatment efficiency of the installed traditional treatment system (on-line tank) has been evaluated. Such analysis has been performed both at the scale of the whole monitoring campaign and at the event scale.

In order to illustrate the observed variability of the pollutant load associated with storm water runoff, the single concentration values observed across the whole monitoring programme have been analysed (see Figure 6). Such analysis has two main purposes: at first taking into account that water quality standards are based on concentration values, it aims at pointing out the exceeding of quality standard on sample basis, secondly it aims at comparing the temporal variation of the pollutant load across the single hydrograph with respect to than the one observed across the whole monitoring programme. Furthermore by comparing the pollutant load associated to both untreated and treated storm water runoff, the analysis of the pollutant delivery behaviour based on sample basis allows to point out if the adopted treatment system is effective in reducing the acute values observed in storm water runoff at the inlet section of the system. At the event scale, the Event Mean Concentration (EMC) that is evaluated as the flow-weighted average of constituent concentrations has been examined (see Table 12 and 13). Due to the significant temporal variation of the pollutant concentration and flow rate across any rainfall-runoff event, the event mean concentration (EMC), which constitutes an event scale parameter, provides a significant assessment of the pollutant load associate with each rainfall-runoff thus allowing comparing results across the whole monitoring campaign.

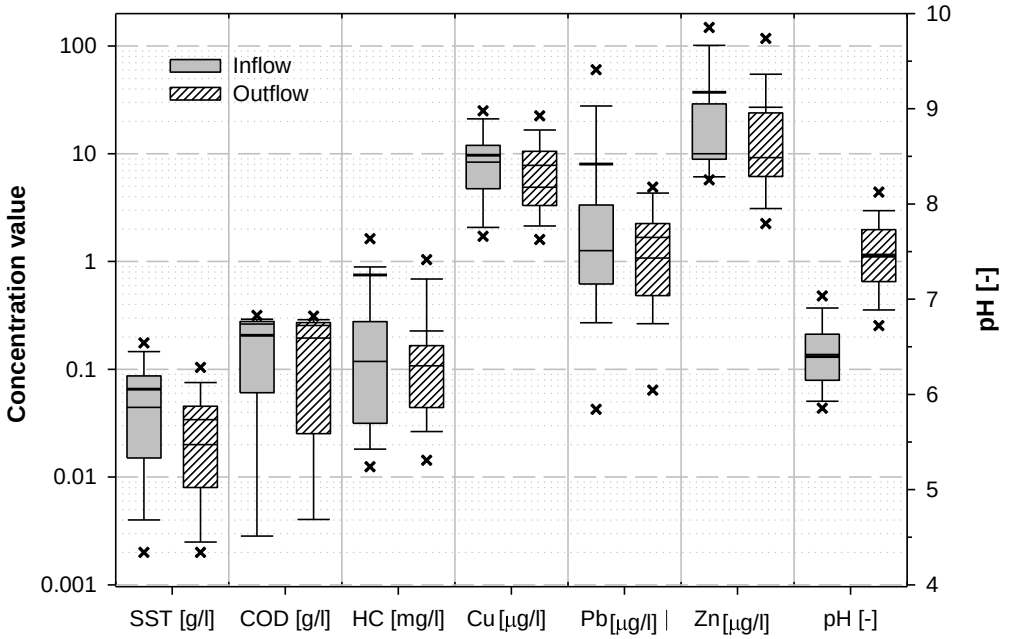

Figure 6 Non-parametric distribution of concentration values for water quality constituents observed in the storm water runoff before (inflow) and after (outflow) the treatment system at the Municipal waste depot

Results of the storm water monitoring programme indicate that the pollutant load associated to storm runoff of the Municipal waste depot is limited. The pollutant load expressed in terms of acute values and EMCs are generally below the quality standards for direct discharging into the receiving water bodies (Annex 5 – Italian Decree by Law 152/06 according to the EC Dir. 91/271). The only exception occurs for the COD whose values exceed the quality standard across the whole monitoring programme. In addition, the total suspended solids, dissolved zinc and total hydrocarbon reveal acute concentration values exceeding the quality standards across the monitoring programme. Based on the characterization of the treated and untreated storm water runoff, the on-line tank seems to be not really effective because of the limited pollutant load flowing into the treatment system; in addiction the on-line tank is effective mainly in removing the load of settable solid particles that is limited in the site of concern. Due to such considerations, the on-line tank could be replaced with a macrophytes treatment system coupled with a small pre-treatment chamber (to remove the coarse material) thus enhancing the potential abatement of COD in case that the COD values are determined by organic matter.

Parameter	SST		COD		HC	
	[mg/l]		[mg/l]		[mg/l]	
EMC	*in*	*out*	*in*	*out*	*in*	*out*
All event Mean	70.5	35.4	238.91	231.27	0.13	0.06
All event SD	62.5	34.8	96.35	101.59	0.21	0.07
All event Median	54.2	32.9	272.15	266.73	0.03	0.03

Table 12 Comparison between the Event Mean Concentration values (mean, standard deviation and median) observed at the inlet (in) and outlet section with respect of water quality constituents (TSS, COD and HC) evaluated across the whole monitoring campaign.

Parameter	Cu		Pb		Zn	
	[μg/l]		[μg/l]		[μg/l]	
EMC	*in*	*out*	*in*	*out*	*in*	*out*
All event Mean	9.60	4.95	5.03	1.01	31.3	21.2
All event SD	5.42	3.40	12.0	1.32	49.6	36.3
All event Median	8.86	3.85	1.07	0.67	9.8	9.3

Table 13 Comparison between the Event Mean Concentration values (mean, standard deviation and median) observed at the inlet (in) and outlet section with respect of water quality constituents (copper, lead and zinc in dissolved form) evaluated across the whole monitoring campaign.

For more details about this action, please refer to deliverable D 6.1 "*Technical Report on the achieved results*".

The activity has been performed by DICCA.

Acion 6.2 **Reuse**

Planned Duration	01/07/2011 – 28/02/2013
Actual Duration	01/07/2011 – 31/10/2013
Responsibility	DICCA
Objectives	Definition of the quantity and quality biomass recovery and the quality treated effluent of phytodepuration plants in order to select the possible reuse
Milestone	✓ 31/10/2013 Issuing of the evaluating deliverable for the optimal biomass recovery system and effluent reuse ✓ 28/02/2014 Reporting Deliverable D6.2.
Deliverables	✓ 31/10/2013 D 6.2: Technical report on the microalgae and final effluent reuse
Progress Indicators	Recover the adequate biomass quantity, evaluate of at least a field where the algal biomass and treated effluent might be reused

This action aims at developing the biomass harvesting systems and at identifying its possible reuse. In the scientific literature several studies show as the recovery of algal biomass is a big problem.

The choice of separation technology more appropriate depends on several considerations. The first element concerns the nature of microalgae, which is so variable to make impossible to identify a technique best ever.

Microalgae consist microorganisms with electronegative surface charge and capable of absorbing macromolecules or extracellular material within them. Compared with other suspended particles, the algae have very different structures, giving rise to many species that differ in shape, size and mobility.

In this regard, the physical properties (size, shape), chemical characteristics (electronegativity) are the basic elements in the selection of the configuration separation.

Moreover the choice of separation technology is also clearly dependent on the specific upstream of the purification process and the corresponding percentage solids input. In particular, the nature of the process, or whether this will operate in a continuous or discontinuous, can affect the opportunity of some technologies separation rather than others. Finally, the final destination of the product may require different design choices of the phase separation.

On the basis of these criteria, and after a careful study of the scientific literature, the laboratory tests have only been conducted on technologies that permitted a good compromise between simple technology and economic advantage.

In this case, in the plants the algal biomass together the bacterial organisms were very adhesive and easily settlable.

As the second step the chemical analyses have been done on the recovered biomass and on treated effluent in order to find a possible reuse.

The chemical composition of algal biomass is shown in Table 14.

Parameter / **value**	C	H	N	S	P	K
	%	*%*	*%*	*%*	*%*	*%*
photobioreactor	40.52	5.70	5.39	0.20	5.21	6.49
pond	45.22	4.51	4.58	0.10	2.43	1.10

Table 14 The average values of elemental composition of autochthonous algal biomass.

The final results of this action proved the possible reuse of the algal biomass as fertilizer and the chemical results (presented in summary Table 15) of treated effluent can be used as irrigation waters according to the Italian Decree by Law 185/03.

Parameter / **value**	$N\text{-}NH_4$ [mg/l]	$P\text{-}PO_4$ [mg/l]	COD [mg/l]
	outlet	outlet	outlet
photobioreactor	4.11	0.92	14.77
pond	30.77	1.51	75.34

Table 15 The average values of effluent from phytodepuration plants.

This action has been completed without problems, for more details about this action, please refer to deliverable D 6.2 “Technical report on the microalgae and final effluent reuse”.

As for a possible continuation of this action, some studies could be made about the reuse of biomass as organic material useful in anaerobic digestion systems for biogas production.

The activities have been performed by DICCA.

Action 7 **Set of rules and technical documentation**

The Action 7 is divided into two sub-actions:

- Action 7.1 "Elaboration of set of rules";
- Action 7.2 "Elaboration of technical documentation".

In the following sub-sections the Action 7.1 and Action 7.2 are described respectively.

Action 7.1 **Elaboration of set of rules**

Planned Duration	01/01/2012 – 28/02/2013
Actual Duration	01/01/2012 – 31/10/2013
Responsibility	COVA
Objectives	Definition of a set of rules to be included in the Municipal Building Code
Milestone	✓ 28/02/2014 Reporting Deliverable D7.1
Deliverables	✓ 31/10/2013 Technical report on the draft proposal to be included in the Municipal Building Code
Progress Indicators	Realization of a legislative database Elaboration of a draft proposal to be included in the Municipal Building Code

The action was devoted to the elaboration of a set of rules to be included in the Municipal Building Code. A data base collecting Italian and European regulations about water and wastewater management has been compiled in order to support the definition of the set of rules.

The architecture of the legislative database regarding the water (storm and waste water) related issues together with the draft proposal to be included in the Municipal Building Code were described in the *"Technical report on the draft proposal to be included in the Municipal Building Code"* Deliverable D7.1.

The data base collecting Italian and European regulations about water and wastewater management has been organized in three sections (European, National and Regional Legislation) and for each section the following fields have been compiled:

- European Legislation : Entry into force (Year), Reference CODE, Act, Amending act, Subject, Brief description of content, Relevant deadlines;
- National Legislation: Reference CODE, Act, In compliance with, Subject, Brief description of content, Relevant deadlines;
- Regional Legislation: Region, Entry into force (Year), Reference CODE, Act, In compliance with, Subject, Brief description of content, Relevant topics.

The draft proposal is specifically related to the management of the waste water in the areas that are not linked to the public sewer systems. The proposal is composed of a single article to be included in the chapter relating to the Prescription on health in buildings.

In particular, in case of civil settlements characterized by discharge effluent lower than 50 IE (Inhabitants Equivalent) it is suggested of conveying all the waste water effluent through a single treatment system in order to minimize the design and installation cost and to maximize the removal efficiency and consequently the environmental protection. Furthermore, in case of civil settlements characterized by discharge effluent lower than 100 IE (Inhabitants Equivalent) it is suggested of conveying all the waste water effluent through a single treatment system. The single treatment system could be composed of a primary treatment system (such as an Imhoff tank) and secondary treatment system (such as a phytodepuration plant). Finally, a specific remark is discussed for the zoo-technical farms of large dimension (load greater than 40 ql/ha of cattle) for which the installation of a tertiary treatment system (such as a phytodepuration plant with microalgae) is suggested. For the design, installation and maintenance of a phytodepuration plant, the draft proposal refers to the Technical Handbook elaborated in the LIFE Project ECOMAWARU.

The action has been performed by COVA with the technical support of DICCA.

Action 7.2 **Elaboration of technical documentation**

Planned Duration	01/01/2012 – 28/02/2013
Actual Duration	01/01/2012 – 31/10/2013
Responsibility	DICCA
Objectives	Elaboration of the handbook containing the technical documentation about design, installation, maintenance, management and control procedures of the phytodepuration systems.
Milestone	✓ 31/10/2013 Issuing of the technical documentation on the waste water "green" technology ✓ 28/02/2014 Reporting Deliverable D7.2.
Deliverables	✓ 31/10/2013 D 7.2: Technical report on the technical handbook
Progress Indicators	Elaboration of the technical handbook

This action aims at drafting an Handbook about the Best Practices in water and wastewater "green" management. In particular the handbook contains the information about design, installation, maintenance, management and control procedures of the phytodepuration systems.

The Handbook wants to be a first useful tool to provide information about the technique of phytodepuration using microalgae as secondary or tertiary treatment of wastewaters.

The Handbook is divided into the following chapters:

1. Introduction
    - *1.1 Phytodepuration: general information*
2. Water pollution and water discharges depuration
    - *2.1 Normative references and main pollutants*
    - *2.2 Traditional biological depuration systems (backgrounds)*
    - *2.3 Natural depuration systems*
3. Phytodepuration with macrophytes and plants configurations
    - *3.1 Designing and management*
4. Phytodepuration with microphytes
    - *4.1 The algae*
    - *4.2 Plants configurations*
5. Case of study
    - *5.1 Designing of the phytodepuration system pond (10 EI)*
    - *5.2 Designing of the phytodepuration system photobioreactor*
    - *5.3 Experiments carried out*
6. Management of the phytodepuration plants
7. Bibliography

Further information about the two different types of prototypal plants (open and closed system) has been provided too.

This action has been completed without problems, for more details about this action, please refer to deliverable D 7.2 "*Technical report on the technical handbook*".

The activity has been performed by DICCA.

5.2 Dissemination actions

5.2.1 Objectives

The main objective of the dissemination action was to enhance the circulation of the technical knowledge tied in with phytodepuration and the creation of a new awareness toward the potential application of such technology in order to improve the quality of the receiving water bodies. Since the project objective aimed at demonstrating the feasibility, reliability and efficiency of the phytodepuration technique with micro algae as a tertiary treatment for wastewater management in rural communities, the aim of this action was the delivery of information to the widest possible range of potential end-users about the wastewater treatment methodology developed within the project phases. In particular the potential end-users include the technicians (i.d. employed in the integrated water cycle management companies or authorities) as well as the public authorities at different stages (i.e. local, regional and national) in charge of authorizing the wastewater/storm water discharges into the receiving water bodies or protecting and improving the quality of the local water bodies. Furthermore, it has to be noticed that the transferability of the technologies applied in Varese Ligure is not strictly limited to the rural communities, on the contrary the project provides the demonstration of the effective application of the phytodepuration technique within the wastewater treatment train, thus pointing out the relevance of the dissemination activities through the different tools both during the project development and after the end of the project.

5.2.2 Dissemination: overview per activity

The planned activities for the achievement of the objectives of action D 8 are outlined below.

The first activity of the dissemination action has been "*Establishment of an observer group exchanging continuously information on the project progress including companies and utilities involved in the integrated water cycle and management*" (in the proposal it was the point A). This group was created at the regional conference, through the completion of appropriate forms.

The observer team is made up of a number of 31 people belonging to different organizations interested in the subject of water management, such as ARPAL, IREN Acqua&Gas, Municipality of Albissola, Municipality of Sesta Godano, AMGA Foundation, TICASS, Liguria Region, TEXEP S.r.l., Ecomacchine S.p.a., Trame verdi, University of Genoa and University of Pavia.

Moreover, this group has been used for the creation of the web design community, which has been held continuously updated through the website. During the project the community has been enriched by additional users. This activity has enabled the dissemination of the information gathered during the course of the project, creating the possibility to various entities interact through the appropriate section of the site www.ecomawaru.it\Guestbook and the use of the e-mail: info @ ecomawaru.it.

The second and third project activities (B and C) have been the "*Design of the Project Logo to promote and spread out the project*" and the "*Design and maintenance at the project web site"* the latter is an important management tool both to share information between beneficiaries and to spread out news related to the project"

On all materials the logo of the project that was carried out by Delta2000 Srl. has been put. The website (www.ecomawaru.it.) was also made by the company Delta2000 S.r.l. and was activated in September 2010. Its management has taken place following the results of the educational and training that were carried out during the entire development of the project in collaboration between COVA, DICCA and the company Delta2000.

The website has been structured so as to permit a detailed description of the project and a continuous update of its progress, creating a special section "News" on the homepage. There is also a section called "News Archive" that allows a new user to identify the timing and the main activities carried out for the successful achievement of the project.

In the site there is a section "Guestbook" which allows us to get more information and the site has been visited by 87 334 people in these three years of the project.

The site has a section "Dissemination activities" where all activities carried out were shown and where one can download all the information material for a comprehensive dissemination of the project ECOMAWARU.

The website has been created in two languages (Italian and English) to a broad audience of disclosure.

The fourth project activity (D) has been the drafting of the "*Layman's report*" containing a summary description, but comprehensive, about the achievements of the project and the developed actions.

The document has been drawn up after the conclusion of the project (31/10/2013) in a synthetic way to allow the disclosure of the obtained results. It was provided a draft in both Italian and English. This document has been printed in 300 copies, which were used during the national conference of 24/01/2014. Part of this material was also placed at the information kiosk located in the municipality of Varese Ligure.

The fifth project activity (E.) has been about the "*Organization of a notice board at the public office of the Municipality of Varese Ligure….".*This notice board has been directed to the local community and has therefore been placed at the municipality of Varese Ligure. In addition, we have also been created a notice board on the project website: www.ecomawaru.it (both in English and Italian) and on the website of the municipality of Varese Ligure: www.comune.vareseligure.sp..

The sixth project activity (F) has been the "Submission of articles dealing with the project thus including the illustration of on-going actions and preliminary results within national, local and specialized press". Some articles have been printed in local newspapers, such as press releases issued by the Municipality of Varese Ligure to publicize the regional and national conference. Some articles such as various articles printed in national newspapers, as "La Nazione" that emphasized the importance of the objectives of the project to make more sensitive the Italian population using environmentally friendly techniques.

The publication of these articles increased the interest of the community by increasing the requests for information received in the portal of the website.

The seventh project activity (G.) has been about the "*Organization of three conferences/workshops involving different targeted audience…*" The three conferences on a local, a regional and a national level have taken place in the following locations and dates:

- Local Conference at the Municipality of Varese Ligure 13/04/2011
- Regional Conference at the Palazzo della Regione Liguria on 12/03/2012
- National Conference at the Palace of Congresses Iren on 24/01/2014.

The local conference was given to staff involved directly and indirectly in the management of the project. A result of this event has been the training to the technicians involved in the management of the facilities and personnel involved in the management of the website.

The turnout expected in the local conference was about 25 people, but there have been about 11 participants, including technical personnel of the municipality of Varese Ligure and staff of the University of Genoa.

The regional conference was aimed at a big audience by involving different situations and different municipal entities of the water management field. During the event have been disclosed the preliminary results of the project.

The turnout expected in the regional conference was about 100 people, but there have been about 36 participants.

The national conference was aimed at a big audience, involving engineers, researchers, companies and government agencies involved in the field of water management. The turnout at the national conference has been about 50 people. During the event have been disclosed the final results of the project.

Moreover at this event a CD-ROM has been produced containing the final results of the project. This support has been made about 100 copies.

The implementation of the various events has allowed us to further increase the contacts between the different people in the field of water management

The eighth project activity (H.) has been about "*Production of descriptive brochures (both English and Italian versions) to distribute during the conferences/workshops above illustrated*" these brochures have been distributed during the conference and have been put in the information kiosk located in the municipality of Varese Ligure and have also been downloaded from the website www.ecomawaru.it web / downloads.

This brochure has been printed in 100 copies and contained a description of the project and obtained preliminary results. The first brochure has been carried out at the local conference.

The second brochure has been made at the regional conference and has been printed in 200 copies and contained the results obtained so far by the project.

The third brochure has been made at the national conference and has been printed in 300 copies and contained the final results of the project.

The drafting of brochures has been useful as a tool to answer many questions that have been done.

The ninth project activity (I) has been about "*Setting-up of an information kiosk within the information point to spread out all information related to the project and distribute the project documentation (brochures, Layman's report, etc.)".*

The information kios is located at the tourist office of the municipality of Varese Ligure. Here all information pertaining to the project has been distributed as panels, brochures, articles, and Layman's report produced during the entire course project.

The informative kiosk increased the attention of the local community to the policies of sustainable approaches followed by the municipality of Varese Ligure.

For more details about this action, please refer to all deliverable D 8.

The activities have been performed by COVA.

5.3 Evaluation of Project Implementation

The project fully achieved its main objectives in demonstrating the performances of the prototypal phytodepuration systems and the storm water traditional treatment system. The analytical programme allows to verify that the microalgae phytodepuration treatment systems are efficient in nutrient removal as well as the produced biomass is easy to separate from the liquid fraction.

The production and use of microalgae is a consolidate technology in several fields such as cosmetics, pharmacy, biofuel, nutraceutical and food science where microalgae are the final process outputs. The methodological approach adopted in the ECOMAWARU project aimed at developing the "opposite process": the use of autochthones microalgae to refine the final effluent of the wastewater treatment plant, thus turn it into "natural green system" for the water bodies protection.

In this framework, contrary to the traditional technologies applied in wastewater treatment (such as activated sludge) the phytodepuration technique with microalgae is characterized by the lack of consolidate technology as well as simulation tools for modelling the processes occurring in a photobioreactor. Furthermore, the laboratory tests performed to assess the biomass development and the treatment efficiency of the photobioreactor require a modification the standard analytical methods (for instance to avoid the bacteriological contamination of the effluent/biomass samples). Similar problems were taken into account when the standard procedure for remote control generally adopted in traditional chemical plant was transferred to the photobioreactor.

Since the phytodepuration technique with micro algae as a tertiary treatment for wastewater management represents a non-consolidate technology as briefly illustrated above, the methodology adopted in the project has been based on a "step-by-step" approach. In particular the following section provides a short description of each action in terms of obtained results and the corresponding cost-efficiency of the action when compared with the project proposal.

The action 1 "State of the literature" and action 3 "Analysis of the territory" dealing with studies and surveys on the territory required a limited effort as for the studies reported in the literature. Indeed the use of microalgae technique as tertiary treatment of wastewater effluent is scarcely documented in the scientific literature and the experimental studies are mainly at the laboratory pilot scale. Based on this consideration the cost-effectiveness of the action 1 is higher compared with the project proposal while the action 3 required an extra effort (in terms of staff activities) for collecting, updating and implementing the data on the GIS platform.

The core of the project was based on the successful implementation of the action 2 "*Specification*", action 4 "*Planning, construction, installation and management of micro phytodepuration systems*" and action 5 "*Monitoring campaign*". Compared to the project proposal the development of these actions during the project reveals the "step-by-step" approach. The action 2 dealing with the definition and the development of the procedure for the experimental activities (such as laboratory test, data collection and validation, etc.) required to develop specific analytical procedure to manage the effluent/biomass samples thus requiring an extra cost claimed on this action mainly in terms of qualified personnel (such as young researchers). However the effectiveness of this action clearly emerges, indeed it plays a crucial role on the successful implementation of action 4 and mainly action 5. The action 4 that was devoted to the design, installation and fully operational of the two prototypal plants (the closed and open photobioreactors) required a greater effort both in terms of time-schedule

than in terms of budget on the other hand this approach allowed carrying out a more effective monitoring programme thus reducing the foreseen costs of this latter action in view of the same expected results. Therefore considering these actions (2,4 and 5) as a whole, it emerges the cost-effectiveness of these actions even when compared with the project proposal.

The action 6 "*Analysis and assessment of the results*" and action 7 "*Set of rules and technical documentation*" were the actions devoted to the analysis of the results and their potential practical uses. Indeed results achieved in such actions represent the main results of the project that have been immediately visible. Since these actions are strictly related to the experimental activities, the "step-by-step" approach determined a more structured process concerning the data elaboration. It has to be considered this action includes the elaboration of the preliminary data collected during the action 4 that allowed to design the prototypal systems as installed in the final configuration. Based on this considerations, it clearly emerge that the costs claimed in the action 6 are higher than the one foreseen in the project proposal, on the other hand the cost effectiveness of these action is still positive being the project results fully achieved.

The action 8 "Dissemination" and action 9 "Project Management and Monitoring" concern the communication and project management phase. As for this activities, it important to notice that the action 8 fully achieved the foreseen objective. Compared with the project proposal, this action reveals very effective in terms of cost-effectiveness for two main reasons: firstly, the partnership has largely adopted the computer technology (such as electronic leaflet, web-site communications, e-mails, etc.) to disseminate the preliminary and final results of the project, secondly the final dissemination activities were carried out after the project end thus the corresponding costs cannot be claimed.

In the following table the achieved results have been compared to the foreseen objectives for each action in order to support the description of the project implementation. In the evaluation field the lessons learned have been synthetically reported for each action.

Action	Foreseen in the revised proposal	Achieved	Evaluation
1. State of the literature	Literature review concerning phytodepuration plants	• Definition of design parameters and climatic/environmental variables	The objective has been fully achieved.
2. Specifications	Definition of specifications for each project component	• Collection and validation of data procedures; • Analytical protocols • Maintenance procedures; • GIS architecture.	The achieved results have met the objective. The definition of design parameters has successfully supported the design and realization of plants.
3. Analysis of the territory	Improve the level of knowledge relating to the management of water and wastewater	• Implementation of a GIS platform concerning the management of water and wastewater	The objective has been fully achieved. The implemented GIS platform allowed to quickly examine and update information based on user-selected criteria
4. Planning, installation, management of plants	4.1 Sites selection; 4.2 Microalgae selection; 4.3 Executive design of plants; 4.4 Installation and Field testing of plants.	• Selection of 3sites; • Inoculation of the micro algal mass; • Realization of 3plants; • Installation of 2 prototypal plants and a storm water monitoring station.	The objectives have been fully achieved. The design of prototypal plants required a “step-by-step” methodological approach.
5. Monitoring campaign	Acquisition and storage of observed field data	• Implementation of the water quality data base for the two prototypal plants and monitoring station.	The objective has been fully achieved.
6. Analysis of results	6.1 Assessment of the removal efficiency of the prototypal plants; 6.2 Design of the biomass recovery system.	• Implementation of the quality-performance indexes data base; • Definition of the procedure for the biomass recovery; • Definition of the biomass possible reuse.	The objectives have been fully achieved. The prototypal plants are easy to implement in the rural existing realities and sustainable in terms of integrated water cycle.
7. Set of rules	7.1 Support the legislation process in the water/wastewater management; 7.2 Define the best practice concerning the phytodepuration technique;	• Implementation of the legislation data base; • Elaboration of a draft proposal to be included in the Municipal Building Code; • Elaboration of a technical handbook.	The objectives have been fully achieved. The draft proposal and the handbook should support the adoption of phytodepuration techniques in the management of the waste water.

The results of the project that have been immediately visible at the end of the project can be summarized as follows:

- Installation of 2 prototypal plants of photobioreactor with microalgae;
- Implementation of the quality-performance indexes data base concerning the photobioreactor performance;
- Definition of the procedure for the biomass recovery and reuse;
- Implementation of a GIS platform concerning the management of water and wastewater in the Municipality of Varese Ligure;
- Elaboration of a draft proposal to be included in the Municipal Building Code;
- Elaboration of a technical handbook on the phytodepuration technique.

The results of the project that only become apparent after a certain time period can be summarized as follows:

- improvement of the quality of receiving water bodies;
- easily and effective control of the authorization procedures of the private wastewater discharges based on the implemented GIS platform;
- economic return due to the production of high value biomass;
- support to the spread out and implementation of the phytodepuration technique within the sustainable "green" technique by ARPAL on the territory of the Liguria Region.

During the project development, the request to postpone the end of the project allowed successfully implementing both the prototypal systems (as foreseen in the action 4) and properly carrying out the monitoring programme in order to evaluate the feasibility and efficiency of the microalgae technique as tertiary treatment of wastewater effluent. Without the acceptance of the requested postponement, the project would have not fully achieved the expected results. In particular, the prototypal systems and the storm water monitoring stations would have installed however the monitoring programme would have been incomplete since the data collected from the pond system would have been limited to the winter period when the system is mainly affect by the climatic conditions. Based on such considerations, it clearly emerges the relevance of the approved postponement.

The effectiveness of the dissemination is proved by the achieved results as illustrated in section 5.2 including the drafting of the dissemination material, setting-up and updating of the website, organization of the workshop and the publication of scientific papers. As for the major drawbacks, the number of website visitors per month (>100), participants at the workshops can be considered as visible indicators of the dissemination activities. Furthermore, it has to be noticed that both during the project implementation and after its end Prof. Mauro Rovatti (scientific coordinator of the project and its staff) have received several contacts and invitation to workshop or conferences (national and international) to illustrate the main results of the project. In particular, a strong relationship between the persons involved in the ECOMAWARU project and the staff involved in the REWETLAND project (another life project) is strengthened, indeed the REWETLAND staff participated to the final conference to shared their experience and results. Finally, ARPAL, that is in role as the technical body of the Liguria Regional Bureau in the field of the Environment, also with control and surveillance competences against both natural and man-made environmental hazards, including pollution, and in charge of the activities related to the fulfilment of the EC Directive 60/2000 (the Water Directive) as far as the quality assessment of surface water bodies, has expressed its direct interest in the project results that can be include in the future within the sustainable "green" technique promoted to be applied on the territory of the Liguria Region.

5.4 Analysis of long-term benefits

As well-known, water resources and greenhouse gases, mainly CO_2, are a major challenge to worldwide environmental sustainability. Regarding the conservation of water resources, the need for treatment of wastewater and their reuse or recycling becomes more and more pressing.

With regard to the water resources conservation, the wastewater treatment plants must have the ability to efficiently remove high concentrations of nutrients, namely nitrogen and phosphorous, in order to prevent eutrophication of water bodies (rivers, lakes). Eutrophication causes a deterioration, often irreversible, of water quality.

Currently there are several technologies based on biological or physical-chemical processes for nitrogen and phosphorus removal from wastewater but, these processes are highly energy-intensive and thus producing high amounts of greenhouses gases, large amounts of waste sludge and requiring high investment and management costs. Finally, all these processes are not able to simultaneously remove nitrogen and phosphorus from wastewater.

The natural processes of water treatment like phytodepuration or constructed wetlands overcome the drawbacks above mentioned, however, they need extended land surfaces and therefore are mainly applied for the treatment of wastewater related to small communities.

The treatment of wastewater with algae has the following long-term environmental benefits:

- lower involved surfaces than the ones required in case of phytodepuration systems with macrophytes;
- increased efficiency of CO_2 photosynthetic conversion with respect to macrophytes (indeed microalgae and cyanobacteria grow much faster than terrestrial plants);
- the effluent discharged into receiving water bodies is oxygenated;
- high value products can be extracted from produced algal biomass.

The algal biomass is a bioresource of primary importance since it can be transformed into a wide range of valuable products: health care products, food additives, chemicals, third generation biofuels; for this reason, the research aims at developing technologies that allow the intensive production of microalgae. The intensive cultivation of microalgae requires water, light, nitrogen and phosphorus salts, carbon dioxide, therefore the environmental impact resulting from this activity obviously emerges: water pollution, air pollution due to the production of reagents and consequent energy consumption. The intensive production of microalgae may constitute an environmental problem that can be significantly reduced by using the nutrients contained in wastewater and, when possible, the CO_2 present in the flue gases from combustion processes or better the CO_2 produced by the processes of conversion of biogas from anaerobic digestion systems to biomethane.

Based on such considerations, the civil wastewater, wastewater produced by the livestock and food industry appear suitable for the algal biomass production; therefore the microphytodepuration technique turns out as a long-term sustainable solution.

The long-term economic benefits that can be expected from the diffusion and implementation of micro-phytodepuration systems are summarized as follows:

- significant reduction in operating and investment costs for nitrogen and phosphorus removal from wastewater;
- economic return due to the production of high value biomass;

- saving on the purchase of chemicals required for the intensive production of algal biomass.

As for the continuation of the project the prototypal systems will be maintained in operation and monitored in order to identify additional useful information in order to optimize the treatment process and scale-up the plants. For this purpose the photobioreactor installed at the municipal wastewater treatment plant of S. Pietro Vara will be fed with the raw sewage (only pre-treated for the removal of solids) that presents organic loads and nutrients greater than ones observed during the project.

In conclusion, the ECOMAWARU project was innovative because enabled the realization and installation of two prototypal plants that effectively treated wastewater effluents from an Imhoff tank and a wastewater treatment plant respectively. The data obtained show that microalgae photobioreactor adopted as tertiary treatment reveals excellent performance in terms of nutrient removal.

6. Comments on the financial report

6.1. Summary of Costs Incurred

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement*	Costs incurred within the project duration	%**
1.	Personnel	450.492	485.060,09	107,67%
2.	Travel	10.980	14.505,49	132,11%
3.	External assistance	225.500	224.144,93	99,40%
4.	Durables: total non-depreciated cost			
	- *Infrastructure sub-tot.*	15.000	0	0,00%
	- *Equipment sub-tot.*	13.000	6.415,20	49,35%
	- *Prototypes sub-tot.*	25.000	52.477,76	209,91%
5.	Consumables	158.500	47.025,73	29,67%
6.	Other costs	0	2.759,50	
7.	Overheads	**61.650**	**49.512,47**	80,31%
	TOTAL	**960.122**	**881.901,17**	92,16%

The implementation of the project gave rise to some variations in the project's budget, variations which were already highlighted in the Annex I "*Technical and financial notes*" in the request for postponement.

As far the cost category **"Personnel"**, the above table illustrates the full costs incurred by the partners for the development of the project. The sum is to be considered eligible only for the value that does not exceed the maximum rate allowed by the rules of the project (Common Provisions art. 25.2), 48% of the eligible cost, i.e. **363.200 €**.

The cost category "**Travel"** shows an increase compared to the forecasts of 3,525.49 €. The increase incurred by this cost category is within the limit provided for by the Common Provisions of 30,000.00 €, as anticipated in Annex I Postponement. The increase in costs is immediately linked to the extension of the project and in particular the extension of the time schedule of action 4.4 "*Installation and testing in the field*" and action 5 "*Monitoring campaign*". As will become more apparent in paragraph 6.5 of this report the extension of the two actions made it necessary, the step-by-step implementation of action 4.4 required to carry out a greater number of onsite visits., while for action 5 the travel costs are fairly consistent with the foreseen ones. These factors therefore increased the number of trips made by DICCA staff at the experimental sites located in the municipality of Varese Ligure. These dynamics determined a decrease in travel operated by the COVA Staff to Genoa. Given the frequent attendance of the DICCA Staff to Varese Ligure, an attempt to optimise resources by organising meetings to monitor and manage the project in conjunction with the technical inspections was made. Sometimes, however, the transfer of the collected samples to Genoa was carried out by the staff of the Municipality.

During the course of the project the total cost for the cost category "External assistance" remained virtually unchanged. On the overall amount there is a minimum variance of 1,355.07 €.

As far as the cost category " **Durable Goods**" is concerned the items included in it have undergone many changes. As for the " *Infrastructure costs"* the costs originally foreseen, during the project implementation were not incurred. The expenses of 15,000 € foreseen for the construction of the pond including excavations, civil works, etc. did not incur since based on detailed evaluation carried out both in action 2 and action 4, the use of external tanks resulted far more advantageous, both from an economic point of view and an environmental one. The use of tanks therefore avoided infrastructure costs while ensuring the smooth running of the foreseen actions. The costs relating to "*Equipment"* in the implementation phase were reduced. The total budget of 13,000 € was reduced to 6,415.20 €. The expenditure did, however, allow COVA to adopt a workstation dedicated to the project and to carry out the planned activities. In contrast to the expenses of Durable Goods, the expenses related to *"Prototypes* " increased. The expenditure initially planned at 25,000 € actually increased to 52,477.76 €, an increase however lower than the maximum threshold of 30,000 €. Also in this case the step-by-step methodology adopted to the prototypal plants design required various modifications and adaptations. This of course required the purchase of a larger amount of equipment to be allocated to the plants than had been predicted during the design phase.

The cost category **"Consumables**" is the category that underwent the most significant reduction. The initial estimate of 158,500 € was reduced to 47,025.73 €. The sharp reduction in its budget is due to DICCA which had initially a budget of 155,000 €. This decrease was mainly due to an overestimation of costs carried out during the design phase.

The cost category **"Other costs",** which in the planning stage had not been given any budget, recorded certain expenses during the implementation phase. The amount charged to this cost category was reduced, 2.759,50 €, an amount however lower than the maximum threshold of 30,000 €. The costs attributed to this cost category by DICCA concern the conference fees, while for COVA the costs are related to the removal of snow from the streets of access leading to the experimental plants.

The cost category of **"Overheads"** was reduced in proportion to the reduction of the eligible expenditure. The reduction of 12,137.53 € was then made to keep the cost of Overheads below the maximum limit of 7% of eligible direct costs.

6.2. Accounting system

Both the beneficiaries of the project are public authorities and therefore as such are subject to the rules laid down by public law.

In the sections below a brief description of the accounting system employed by each beneficiary and the code identifying the project costs in the analytical accounting system is provide.

As far the coordinating beneficiary, COVA, its budget is divided into sections identified by a numerical code defined at the ministerial level, within which are placed the various cost categories also identified by a numerical code. Each operation is characterised by title, function, service, and type of intervention. With regards to the ECOMAWARU project, COVA gained approval with Resolution from the City Council dated 20th April 2009. For the ECOMAWARU project, COVA didn't adopt a specific accounting system, however introduced a new spending category to the municipal budget identified by the number 1194 and entitled "Life project ECOMAWARU" inserted in the operation number 2090401. The costs of the project were then uploaded on the expenditure item N° 1194.

It has to be noticed that there are certain expenses relating to the category "other costs" and "consumables" that were placed in other categories of expenditure. The costs incurred

under other headings are related to invoices which can be attributed only in part to the project or which fall in the category of a wider supply. These costs affected the supply of materials and services related to the improvement and maintenance of the premises used for experimentation, items for which the municipal budget had already specified the categories of expenditure.

On the expenditure documents in whole or partly attributed to the project, whether related to the specific category of expenditure or not, these were nonetheless marked with the stamp of the project. For invoices charged to the project, but attributed to different items of expenditure was produced a statement by the Head of the Department which is enclosed as an attachment.

For the associated beneficiary, DICCA, there is also an accounting system broken down into expenditure categories. For the project, DICCA did not implement an analytical accounting system due to the characteristics of the accounting system of its public bodies which defines the impossibility to use an accounting system for the cost centre and a current account dedicated to the project. Furthermore, due to the modality of the co-financing procedure foreseen by the LIFE program, it was no possible to use a dedicated accounting system for the cost centre. Indeed, for projects with a duration of more than 24 months and an EU contribution of more than 300,000 €, as in the case of the ECOMAWARU project, the Methods of payment (Common Provisions Article. 28) provide for a pre-financing payment equal to 30% of the funding granted and a subsequent 40%, once reached the expenditure of 150% of the first advance quota.

In order to reach the expenditure of 150% of the pre- pre-financing payment thus gaining access to the interim payment, DICCA would have had to cover the costs of the project following the "accertamento" procedure, i.e. using the common funds of the Department. However, this procedure cannot be applied by the University so that in the absence of resources for project category, DICCA have to use funds not covered by other statements of accounts. The adopted procedures were the object of a specific statement from the Head of the Department (Professor Mauro Rovatti) and Executive Secretary of the Department, and supplied to the auditor.

The University established a category of expenditure of the project on which expenses were charged conformably with the available funds. In the accounts of the University, the project was identified by the unique code of the project CUP D35J10000520006.

All expenditure documents related to the project were nonetheless stamped with the official stamp of the project.

All costs incurred for the implementation of the project, with regard to the coordinating beneficiary, COVA, were approved and documented by official records of the Municipality, that is to say the acts of the City Council and determined by the Head of Service (Surveyor Serventi Massimo). Each payment is accounted for by a document of the cost and a payment order regularly receipted by the treasurer of the municipality.

All contracts relating to the purchase of goods and provision of services occurred through direct contracts as they related to costs which were lower than the 40,000 € threshold laid down by the law.

As for the associated beneficiary, DICCA, the rules that govern the procedures of cost approval is more complex due to the institution structure. Generally speaking, the University system allows that the supplies available on the MEPA system (the system through which purchases are managed was established by Law 228/2012 Law of stability - and with the previous Law 296/2006 - 2007 Budget), can be acquired directly. Indeed trough the MEPA

system, it is possible to access a list of accredited suppliers. For supplies not included in the MEPA system, the University procedure requires to collect at least 4 quotations from different suppliers; the final selection is based on the most economically advantageous, according to the quality of the proposal.

All expenses that were over 5,000 €, previously approved by the Council of the Department, had to be approved by the Head of Service of the Polytechnic School (corresponding to the faculty level). All expenses of the project that were over 5,000 €, underwent this approval process with the exception of the assignment of the Project Manager, (Company A4 Srl.). In this case, given the extraordinary urgency of the appointment, a direct assignment by the Director of the Department on the basis of the evaluation of the curriculum vitae of the members of the Company was carried out.

With regard to the system of registering the hours of work dedicated to the project, the partners jointly agreed to use a common method. For both partners the individuals who worked on the project were responsible for filling in timesheets directly on computer and using the template excel made available by the project. Each individual was responsible for the daily updating of his/her own timesheet. Some exceptions occurred during transfers, when the return time was beyond normal working office hours. In these cases the timesheets were updated the following day or as soon as return was made to the office.

The timesheets were therefore finalised on the last day of the month. Usually every employee took it upon themselves to print, date and sign the timesheet within the first week or the first half of the following month of reference.

As for COVA, given the more limited size of the organisation and the limited number of staff employed in the project, the signature of the staff members and that of the individual responsible for the project, the Mayor Mrs. Marcone took place at the same time.

Instead, as for DICCA, due to the Department structure, the higher number of individuals involved in the work group and the different locations of the offices, the dates of signatures of the project staff and of the project manager Prof. Rovatti, did not always coincide. Even in these cases the staff member did however proceed in the signing of the documents within the first half of the following month.

The invoices regarding the purchase of goods and services received by both beneficiaries for the project contain clear references to LIFE + project. In some invoices the specific reference to the project was indicated by the supplier, in the same description of the invoice. Instead, some invoices do not report all the specific terms: this is due to the fact that either the supplier failed to fill in the specifics requested or that the invoice is related to a wider supply attributable only in part to the project. However, on all expenditure documents and particularly on those without specific reference to LIFE + project, a stamp of the project had been applied. For all invoices charged to the project, but attributable to different cost categories other than those specific n. 1194, statements were produced by those responsible , and can be found as an attachment to the present.

6.3. Partnership arrangements (if relevant)

Financial transactions that occurred between the coordinating beneficiary and the associated beneficiaries took place according to the ground rules laid down in Article 7 of the partnership agreement.

COVA, in the role of coordinating beneficiary, received two instalments of funding from the European Union: the first instalment was equal to 40% of the grant requested, amounting

to 188.474,40 €, identified in the accounting system by “Reversale” N. 188 dated 30/12/2009 and a second instalment equal to 30% of the grant 141.355,80 Euro, “Reversale” N.205 del 19/05/2012.

COVA received the accounting records of the associated beneficiary, DICCA, with respective invoice notice N.12/2010 17/05/2010 which became the invoice numbered 10/000014/00108 dated on 01/06/2010 and the ones numbered 12/000021/00108 dated on 25/05/2012 arranged to transfer the shares.

The transfers to the beneficiaries were made with payment mandate No. 382 of 20/05/2010 for an amount of 161,227.20 € and payment mandate No. 507 of 09/06/2012 for an amount of 120,920.40 €.

As for the compilation of financial reporting and in particular the compilation of data regarding expenditure and supporting documentation each partner was responsible for the updating of their tables.

Each beneficiary was responsible for the constant updating of the tables by entering financial data relating to expenditure documents and data and as soon as they were available of payments.

The financial tables as well as the updated general picture of the progress of the different actions were shared by the partners on a quarterly basis to ensure that a constant and full knowledge of the state of the project was maintained.

The compilation of the financial tables were assisted by the Project Manager.

Obviously the "Standard Payment Request and Beneficiary's Certificate" and the "Consolidated Cost Statement for the Project" were compiled by the coordinating beneficiary once the final framework of expenditure had been defined by the partners.

6.4. Auditor's report/declaration

In accordance with Article 31 of the Common Provisions, the project, with a Community contribution of more than 300,000 €, is subject to the constraint of the Independent financial audit and therefore the audit report.

The external auditor was appointed by the Coordinating beneficiary, COVA. Among the three proposals submitted, the one submitted by Dr. Riccardo Calvi was selected.

Dr. Riccardo Calvi (with offices in Genova, Via Fieschi 1/20), was appointed by COVA with the decision of the 7th December 2011.

The auditor's report was prepared by Dr. Calvi and is attached to the financial report.

6.5 Summary of costs per action

The following table presents an allocation of the costs incurred per action.

Act.	Name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.a Infra-structure	4.b Equip-ment	4.c Prototype	5. Purchase or lease of land	6. Consumables	7. Other costs	TOTAL
1	State of the literature	11.711,55	-	1.639,00	-			-			13.350,55
2	Specifications	18.151,94	-	11.473,00	-			-	3.778,38		33.403,32
3	Analysis of the territory	28.809,14		16.155,21	-	6.415,20		-			51.379,55
4	Planning, construction, installation and management of micro phytodepuration systems	140.777,55	3.523,75	42.402,00	-		52.477,76	-	20.482,06	1.079,93	260.743,05
5	Monitoring campaign	143.897,03	7.109,32	92.911,65	-			-	19.571,22	1.279,58	264.768,80
6	Analysis and assessment of the results	55.476,84	-	21.121,51	-			-			76.598,35
7	Set of rules and technical documentation	13.749,10	-	5.910,66	-			-			19.659,76
8	Dissemination	27.267,88	1.842,51	12.563,25	-			-	1.748,51	400,00	43.822,15
9	Project Management and Monitoring	45.219,06	2.029,91	19.968,65	-			-	1.445,59		68.663,21
Over-heads		25.384,85	1.011,59	15.760,66	0	223,69	3.659,73	0	3.279,51	192,44	49.512,47

Comparing the above table with the table Form FB of the project approved proposal, it emerges some significant differences that, however, prove to be in line with the results achieved and difficulties encountered.

In accordance to what was highlighted also in paragraph 5.3 significant cost savings were detected in **Action 1** "*State of the literature*". Compared to the project proposal, this action in fact led to a lower commitment in terms of personnel (-1782.45 €) and of external assistance (-25 361 €). Since the use of microalgae technique as tertiary treatment of wastewater effluent is scarcely documented in the scientific literature and the experimental studies are mainly at the laboratory pilot scale the commitment of staff and external assistance was more contained than initially expected.

As for **Action 2** "*Specifications*", it is to be noted that during the implementation phase the overall cost increased. The increase affected mainly the cost category of external assistance which was not foreseen in the proposal (+11,473 €) and also the addition of costs of consumables (+3,778.38 €). This action that actually formed the basis for the definition and development of procedures for the implementation of the demonstration/experimental required a greater than expected use of qualified personnel, identified in young researchers.

Also for **Action 3** "*Analysis of the territory*" there is an overall increase compared to the budget initially planned. Moreover, a different allocation of the expenditure between the different cost items is also highlighted. The updating and implementation of data on the GIS platform in fact required more work than expected. COVA, not being able to cope with the extra work required by the action only with its internal staff, identified a third person in the

form of "Cantiere scuola-lavoro" to support the data processing for implementation of the GIS platform. The entry of external assistance initially not foreseen in the project determined an expenditure of € 16,155.21 € for this action. The acquisition of the equipment instead allowed a saving of expenditure (-6,584.80 €).

Action 4 "*Planning, construction, installation and management of micro phytodepuration systems*" represents one of the crucial actions in the implementation of the project. Action 4 in fact includes all activities related to the planning, construction, installation and management of the prototypal plants and monitoring stations. Precisely for its centrality and importance it is the action which most of all suffered from the difficulties encountered in the project. The lengthening of the project due to flooding, along with the technical difficulties encountered in the design phase which later during the first field tests required greater work force and subsequent updating of the experimental plants. From this set of mishaps, technical difficulties and subsequent updating came the substantial increase in personnel expenses (+ 62,885.55 €), external assistance (+15,402 €), prototype (+27,477.76 €), consumables (+ 20,482.06 €), travel costs (+2,443.75 €) and other costs (€ +1,079.93). The latter, not foreseen in the project proposal, covered the costs for maintaining accessibility to the experimental sites and plants during the winter months.

Action 5 "*Monitoring campaign*" was another key action of the project. Also the was affected by flooding lengthening the times. Concerning the budget, there is a significant reduction dictated in particular by the initial overestimation of consumables item, made during the project proposal.

In fact, during the realisation phase the purchase of consumables underwent a significant reduction (-83,428.78 €). The reductions although more contained, concerned also the personnel (-14,358.99 €) and external assistance (-15,088.35 €). Instead travel costs slightly increased (+485.32 EUR) and other costs (+1,279.58 €) included the costs for maintaining the accessibility of the experimental sites during the winter months. The overall reduction in the budget of the Action 5 is also attributable to an effective design of the prototypal plants based on a step-by step methodology approach carried out in action 4.

Action 6 "*Analysis and assessment of the results*" concerns the validation and processing of data collected in actions 4 and 5. Given the amount of data collected and the considerable improvements made in the course of designing, installing and updating of the prototypal plants for the analysis and processing, a more structured process was needed and therefore greater use of specialised individuals. Specifically were employed young researchers as external assistance (+21,121.51 €) which was not foreseen in the planning phase of the project.

Action 7 "*Set of rules and technical documentation*" also played a key role in the project dealing with the transfer of the collected data collected into practical applications in non-experimental contexts. As for action 6 the realisation required the use of a greater quantity of human resources. Therefore external assistance was employed (+ 5.910,66 €) which was not calculated for in the project proposal.

Action 8 "*Dissemination*" despite having achieved its objectives recorded a significant saving in costs. These savings came primarily from the extensive use by the partners of information technology, and secondly by the realisation of the final events after the end of the project (which leaves the costs as not accountable). There was a slight increase in the cost of personnel (+2.128,88 €), travel costs and subsistence (+1.842,51 €) not initially foreseen, but that allowed the dissemination of the project on a larger scale throughout the attendance to the international conference CEMEPE 2013 held in Greece. This resulted in the additional cost

also not foreseen by the project of other costs (+ 400.00 €). Instead savings were registered regarding external assistance (-9.936.75 €) and in the consumables category (-50,751.49 €) a saving gained from a more consistent use of computer support and an overestimation of costs during the drafting of the proposal.

The use of IT between partners also led to a saving in costs also for **Action 9** *"Project management and monitoring"***.** The project despite reaching its objectives showing that it was able to cope with a joint action of the partners, with all the difficulties encountered during the course of the project did however in fact register savings in all the foreseen cost categories: personnel (-8.888,94 €), travel and subsistence (-706,09 €), external assistance (-21.031,35 €) and consumables (-554,41 €).

7. Annexes

7.1 Administrative annexes

- **Partnership agreement** between COVA and DICHEP signed on the 08/06/2010 was delivered to the EC with the Inception Report on the 30/09/2010.

7.2 Technical annexes

- List of keywords and abbreviations used (see Annex 7.2-A)
- Database quality data of phytodepuration systems (see Annex 7.2-B)
- Database quality data of storm water monitoring stations (see Annex 7.2-C)
- Data base quality-performance indexes for the pond system (see Annex 7.2-D)
- Data base quality-performance indexes for the photobioreactor system (see Annex 7.2-E)
- Data base quality-performance indexes for the storm water monitoring stations (see Annex7.2-F)
- Technical Handbook on good practices and processes of phytodepuration for wastewater treatment "Trattamenti naturali delle acque reflue" (see Annex 7.2-G)
- Deliverable products of the project (see Annex 7.2-H)

As for the paper copy, the following deliverables have been previously delivered to EC:

Deliverable	**Delivery to EC**	**Delivery date**
D1: Technical report on the actual microalgae practices	Inception Report	30/09/2010
D2: Technical report on system specifications	Inception Report	30/09/2010
U2.: Specification Update on the "monitoring campaign"	Mid-term. Report	28/09/2011
D3.A: Technical report on preliminary database for the GIS platform	Mid-term. Report	28/09/2011
D4.1 Technical report on sites selection	Inception Report	30/09/2010
D4.2 Technical report on microalgae selection	Mid-term Report	28/09/2011
D4.4 Technical report on systems as installed	Mid-term Report	28/09/2011
D8.A Technical report on the design of the project logo	Inception Report	30/09/2010

7.3 Dissemination annexes

7.3.1 Layman's report

- Layman's report in English version (see Annex 7.3.1-ENG)
- Layman's report in Italian version (see Annex 7.3.1-ITA)

7.3.2 After-LIFE Communication plan – for LIFE+ Biodiversity and LIFE Environment Policy and Governance projects

- After – life communication plan (see Annex 7.3.2)

7.3.3 Other dissemination annexes

- Informative panel of the project (see Annex 7.3.3-1)
- Informative panel of the closed photobioreactor plant (see Annex 7.3.3-2)
- Informative panel of the open photobioreactor plant (see Annex 7.3.3-3)
- Informative panel of the storm water monitoring station (see Annex 7.3.3-4)
- Informative Brochure with preliminary results in Italian (see Annex 7.3.3-5)
- Informative Brochure with preliminary results in English (see Annex 7.3.3-6)
- Informative Brochure Regional conference in Italian (see Annex 7.3.3-7)
- Informative Brochure with final results in Italian (see Annex 7.3.3-8)
- Informative Brochure with final results in English (see Annex 7.3.3-9)
- Informative panel of Regional conference in Italian (see Annex 7.3.3-10)
- Poster Greece Conference CEMEPE 2013(see Annex 7.3.3-11)
- Abstract Greece Conference CEMEPE 2013 (see Annex 7.3.3-12)
- Presentation of Local conference (see Annex 7.3.3-13)
- Presentations of Regional conference (see Annex 7.3.3-14)
- Presentations of National conference (see Annex 7.3.3-15)
- Presentation of the Ist Review meeting (see Annex 7.3.3-16)
- Presentation of the IInd Review meeting (see Annex 7.3.3-17)
- Presentation of the IIIrd Review meeting (see Annex 7.3.3-18)
- Presentation of the IVth Review meeting (see Annex 7.3.3-19)
- Presentation of the Vth Review meeting (see Annex 7.3.3-20)
- Brochure of International Conference ECOMONDO (see Annex 7.3.3-21)
- CD-ROM of the project (see Annex 7.3.3-22)
- CD-ROM "All photo of the project" (see Annex 7.3.3-23)
- Dissemination/publication list (see Annex 7.3.3-24)
- Press release relating to regional conference (see Annex 7.3.3-25)
- Press release relating to national conference (see Annex 7.3.3-26)
- Article published on Secolo XIX La Spezia (see Annex 7.3.3-27)
- Article published on La Nazione (see Annex 7.3.3-28)
- Article La Nazione (see Annex 7.3.3-29)

7.4 Final table of indicators

- The final outcome indicators' tables (see Annex 7.4-A)

8. Financial report and annexes

- "Standard Payment Request and Beneficiary's Certificate" signed by COVA, the Coordinating Beneficiary (original copy);

- "Consolidated Cost Statement for the Project" signed by COVA, the Coordinating Beneficiary (original copy);

- "Financial Statement of the Individual Beneficiary" signed by COVA, the Coordinating Beneficiary (original copy);

- "Financial Statement of the Individual Beneficiary" signed by DICCA, the associated Beneficiary (original copy);

- Independent audit Auditor's report signed by the Independent Audit (Dr. Riccardo Calvi)

- The *ANSWERS TO THE FINANCIAL REMARKS* (see Annex 8-A)

- List of content of financial CD-ROM (see Annex 8-B)