LIFE Project Number

LIFE09 ENV/FI/000575

FINAL Report

Covering the project activities from 01/09/2010 to 30/06/2015

Reporting Date

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LIFE+ ABSOILS

Sustainable methods and processes to convert abandoned low-quality soils into construction materials.

Project Data

Project location	Finland
Project start date:	01/09/2010
Project end date:	31/12/2014 **Extension date:** 30/06/2015
Total Project duration (in months)	58 months (including **Extension of 6 months**)
Total budget	€ 2 736 363
Total eligible budget	€ 2 625 738
EU contribution:	€ 1 312 869
(%) of total costs	47,98 %
(%) of eligible costs	50 %

Beneficiary Data

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2. Executive Summary

Construction activities are among the biggest waste producers in Europe. Waste rock, redundant soil and sediments are the second largest waste stream in Finland. Finland shows also a very high percentage of the average annual use of material - 35 tonnes per person - whereas the average in Europe is 16 tonnes per person.

In the past decade, the Finnish infrastructure has been under rapid development. Excavation in thousands of construction sites has generated and will further generate huge amounts of soil. These soils often include soft clays and sediments which are difficult to be utilised and therefore they are usually disposed at landfills as redundant soils. The estimated annual amount of such soils is about 20 – 30 million tonnes in Finland. This number depends on the amount, sites, sizes and types of construction projects.

At the time when the Absoils project was initiated, in the Uusimaa region alone, the amount of the annually generated abandoned soils - in most cases clays - was about 4 million tonnes per year. A typical problem connected with surplus poor quality soils is the shortage of available deposit sites in the cities of Helsinki, Espoo and Vantaa. In the case redundant materials are not used in earth construction, the cities need new deposit sites which mostly can be found only outside the metropolitan area. Landfilling of surplus soils results in long transportation distances with associated high costs and negative impact on the environment (high CO_2, noise, dusting). Moreover, landfilling of soft soils brings about the necessity of importing non-renewable virgin materials (e.g. natural gravel or crushed rock) as replacement. This requires quarrying and transportation with all the associated negative environmental impacts such as landscape deterioration, deforestation, ground water pollution and greenhouse gas emissions. The environmental and economic factors were among the reasons why the technical departments of the cities at Uusimaa region have been supporting the ABSOILS project by enabling the implementation of the project pilots.

With the application of proper design and innovative treatment methods, surplus soft clays and sediments can be turned into construction materials. The technical solution for soil improvement used by the Absoils project was mainly mass stabilisation.

Mass stabilisation is the process of utilising chemical admixtures and stabilising agents to alter the engineering properties of a soil mass so that cost-effective development results are achieved. The goals of the mass stabilisation programme are typically to improve the geotechnical engineering performance of a given subgrade, or to achieve environmental performance objectives. The application of mass stabilisation techniques alters the technical engineering and environmental properties of soft soil in such a way that it is possible to construct directly on top of the stabilised soil or to utilise it as filling or construction material. Owing to the development of versatile binders, various kinds of soft soils can be stabilised in a cost-effective way.

All mass stabilisation projects utilise a binder, or chemical stabilising agent which reacts with the soil mass to change its properties. As a result of the ground investigation and laboratory testing programmes, the quantity and quality of the binder are optimised to achieve target properties with minimal investment. The use of various industrial by-products as binders in mixtures with commercial binders enables cost-effective application of the mass stabilisation method.

The LIFE+ Absoils project has demonstrated the conversion of surplus and low-quality soils - such like soft clays and sediments - into construction materials. The ABSOILS project was carried out in co-operation among the following beneficiaries: Lemminkäinen (previously Biomaa), Rudus and Ramboll Finland. It was also supported by the Finnish Ministry of the Environment and the Uusimaa cities - Helsinki, Espoo and Vantaa. The project was co-financed by the EU LIFE+ Environmental Policy & Governance programme (LIFE09 ENV/FI/000575). The ABSOILS project started in September 2010 and was finished in June 2015.

In general, the project has addressed the challenges of the European policies and legislation concerning waste and has promoted waste recovery and sustainable recycling with a focus on life-cycle thinking and the development of recycling markets. The

objectives of the project related to the abandoned soils and their conversion into useful earth construction materials have included:

- the creation of necessary knowledge and know-how 1) about the possibilities and methods to use materials based on different types of redundant soils for the construction of different types of civil-engineering applications, and 2) about the environmental and economic value and benefits resulting from the use of materials based on the abandoned soils for civil-engineering purposes (like earth construction)

- the verification of the feasibility of the materials and applications based on abandoned soils for civil-engineering with respect to the environmental safety criteria, the technical criteria given for the intended applications and the economic competitiveness with the conventional civil-engineering solutions;

- the assurance of the established use of surplus low quality soils in civil-engineering projects through the coordination of the regional material flow and civil-engineering projects and the elimination of legislative obstacles that prevent the efficient use of valuable secondary materials in appropriate civil-engineering applications.

With the construction of the pilot applications in the cities involved, the Absoils project has demonstrated the practical implementation of four challenging types of civil-engineering applications including flood barriers, noise barriers, supporting banks and landscape construction. The locations of the pilot applications, their type and the time of implementation were as follows:

Flood barriers
- Dog Park in Espoo (2012/2013)
- Pirttiranta in Vantaa (2012)

Noise barriers
- Jätkäsaari 3 in Helsinki (2014)

Supporting banks
- Arcada 2 in Helsinki (2011)
- Dog Park in Espoo (2012/2013)
- Honkasuo in Helsinki (2014, 2015)

Landscape construction
- Jätkäsaari I and II in Helsinki (2011/2012/ 2013)
- Dog Park in Espoo (2012/2013)

The use of the stabilisation method provided technically, environmentally and economically feasible materials out of soft (clean and contaminated) redundant soils (clays and dredged sediments which were difficult materials with respect to construction) for appropriate earth construction applications like for flood protection and control structures, other sealing and support structures, noise walls and foundations.

The project verified that it is possible to significantly increase the utilisation of redundant poor quality soils produced in the construction projects and to decrease the amount of land-filled waste involving long-distance transports. Consequently, large amounts of valuable non-renewable natural aggregates from rocks and hills were saved for the more demanding purposes.

The Absoils project's most important impacts on the environmental problems targeted are as follows:

- The piloting actions (Arcada 2 and Jätkäsaari I and II) allowed for the stabilisation and utilisation of 142 000m^3 of surplus soft clays and dredged sediments, and owing that the need for landfilling of these masses was minimised
- The Pirttiranta pilot enabled the reuse of 4 000m^3 of surplus clays
- The Dog Park pilot allowed for the stabilisation of about 15 000 m^3 of poor quality, soft clays. It gave the possibility to use fly ash and FGD as binder components, which is very important from the point of view of future permit applications of similar kind
- The Jätkäsaari III pilot gives the possibility for utilisation of 90 000 m^3 of dredged soft sediment for various future engineering applications, thus allowing for saving virgin materials that would have to be otherwise used for the construction of noise barriers in the city of Helsinki. Fly ash as binder was also tested at this site.
- The so-far expected impact of the Honkasuo pilot is saving of 45 000 m^3 of non-renewable materials.
- Additionally, about 40 000 m^3 of rock aggregate material was recovered in the Arcada 2 pilot site by processing and reusing. This, in turn, diminished the need for virgin rock material.
- Stabilised masses from all the three stages of the Jätkäsaari pilot have been used for various construction purposes. Part of the masses were transported to other parts of Helsinki and utilised there, e.g. for the Vuosaari landfill cover or landscaping purposes in the Ida Aalberg park.
- Due to the pilot applications, long-distance transportations to soil deposit sites were avoided, as well as the need to transport virgin rock material as replacement masses.
- The impact of the pilots on the decrease of CO_2 emissions was calculated during carrying out the LCA studies.
- Diminished transport of materials has improved the quality of air in the cities involved in the project resulting in a positive influence on the inhabitants' health.

The ABSOILS project has provided the stakeholders with new knowledge and guidance (International Guidelines) on the possibilities and methods of using earth construction materials based on various types of redundant, poor quality soils. The project has served as a successful example demonstrating environmental and economic benefits based on the utilisation of surplus soft soils for versatile engineering purposes.

Quality control activities, as well as the LCA studies carried out in the framework of the project provide the construction sector with reliable data on how such materials fulfil the technical and environmental criteria set for intended applications. The LCC study gives a proof of the economic competitiveness of the project pilot solutions.

The project has created an efficient and user-friendly system – the RMSS - that will allow for monitoring the current and future sources of surplus soils in order to plan their effective utilisation.

The ABSOILS project team members have taken an active role in disseminating the information on the project and its objectives in discussions with various stakeholders both in Finland and internationally. Continual networking activities have increased the level of knowledge and raised the awareness of the importance of solving the issue of surplus soft soils. The project has received a very positive feedback from the representatives of the cities involved as a pioneering initiative in this field.

- Project webpage: http://projektit.ramboll.fi/life/absoils/index_eng.htm
- DVD presentation (available on the project website)
- European Guidelines on the methods of converting surplus soils into useful construction materials (on the project website)
- LCA/LCC Report (on the project website)
- Conference papers, conference presentations, posters, numerous networking activities, publications, media articles
- Road shows: 2013-2015
- International Workshop in Finland, September 2014

The Final Report comprises of the following chapters:

- Introduction – shortly describes the project background, targeted problems and objectives, as well as the methodological solution applied and the results and benefits.
- Administrative part – describes the issues concerning project organisation and cooperation among the partners, as well as the activities of the Steering Group and amendment of the original project proposal.
- Technical part – presents the information on the implementation of the following Actions: 1. Preparations; 2. Materials; 3. Applications; 4. Piloting; 5. Verification and 6. Modelling; and 7. Dissemination. Project implementation and its long-terms benefits are also analysed.
- Comments on the financial report – provide information concerning accounting systems and other relevant information on financial issues of the Absoils project.
- Annexes – include the list of all annexes attached to the Final Report.

3. Introduction

Construction activities are among the biggest waste producers in Europe. Waste rock, redundant soil and sediments are the second largest waste stream in Finland. Finland shows also a very high percentage of the average annual use of material - 35 tonnes per person - whereas the average in Europe is 16 tonnes per person. Finland is constantly undergoing the process of infrastructure development. The development of industrial activities frequently results in a demand for a new land in the vicinity of the main operation. In many cases, there is a shortage of land that is characterised by good geo-technical features or there is a need to rehabilitate or clean-up the contaminated land. In such cases, the most common solution is mass exchange including transportation and landfilling of poor quality soils.

Some of the left-over masses like stone materials can easily be reused in on-going and future construction works, for instance in noise barriers or fillings. However, there are other spoils like muddy clay, silt, humus or peat which are challenging for reuse. Unfortunately, landfilling is a common practice as soft soils are generally considered unsuitable construction material. This exerts a negative impact on the environment due to associated transportation and the need to increase landfill capacity. In many cases – especially in the vicinity of cities – surplus soils landfill capacity is exhausted and soil masses need to be transported for considerably long distances to available reception sites. In general, landfilling of soft soils brings about the necessity of importing non-renewable virgin materials (e.g. natural gravel or crushed rock) as replacement. This requires quarrying and transportation with all the associated negative environmental impacts such as landscape deterioration, deforestation, ground water pollution and greenhouse gas emissions.

- The Absoils project came as a response to the problem of surplus, excavated soft soils resulting from infrastructure development,
- In the Uusimaa region alone, the amount of the annually generated surplus soils - in most cases soft clays - has been about 4 million tonnes per year,
- In the year 2009, the annual generation of excavated soils in Helsinki was about 0,6 million m^3. At that time, 70% of this amount was landfilled,
- In 2012, the landfill for surplus soil masses in Helsinki was closed down due to its exhausted capacity and transportation distance increased up to 40 km,
- At the same time, various industrial activities generate versatile waste streams which in most cases are still deposited in landfills. From the economic and environmental point of view, this constitutes a considerable loss with serious negative impacts on the state of the environment and the competitiveness of the EU economy,
- There has been a burning need to change this situation, which is possible only when successful pilot applications set an example to follow and provide reliable and verified data on the material engineering and environmental properties, their performance (also long-term) and economic factors (actual savings that can be obtained with the use of alternative solutions).

The aims and objectives of the Absoils project were as follows:

- To address the challenges of the European policies and legislation concerning waste
- To promote waste recovery and sustainable recycling with a focus on life-cycle thinking and the development of recycling markets
- To tackle the challenges related to surplus soft soils and their conversion into useful earth construction materials
- To provide technical, environmental and methodological data and information on materials, materials mixtures and additives, their treatment, as well as the diverse stages of construction
- To demonstrate the practical implementation of four challenging types of civil-engineering applications in full-scale pilots based on the use of redundant soft soils: flood barriers, noise barriers, supporting banks and landscape construction.
- To create and demonstrate a Model for Sustainable Regional Material Service System (RMSS) for the Uusimaa region. The role of the RMSS is to direct the use of regionally generated surplus materials to short-term and long-term infrastructure construction projects with the assistance of an Internet operated database.

With the application of proper design and innovative treatment methods, surplus soft clays and sediments can be turned into construction materials. The prevailing soil improvement method used in the ABSOILS project was mass stabilisation.

Mass stabilisation is the process of utilising chemical admixtures and stabilising agents to alter the engineering properties of a soil mass so that cost-effective development results are achieved. The goals of the mass stabilisation programme are typically to improve the geotechnical engineering performance of a given subgrade, or to achieve environmental performance objectives. The application of mass stabilisation techniques alters the technical engineering and environmental properties of soft soil in such a way that it is possible to construct directly on top of the stabilised soil or to utilise it as filling or construction material. Owing to the development of versatile binders, various kinds of soft soils can be stabilised in a cost-effective way.

All mass stabilisation projects utilise a binder, or chemical stabilising agent which reacts with the soil mass to change its properties. As a result of the ground investigation and laboratory testing programmes, the quantity and quality of the binder are optimised to achieve target properties with minimal investment. The use of various industrial by-products as binders in mixtures with commercial binders enables cost-effective application of the mass stabilisation method.

The ABSOILS project has provided the stakeholders with new knowledge and guidance (International Guidelines) on the possibilities and methods of using earth construction materials based on various types of redundant, poor quality soils. The project has served as a successful example demonstrating environmental and economic benefits based on the utilisation of surplus soft soils for versatile engineering purposes. The results of the project have helped to develop new legislation in Finland that will make the use of fly ash as binder in mass stabilisation as a way of soil improvement more easy. The reviewed decree (current number 591/2006 on the use of waste as material in construction) is currently under preparation and is expected to enter into force in 2016. The project results have been also used for the purpose of development of the Act on Soil Excavation (555/1981) which is currently under review.

Quality control activities, as well as the LCA studies carried out in the framework of the project provide the construction sector with reliable data on how such materials fulfil the technical and environmental criteria set for intended applications. The LCC study gives a proof of the economic competitiveness of the project pilot solutions.

The project has created an efficient and user-friendly system – the RMSS - that will allow for monitoring the current and future sources of surplus soils in order to plan their effective utilisation.

It is expected that in the longer run, the civil-engineering materials based on soft, poor quality surplus soils will become an established practice in Finland and in Europe followed by significant environmental and economic benefits. It is expected that landfilling and associated transportation of redundant soils will be reduced and the converted soil materials will replace a considerable part of natural non-renewable aggregates currently used for mass exchange purposes. This should lead to reduced atmospheric greenhouse gas releases and to the improved condition of landscape and groundwater. The reduction of greenhouse gas release due to reduced transportation (as CO_2 eqv.) may reach 1,2 billion tonnes of CO_2 per year. In Europe - based on rough estimates - the costs of landfilling may be reduced by more than 27 000 M€/a and the costs of construction by around 3500 M€/a.

4. Administrative part

The ABSOILS project has been managed by the Coordinating Beneficiary – Ramboll Finland (RAMFI). The home office of the project coordinator – Dr Pentti Lahtinen - is in Luopioinen (in the municipality of Pälkäne in Pirkanmaa). Dr Lahtinen remained in his role from the start until the end of the project. Some changes occurred in the project's management structure in Ramfi. The first project manager – Ms Aino Maijala - retired from her tasks due to illness and in spring 2011 she was temporarily replaced by Mr Harri Jyrävä. Starting from the end of August 2011, the project management responsibility has been taken over by Kata Kreft-Burman (positioned in the Espoo office of RAMFI). Apart from the staff in the Luopioinen

office, the staff from the Espoo office and Tampere were actively involved carrying out the project tasks.

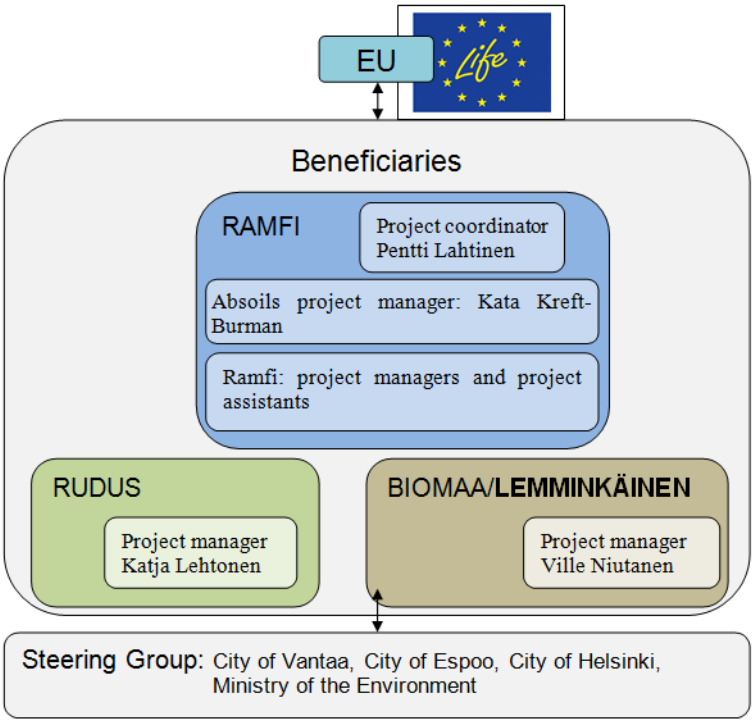


Figure 1. The organigramme of the Absoils project.

The division of tasks in Ramfi has been as follows (the overall picture)

- Luopioinen office (Material Action – laboratory tests for pilots, Verification - laboratory quality control test including reports, LCA and LCC report; Dissemination – organisation of road shows, articles, presentations on the project, networking, cooperation with other projects)
- Espoo office (Applications – geotechnical plans for pilot applications, Piloting – pilots' implementation supervision, quality control, Verification – planning and setting quality control system, sampling taking, Dissemination – articles, presentations, networking, organisation of the international seminar, project video, International Guidelines, RMSS, Management – project management, HR / salaries for TES, editing some project dissemination documents,
- Tampere office (Dissemination – setting up and maintenance of the webpage and for the designing of on-site panels, Management - financial issues, internal quality control

The Project coordinator and the project manager have also been the members of the project's Steering Group.

RAMFI has co-operated actively with the Associated Beneficiaries: Lemminkäinen (previously BIOMAA) and RUDUS. At the start of the project, BIOMAA nominated Mr Ville Niutanen and RUDUS nominated Ms Katja Lehtonen as their project directors and the members of the Absoils project's Steering Group. After the fusion of Biomaa with Lemminäinen, Mr Niutanen continued in his role of a project director. The active co-operation of the beneficiaries involved beneficiary meetings at intervals of three to six months but also other work meetings, and active discussions on phone or by e-mail. The project's website has also had a channel for the information between the beneficiaries and other parties involved in

the project: the Project Bank. The first official beneficiary-meeting was held in Luopioinen at the 1st September 2010 and it was followed by 13 meetings (the last one held in February 2015).

The arrangements for establishing the Steering Group had started before the official start of the project but the final decisions concerning the involvement of the potential SG members including the cities of Helsinki, Espoo and Vantaa, as well as the Ministry of Environment were made at the beginning of September 2010. The first Steering Group meeting was held in RAMFI Helsinki office on 23rd September 2010 and it was followed by 13 meetings with the last one in Espoo, in February 2015.

All the partners (RAMFI, BIOMAA/Lemminkäinen and RUDUS) have cooperated in order to carry out the pilots planned in the framework of the ABSOILS project. RAMFI has been carrying various tasks in all the project Actions, such as materials tests, design and verification issues for the Arcada 2, Jätkäsaari I & II, III, the Dog Park, and Honkasuo pilots, including a supportive role in the Pirttiranta pilot, as well as the management related activities. BIOMAA/Lemminäinen carried out the stabilisation works and worked on the improvement of the efficiency and capacity of the stabilisation equipment while performing its tasks in the first pilot sites (Arcada II, Jätkäsaari I, 2011). Also, the efficiency of feeding stabilisation binders into stabilised materials were tested. RUDUS tracked binder producers and was very active in searching for the new pilots sites application that would enable the effective utilisation of ashes in the stabilisation process. Along with RAMFI, both project beneficiaries were actively involved in the dissemination activities which involved, among others, participation in the project events, presenting information on the project progress and impact during various events, networking, writing scientific articles, participating in writing and commenting on reports.

A request for an amendment to the Grant Agreement was sent to the Commission on 31.1.2014 and it was accepted by the Commission in May 2014. The new Grant Agreement was delivered to the Commission in August 2014.

The amendment to the grant agreement included changes in the following areas:

- Change in the partnership structure
- A request for modification of the budget
- A request for an extension of the project duration

In 2012, BIOMAA started a fusion process with a company called Lemminkäinen (http://www.lemminkainen.com/). The fusion was completed in summer time, 2013 and from this point on BIOMAA ceased to exist independently and its name disappeared. From the point of view of the Absoils project, the fusion did not bring change as all the staff involved in the Absoils project was carrying on with the obligations and tasks originally planned for BIOMAA.

The changes in the anticipated costs caused the budget to alter by more than 10% and 30.000 Euro in some of the budget categories, which was the reason for the request for an official modification. The total eligible budget remained the same, as well as the requested Community contribution (the same amount, the same percentage of the eligible costs). There has been a slight change in the total costs (the total costs are smaller by 50 625 € due to the diminished equipment budget).

The end date of the Absoils project, as set out in the original grant agreement, was on 31.12.2014. A new end date, 31.6.2015 was proposed in the request for amendment, i.e. a six months extension of the project duration and it was accepted by the Commission.

4.2 Evaluation of the management system

The administrative tasks of the project proceeded well. The cooperation among all the project partners has worked well and the project director (Pentti Lahtinen) and the project manager (Kata Kreft-Burman) have been in a frequent contact with all the parties involved.

All the partners remained in a close contact and project meetings were organised on a regular basis in the premises of RAMFI, either in Espoo or in Luopioinen. The official beneficiary meetings were held at intervals of about three months and there were also other work meetings concerning practical issues related to e.g., the Piloting Action. Apart from the meetings, active contact has been retained by phone and email. During the project, 14 official beneficiary meetings took place. The last project beneficiary meeting was held in Espoo on 11.2.2015.

Also the Steering Group members took an active role in helping to implement the project and to disseminate the information on the project and its objectives in their organisations and through their networks. The meeting of the SG group took place regularly - 14 SG meetings were held within the project duration. The last SG meeting took place in Espoo on 11.2.2015.

Reporting to the EU wise, the inception report of the Absoils project was delivered on the 31st January, 2011. The Progress Report covering the time period 01/01/2011 to 30/09/2011 was delivered to the Commission on the 30th of September 2011. The comments and recommendations received from the Commission were addressed in the following Progress Report from 30th March 2012. The technical part of this Midterm report provided information from the project start till November 2012 and the financial report covered the period from 1st September 2010 to 31st August 2012. The following Progress Reports was delivered to the Commission on 15th of October 2013.

After the Progress Report has been delivered in October 2013, it was realised that the project might need some more time to deliver all the actions according to the requirements of the Grant Agreement. This was consulted with Ms. Lahdesmäki (the Finnish Monitoring Team). In January 2014, the amendment request letter was delivered to the Commission.

Changes were required in the project timetable (the new end date of the project) and budget, as the original budget allocations were not viable any more.

All the necessary changes were accepted by the Commission. The last Progress Report was submitted on 3.10.2014.

The project coordinator and manager have been in touch with the external monitoring team during the whole duration of the project and this has been seen as very helpful in case of any questions, changes or doubts about any issues connected to the project implementation.

5. Technical part

The project was implemented by means of eight distinct but interdependent actions that are listed in the following sections .

5.1.1 Action 1: Preparations

The Preparation Action created a good background for the development of the subsequent project actions. This action included determination of the pilot sites, the target applications, rough mapping of relevant materials and deposits at the Uusimaa region; choices for the new equipment for the project; definition of the technical, environmental and economic criteria for materials and applications; definition of laboratory test programmes; and revision of the project details where necessary. With the progress of the project, part of the Preparations Action was shifted as an integral part of planning for the Piloting Action (4) and has been reported as part of this Action. This was due to the fact, that the city planning is carried out on annual or even shorter time basis and it was not possible to determine all the pilot sites during the duration of this action (according to plan it was to be completed at the beginning of 2011). The **Report on the Preparations Action** was delivered as annex to the Inception Report (31.1.2011) and it attached in the Final Report as Annex 1.

5.1.2 Action 2: Materials

The aim of the Materials Action was to produce technical, environmental and methodological materials data and information required for the implementation of Actions 3, 4 and 5, and to demonstrate proper test procedures for full-scale projects. Material investigations included testing of the geotechnical and environmental properties of the soils before and after stabilisation. The Materials Action and its deliverables, as well as reporting connected to it were strongly interconnected with the progress of the Piloting Action and lasted longer than originally planned -in practice - until the end of 2014/beginning of 2015. This action was implemented mainly by Ramfi (the Laboratory in Luopionen) and Ramfi in Espoo (sampling), in the cooperation with the project partners concerning sampling (Biomaa/Lenmminkäinen) and the delivery of fly ash (Rudus). The detailed results of this Action are described in the **Final Report on the Material Action** which is attached as Annex 2.

In 2011, the Materials Action included testing of strength development properties of soils stabilised with fly ash and cement were studied along with the classification properties of the soils. The material tests were carried out for Arcada II, Jätkäsaari I and II, the Dog Park in Espoo, and Länsisalmi in Vantaa which was considered a potential pilot site for that year.

In 2012, the Action continued with further tests for the Dog Park in Espoo and Jätkäsaari II.

Figure 2: Samples collected from the place adjacent to the Dog Park that constituted a source of the additional surplus soils required for the fillings in this area. The redundant soil (very soft clay) came from mass replacement from a street construction behind the Dog Park.

Works in the Jätkäsaari – Jätkäsaari III - continued in 2013, 2014 and 2015. By the end of 2014 and in 2015, two trial noise barriers were constructed at the site. After the trial period, the stabilised material will be used in the city of Helsinki for construction of noise barriers. This will happen after the end of the Absoils project. For the needs of the Absoils project, piloting works in Jätkäsaari were divided into three phases (I, II, III). This division has been reflected in project reporting.

By the end of 2013 and in 2014 tests for the Honkasuo pilot site were carried out.

The material tests were performed according to the following methods:

- **Water content** (SFS 179-2 – CEN ISO/TS 17892-1:fi) describes the ratio of water to the dry mass of the material. The water content is measured by drying the sample in an oven at 105 °C temperature until dry. The water content is calculated according to the formula

$$w = \frac{m_m - m_d}{m_d} * 100\%$$

where m_w is the wet mass of the sample and m_d is the dry mass of the sample.

- **Loss of Ignition** (LoI) (SFS-EN 1997-2 5.6) describes the content of organic matter and crystal water in the material. In the determination of LoI a small amount of dry sample is kept at 800°C (dredging sediments at 550°C) for three hours. In the course of heating the organic matter is combusted and crystal water is evaporated. The loss of ignition is calculated from the loss of mass in relation to the dry mass of the sample according to the formula below.

$$LoI = \frac{m_d - m_i}{m_d} * 100\%$$

where m_d is the dry mass of the sample and m_i is the mass after ignition. Usually LoI is determined as the average of two samples. Crystal water has to be reduced from samples with clay content equal to or more than 10% of its mass.

- **pH** is determined by mixing dry soil with ion-exchange water in a ratio of 1:5 per mass. If the sample is studied wet in its natural composition, the water content has to be known and taken into consideration to ensure the correct ratio. The sample is mixed for five minutes and then let to settle for 2-4 hours. After settling the solution is mixed again and the pH is measured with a calibrated pH instrument.

- **Particle Size Distribution** (SFS 179-2 – CEN ISO/TS 17892-4:fi) is determined by sieving and sedimentation tests. The proportion of particles smaller than 0.063 mm is determined with wet sieving, while sedimentation test reveals the more accurate distribution of grains smaller than 0,063 mm. The particle size distribution of 32–0.063 mm particles is determined by dry sieving.

- **Density control** for samples is done by adding a determined amount of water to the sample which is then homogenised. The density of the sample is measured by filling a cylinder with known mass and volume with the sample and weighting the total system. The density of the sample is calculated by dividing the mass of the sample inside the cylinder with the volume of the cylinder.

- **Preparation of the aggregate specimens**. The preparation of the specimens begins with calculation of the amounts of binders mixed with the aggregate (clay, dredged sediment, etc.). The aggregate and the binders are mixed in laboratory mixer for 2 minutes. After mixing the mixture is compacted in to a cylinders having uniform diameter (42…50 mm) and the cylinders are put in to plastic bags to prevent the drying of the specimens. For the first two days the specimens are kept in room temperature after which the specimens are put in refrigerator (+8^{o} C) to stabilise. The specimens can also be thermally treated in which the specimens are stored in thermally insulated in +30^{o}C temperature. Usually the stabilisation time is 28…90 days for normally treated specimens and 3…14 days for thermally treated specimens, but the stabilisation method and time is determined separately for every material. The target of thermal treatment is to find out the potential maximum unconfined compressive strength of the material, but usually it is not recommended to use the values in designing the actual structures. Before testing the unconfined compressive strength the specimen is cut so that the height of the specimen is twice the diameter of the specimen.

- **Preparation of the peat specimens** for the unconfined compressive strength test begins with mixing the sample. The amounts of the binders are calculated in relation to the density of the soil [kg/m^{3}]. The soil and the binders are mixed in a laboratory mixer for 2 minutes. After that the mixture is compacted in cylinders having uniform diameter of 68 mm and height of 195 mm. The specimens are put in to a loading bench where the cylinders are put under 18 kPa load (see Figure 3). The difference between the original height of the specimen and the final height after the stabilisation period is being recorded. The temperature on the load bench is about 18 °C for normal specimens and 30 °C for thermally treated specimens. The constant moisture content of the specimens is insured by having the bottom of the specimen cylinder under water. Usually the curing time is 28…90 days for normal specimens and 3…28 days for thermally treated specimens. With the thermal treatment the aim is to find out the potential maximum unconfined compressive strength of the material. However it is not recommended to use the values in the design of the actual structures. Before testing the unconfined compressive strength the specimen is cut so that the height of the specimen is twice the diameter of the specimen.

Figure 3. Loading bench and peat specimen samples.

- **Unconfined Compressive Strength**, UCS, (adjusted SFS 179-2 – CEN ISO/TS 17892-7:fi) is a standard test where a cylindrical test piece is loaded with a steady rate, until failure occurs (see Figure 4). The loading rate is 1 - 2 mm/min. If any noticeable failure does not occur, the maximum value of the compressive strength is taken when the deformation (change of height) is 15 %. Usually, the test will be made on test pieces after at least 28-30 days stabilisation.

Figure 4. Unconfined compressive test in progress. Ramboll Finland Oy.

- **Modified diffusion test** (NVN 7347) is used to study the leaching of harmful substances from stabilised specimens. The result gives the cumulative amount of the harmful substances released from the top surface of the specimen (mg/m^2). In the diffusion test the test specimen is wrapped in a teflon tape all around except for the top surface, which is covered with glass pearls. The specimen is submerged in to water which has pH 4. In modified diffusion test the water is changed twice, first time 4 days and second time 14 days after the beginning of the of the test. The last water sample is taken 64 days after the beginning of the test. The pH and the electrical conductivity of the water samples are tested and also concentration of anions and metals are analysed from the water samples. The analysed substances are the same which are presented in the Finnish legislation about the use of fly ashes in earth construction (VNa 591/2006 and Vna 403/2009). The analysis methods of the water samples are based on the standards SFS-EN ISO 10304(1-2), ISO 17294-2, SFS-EN ISO 15587-2, SFS-EN ISO 15587-1. The standard to be used in the **modified diffusion test** standard has changed (EA NEN 7375:2004) and since year 2013 the test has been performed like described in previous paragraph, but the water used in the test is ion exchanged water with the pH of 7.

- The **Proctor compaction test** (SFS-EN 1997-2 5.10) is used to establish the maximum bulk density (dry) and the optimum water content of a material. In enhanced Proctor compaction test, the sample is compacted in five different layers into the mold of a known volume. Each layer is compacted 25 times with a Proctor hammer. The compacted sample is weighed and dried, which gives the water content at the time of compaction as well as the dry bulk density. Commonly four compactions at different water contents are required to ascertain the optimum value.

The results of the implementation of the Materials Action can be summarised as follows:

1. On the basis of the material tests, applicable materials were found for each pilot and thus the ABSOILS project objective – the utilisation of surplus soils in various civil engineering applications – was met.

2. All the structures carried out in the framework of the Absoils project had at least as good technical performance as conventional structures.

3. Mass stabilisation is a feasible method for the stabilisation of soft clays and contaminated and clean soft sediments and for the utilisation of stabilised masses.

4. The stabilisation technology requires technical and environmental material tests in the laboratory before the launch of construction works and follow-up studies afterward.

5. Technical properties of the materials are determined by laboratory studies including compression strength tests after a specified curing time. Several different binders and their amounts are tested in order to determine a suitable binder mixture for a given application.

6. The most commonly applied binder in stabilisation has so far been cement. However, its high price and its considerably high carbon footprint encourage searching for alternative solutions. The replacement of cement with binders based on secondary materials such as e.g. fly ashes, FGD or oil shale ash in the stabilisation of soft clays and dredged sediments has been studied both in the laboratory and on site with the Absoils project pilot applications.

7. Several kinds of industrial by-products are applicable in binder mixtures. These products make the method more economic and environmentally friendly.

8. The environmental acceptability is evaluated by testing leaching of contaminants from the stabilised material in the laboratory. The results of the tests provide good reasons for the use of industrial by-products as binder components in the process of stabilisation of soft clays and dredged sediments.

9. Due to considerable variations in quality of the mass stabilised sediments, the need for an active quality control in all stages of work is indispensable.

5.1.3 Action 3: Applications

The aim of the Applications Action was to ascertain that the Piloting **Action (4)** was based on appropriate and efficient plans to produce successful applications, and to provide the project team with full and appropriate information and data for the evaluation of the results during Verification **Action 5**. The action involved civil-engineering and –environmental survey of the pilot sites; design and planning of the pilot applications; planning and production of written instructions for the implementation of each pilot application and for the quality control and follow-up activities of the pilot applications. This Action was mainly carried out by Ramfi in cooperation (planning and comments) with the project partners.

In the end of 2010 and in 2011, the Applications Action included planning necessary for carrying out pilot activities in Helsinki: Arcada II, Jätkäsaari I and in Espoo: Dog Park.

The works embraced:

- Plans of a light weight structure constructed with surplus soft clays by density control and stabilisation in Arcada 2 including Quality Control (**Written instructions** attached as Annex 3).
- Plans for ex-situ stabilisation of dredged sediments in the stabilisation basins located in Jätkäsaari including Quality Control (**Written instructions** attached as Annex 4).

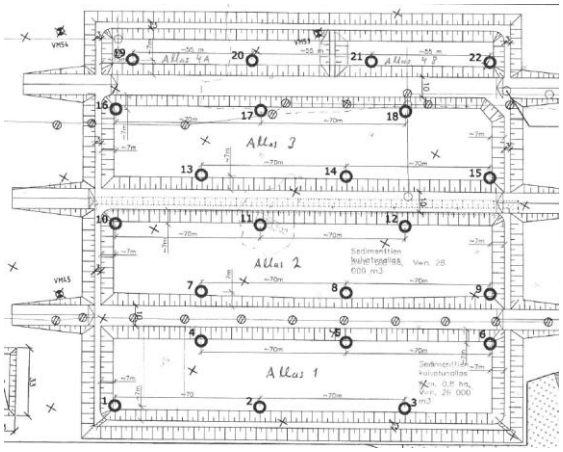


Figure 5. Plans of the stabilisation basins in Jätkäsaari.

- and planning for a Dog Park (including Quality Control instructions) structure to be carried out by utilising the low quality soil on site and abandoned soils form the nearby locations (**Written instructions** attached as Annex 5). Since it was intended to use ashes for the stabilisation of soils in the Dog Park, there was a need to apply for the environmental permit and duration of the permit process delayed the launch of works in this site. The environmental permit allowed for the use of fly as one of the components of the binder admixture used in the stabilisation process of the abandoned soils. The area of the park to be constructed was 3 500 m^2 and the volume of mass stabilisation was 13 000 m^3. The soil of the area was soft clay with low load bearing capacity. The poor quality soils that were already in the site were stabilised in order to avoid mass exchange and transportation to landfill. Moreover, the poor quality soils originating from an adjacent construction site were transported to the site, stabilised and utilised there, too. They were necessary as filling as the whole area needs to be risen as otherwise it is prone to flooding. The Dog Park pilot is considered as a flood

prevention and landscaping application. With this application, the target was to reduce the occurrence of flooding to less than once in 20 years.

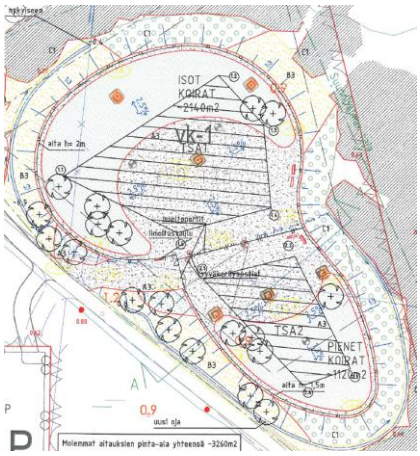


Figure 6. Dog Park drawings (2012)

Pirttiranta (as a flood prevention wall application in Vantaa) which had been on the list of the project potential pilot sites already in the application stage was not possible to be carried out fully in the framework of the Absoils project. Therefore, it has been chosen as a supportive Pilot 2012 providing valuable information for the application of redundant soils in the flood prevention constructions, and allowing for a collection of the follow-up data.

Figure 7. Pirttiranta – the location of the flood dikes (Vantaa).

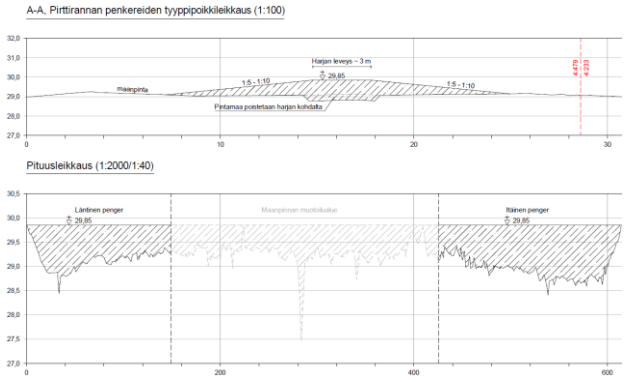


Figure 8. Technical drawings of the Pirttiranta pilot application.

In 2012, the **Written plans for carrying out the Jätkäsaari II pilot application** were created (attached as Annex 6).

The noise barrier application which was under consideration in 2012 to be carried out in 2013 was a Konala noise barrier as part of a bigger, combined pilot application - Honkasuo, Konala and Malminkartano. In 2014, it became known that due to schedules not depending on the

project partners, only Honkasuo as a peat /abandoned clays stabilisation pilot/supporting bank could be included into the works of the Absoils project. The **Written instructions for carrying out the stabilisation works in Honkasuo** (including Quality Control instructions) are attached to this report as Annex 7.

Because Konala site was not available, the noise barrier was decided to be implemented as part of the Jätkäsaari III pilot. The plans were made in 2014. The trail barrier has been planned to be a target for various quality and environmental tests. The **Written instructions for the construction of noise barrier with stabilised sediments in the Jätkäsaari III application** with a focus on their further use as a material for building noise barriers and for the construction of a trial noise barrier in the Jätkäsaari area are attached as Annex 8.

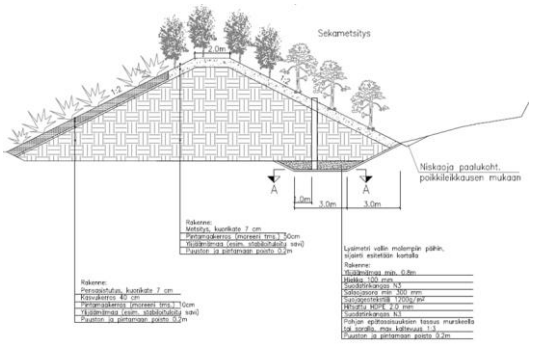


Figure 9: Drawings of a noise barrier constructed with stabilised surplus soil (e.g. clay or sediment)

5.1.4 Action 4: Piloting

In the planning stage of the project, it had been assumed that all the sites of the project pilot applications would be known in an earlier stage and the deadlines for the deliverables and milestones of the related actions were designed according to this assumption. However, due to the planning schedule of the cities involved which is based on annual terms, it proved not possible to determine all the piloting sites in the early stage of the project. Therefore, planning and implementation of the Piloting Action has in practice lasted during nearly the whole duration of the Absoils project (2011-2014).

The aim of the Absoils project has been to demonstrate the practical implementation of four challenging types of civil-engineering applications including flood barriers, noise barriers, supporting banks and landscape construction. During the project duration, it has turned out that it is not always possible to draw a clear border among the types of the applications. Most of the pilot applications combine some of the features of the applications described above. However, the objectives of the Piloting Action have been reached and all the planned types applications were performed. The development of the piloting plans and the changes in the plans of the cities involved that were reflected in the project were reported to the Commission in the progress reports.

The applications carried in the framework of the Absoils project out can be defined as follows:

- **Flood barriers**
  - ✓ Dog Park in Espoo (2012/2013)

- ✓ Pirttiranta in Vantaa/ supporting pilot (2012)

- **Noise barriers**
  - ✓ Jätkäsaari III in Helsinki (2013/2014/2015)
- **Supporting banks**
  - ✓ Arcada2 in Helsinki (2011)
  - ✓ Dog Park in Espoo (2012/2013)
  - ✓ Honkasuo in Helsinki (2013/2014/2015)
- **Landscape construction**
  - ✓ Jätkäsaari I and II in Helsinki (2011/2012/ 2013)
  - ✓ Dog Park in Espoo (2012/2013)

For the year 2011, two pilot sites: Arcada 2 and Jatkäsaari I (part one: stabilisation of sediments with cement) were completed. In both cases, the stabilisation works were carried out by Biomaa.

In Arcada 2, stabilised abandoned soft soil was used as a light weight structure. The structure was designed to replace an old embankment floating over clay layer. Test stabilisation in the area was performed in December 2010 and the construction works were performed from April 2011 and completed in November 2011.

Figures 10-13 Stabilisation works in progress in Arcada 2 (Helsinki)

In Jätkäsaari I, dredged sediments were solidified with the mass stabilisation technique. The area is a pre-construction area where the uncontaminated dredged sediments are utilised in the fillings and the contaminated sediments are being treated on the area. The stabilisation work was performed during April and May 2011. After the stabilisation works performed in the basin, the stabilised masses were dug out and utilised as filling in the adjacent park area.

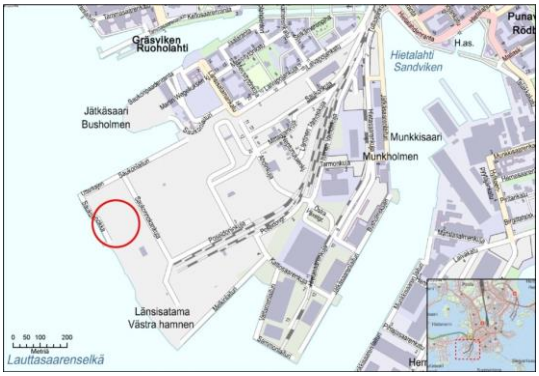


Figure 14. The location of the Jätkasaari I/II/III stabilisation basins (city of Helsinki).


Figure 15. Stabilisation basins ready for filling with dredged sediments.

Figures 16-17. Stabilisation basins filled with dredged sediments.


Figures 18-19. Jätkäsaari I/ Stabilisation in progress and stockpiled stabilised sediments waiting for transportation and further utilisation.

In 2011, there were also plans to start the next pilot application - a Dog Park in Espoo. However, the need for an environmental permit in order to use the fly ash in the stabilisation of the abandoned soils in this site together with the delays in the adjacent construction site which had been planned to deliver surplus soft soil masses had delayed the start of this pilot site.

The permit was granted and the clearing works in the pilot site started in February 2012. After the launch of the works it turned out that the master plans for this area prohibited the use of engine vehicles – according to the city officials in the city of Espoo, this ban was introduced in the past (1983) to prevent driving cars and the motorbikes in this place as it was considered to disturb the recreational use of the site. The works had to be temporarily ceased in this site and in practice, this meant for the project that no machines could be used at this site until the ban was dismissed.

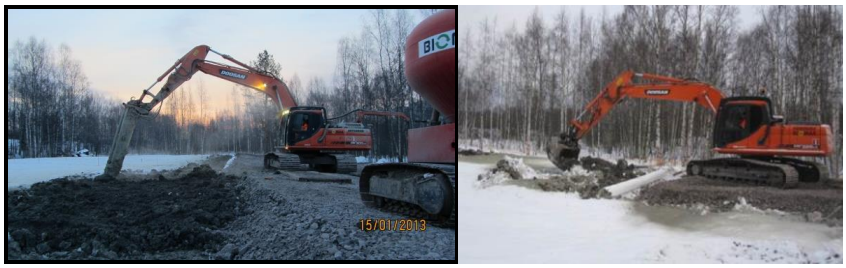
Figure 20. The location of the Dog Park pilot site (Espoo).


Figure 21. Dog Park site before construction



Figures 22-25. Surplus clays transported from other sites to the Dog Park as filling waiting for the start of stabilisation works.

For this reason, the start of stabilisation works in this area was delayed and was carried out in January-February 2013. The stabilisation works in this site were carried out by Biomaa.



Figures 26-27. Stabilisation works in Dog Park carried out in winter time.


Figure 28. Dog Park before completion.

At the beginning of 2012, a Pirttiranta site was chosen to be a supportive pilot for the needs of the Absoils project. Pirttiranta is a housing area in Vantaa in the vicinity of the Vantaa river. The area has been prone to flooding an there was a need to construct dikes to prevent floods in the future. It was decided to construct the dikes with the abandoned soils (clays) generated in Vantaa. The construction of the dikes took place in May-June 2012 and Ramfi was involved in the process as a supportive consultant on the use of surplus clays.

In this case, the abandoned soils (dry crust clays) were rather dry and therefore there was no technical requirement for stabilisation. The abandoned soils were transported from close-by locations. The total volume of utilised soils was 4 000 m3. Because there was no need for stabilisation works as the material allowed for the use as such – this has in turn excluded the participation of Biomaa and Rudus. The data obtained during the construction and follow-up process of this site provided valuable information for the application of redundant soils in the flood prevention constructions. It was also seen crucial from the point of view of the future of similar applications in the city of Vantaa as an example to be followed – otherwise, the pilot sites were located in Helsinki and Espoo.

Figures 29-30. The location of the Pirttiranta site (Vantaa). Flooding problem in the Pirttiranta area (picture from 2004)

Figure 31. The new flood prevention dike was constructed with surplus clays originating from other construction sites in Vantaa in May-June 2012. The situation in October 2012.

In 2012, the stabilisation of the dredged sediments for the pilot Jätkäsaari II in Helsinki took place between August and November. Mass stabilisation was carried out in five sedimentation basins. Stabilisation works were carried out by Biomaa.

Plus cement was applied as binder in all the basins apart from basin 3 which served as a trial field for fly ash stabilisation. Fly ash used as a binder in the binder mixture implemented in this case originated from the Helsinki Energia power plant in Hanasaari. Fly ash was transported directly to the pilot site from the power plant.


Figure 32. Aerial picture of the sedimentation basins. Stabilisation in progress in basins 1 and 2.

The stabilisation trial work with the use of fly ash was implemented according to the work specification between 20.11.-21.11.2012.

The fly ash was fed in two different ways:

1. it was mixed with the sediment with the use of a pressure feeder and mixing tool– dry ash
2. it was spread on top of the sediment – moistened fly ash

The fly ash spread on top of the sediment layer was carefully mixed with the sediment before mixing cement. After mixing both binders with the sediment, a 1m thick sealing layer was constructed on top of the blocks where fly ash was used for the stabilisation process.

Figures 33-34. Jätkäsaari II - stabilisation in progress and sealing layer on top of the stabilised sediments.

In the Jätkäsaari III pilot, the stabilisation method was used to treat dredged sediments in the basins. Stabilisation works were performed in spring 2014. Stabilisation works were carried out by Lemminkäinen. Two different methods were used: mass stabilisation and windrow turner stabilisation. Various binders and binders' mixtures were applied. these include also such secondary materials as fly ash, FGD and oil shale ash from Estonia.


Figures 35-36. Jätkäsaari III: stabilisation work in progress. Geotextile is spread after stabilisation and the settlement embankment load placed on top.

The stabilised sediments form the stabilisation basin 1 served as material for the construction of a trial noise barrier in the Jätkäsaari area, in the vicinity of the basin. The works were carried out in January 2015. Another trial noise barrier was constructed with sediments stabilised with a crusher screener. The aim has been to test the properties of stabilised sediments in order to use the stabilised material later on in some other noise barrier applications. The possible applications for the sediments from Jätkäsaari III is planned to the Sepänkylä noise barrier which is scheduled for construction in 2016 (this will take place outside the scope of the Absoils project).


Figure 37. Test embankment – smaller noise barrier constructed with sediments stabilised with a crusher screener

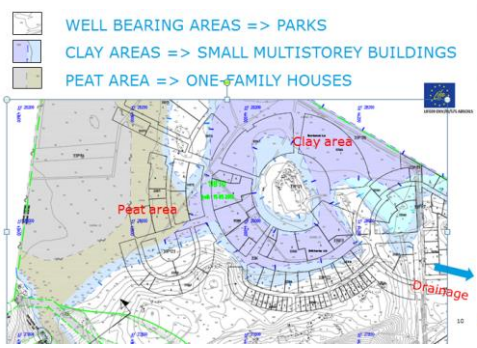
Figure 38. Larger test noise barrier constructed with mass stabilised sediments

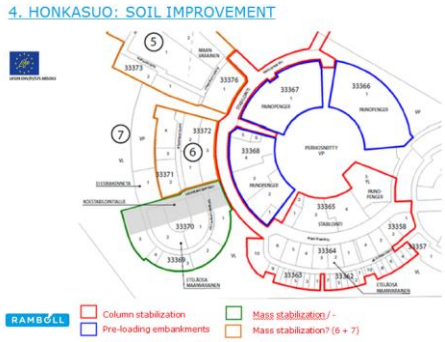
In 2013, a combined site – Honkasuo, Konala an Malminkartano and Viikki Dog Park was considered potential pilot applications for this year and negotiations were taking place. However, due to factors independent of the project partners the timetables of those turned out not realistic to be carried out in the framework of the Absoils project apart from the Honkasuo application. Honkasuo is an area in Helsinki (on the border with Vantaa) which planned to be pre-constructed for a new housing district. The size of the Honkasuo pilot area is ≈7000 m^3 and the soils encountered at this site are soft clays and peat.

Figure 39. The location of the Honkasuo area (Helsinki)

Clearing and preparation works in the Honkasuo area started in spring 2014. Surplus clays from various other sites in Helsinki were transported there for further utilisation during the stabilisation process that was originally planned to be carried out in spring 2015. However, due to the decision of the site owner (the city of Helsinki) the stabilisation works were shifted for the following year. Therefore, the actual utilisation of the surplus soils planned (by stabilisation) and tested by the Absoils project will take place after the project ends.

Figure 40. Honkasuo area – soft, wet soils are a challenge in the pre-construction process.





Figures 41-42. Honkasuo: peat and clay areas. Areas with various stabilisation applications marked

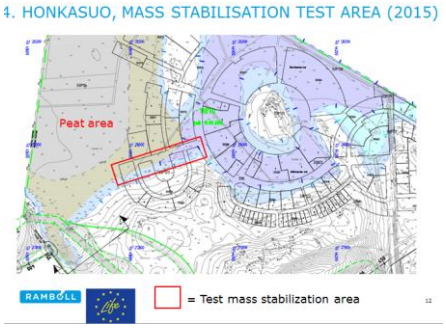


Figure 43. Honkasuo: mass stabilisation test area marked in red

If the Honkasuo area were constructed in a traditional way, which in this case means mass replacement, this would require landfilling of about 36 000 m^3 of clays and peat and transportation of 45 000 m^3 of virgin materials as replacement.

The solution offered by the Absoils project includes spreading redundant clays originating from the capital area on top of the peat layer and stabilising both of them with the use of binders.

In spite of the challenges concerning the decision making process concerning the pilot sites which was dependent on the cities' planning on annual basis, the piloting action succeeded well and allowed to construct all the applications planned in the application. The environmental impacts of the pilot activities are presented in section 5.4 of this report.

One of the issues concerning Piloting Action that did not meet fully the project objectives deals with the use of secondary materials as binders in the process of mass stabilisation. It was originally planned that the poor quality abandoned soils will be transformed into construction materials by the application of stabilisation technology with a considerably high use of fly ash and the FGD (flu gas desulphuristation gypsum). Since Rudus is a major player in the fly ash generation sector in the area of concern for the Absoils project, it had been planned that the involvement of this partner would be strong both in case of the expertise and the fly ash supply for the needs of the pilot applications. However, it had turned out not to be the case. There have been a few factors hindering the use of fly ash in the scale predicted in the project proposal. The pilot sites have been owned by the cities involved in the project (Helsinki, Vantaa, Espoo) and the last word concerning the materials to be used was up to them. Although the use of fly ash has been strongly recommended by the project team, the need to apply for the environmental permit and the length of the permitting process have been the major setbacks for its use. Generally, so fly ash was used in two pilot applications, but in a much smaller degree than had been originally planned. This issue was covered in progress reports and the request for amendment. Budget wise, in the case of Rudus, this meant mainly

some considerable decrease in the external assistance and consumables categories, as most planned actions related to the fly ash storage, transportation, etc. did not take place. And in the case of Biomaa/Lemminkäinen, this caused), there has been a need to replace binders made of secondary materials with a commercial binder, in this case - cement. This has naturally had an impact on the costs of carrying out the pilot applications and this increase is mostly visible in the consumables category of Lemminkäinen.

The **Final Report on the Piloting Action** (attached as Annex 9) includes detailed information on the implementation of this Action and the results of quality control tests which are part of Action 5.

5.1.5 Action 5: Verification

The aim of the Verification Action has been to give a proof that soft redundant soils normally considered unsuitable for construction purposes after the application of a suitable ground improvement method become valuable and feasible materials for different types of civil-engineering applications.

The activities of the Verification Action have included geotechnical field and laboratory tests to control the performance of the materials and applications in real conditions. The quality control and follow-up tests concentrated on the strength and durability properties. The Verification Action included also the Environmental and Economical assessment of the pilots carried out with the help of the methodologies of environmental life-cycle assessment (LCA) and qualitative life-cycle cost assessment (LCC). Additionally, the Verification has used the results of the quality control and follow-up studies (like determined in Action 3) as well as the results of the laboratory tests on materials (Action 2).

The Quality Control Action was carried out mostly by Ramfi (sampling, laboratory tests, soundings, installation of settlement plates and lysimeters) and Biomaa/ Lemminkäinen (sampling, assistance in installation of tests equipment during piloting). The LCA/LCC studies were carried out by Ramfi (with the use of data delivered by Biomaa/Lemminkäinen and Rudus).

<u>During the stabilisation work, the following quality control actions are carried out:</u>

- Working practice for overseeing the mixing of binders (the machine operator of the contractor controls visually that the binder is mixed evenly to the stabilised material).
- The amount of used binder is confirmed by weighing on the scales used in binder tanks and the total amount delivered to the work cite.
- The designer visits the construction site and follows the construction process, photo- and video documents the work progress.
- The contractor keeps a record of the stabilisation process including the following information about the stabilisation block: width and length, stabilisation depth and date, used binder amount, other observations made by the machine operator including (stones, boulders, stubs and watery, etc.)
- Quality control soundings – to make sure that the material is strengthening.

Quality control activities at the pilot sites (Arcada 2 pilot and Jätkäsaari I) started in 2011: with soundings.

In Arcada 2, the quality control carried out during the construction work showed good results of the strength of the material. Soundings were performed in the stabilisation basins as the work proceeded and the results showed that the strengths filled the demands given to the structure in the design phase of the project. Partially, the strengths were many times higher than demanded. After the surface layer the shearing strengths are mostly over 200 kPa.

In Jätkäsaari I, dredged sediments were stabilised in the basins from where the masses were subsequently moved to the actual deposit. The quality control results showed, among others, that after the stabilisation the stabilised masses were mainly really firm, almost too strong firmed to be removed from the basins. However in the transportation the bonds on the material had been weakened notably. In some points in the middle of the stabilisation pool and in the bottom of the stabilisation pool the strength of the stabilised mass was not so firm and homogenous because of some problems with the timetable, compression embankment and the bottom asphalt which was not allowed to be damaged. These observations are an important lessons learned and will be utilised in other applications of this kind.

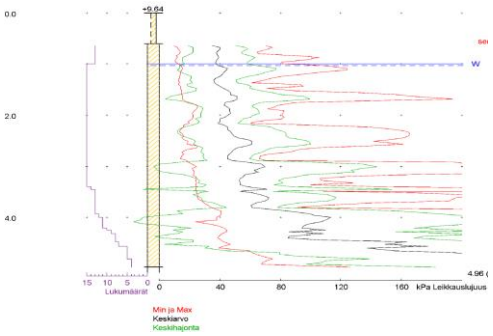


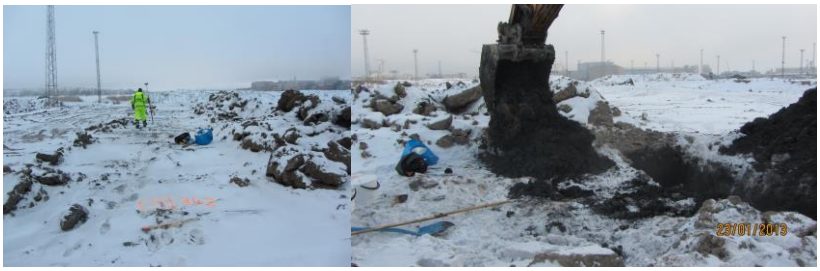
Figure 44: Strength results for the stabilised sediments in Jätkäsaari I.

In Jätkäsaari II, quality control soundings were performed in January 2013. The table below shows the locations and numbers of the sounding that were carried out. In order to carry out soundings, the sealing layer and the strainer cloth had to be removed.

Column penetrometer and vane penetrometer for columns are the two most common methods for quality control soundings in mass stabilised structures. Column penetration sounding is the most used method of quality control for deep stabilisation (column stabilisation and mass stabilisation) in Finland. The soundings give information about the strength properties of the material.

Table 1. Jätkäsaari II: Number of soundings.

Block	Binder	Column sounding	Vane sounding
3.1T	Ce + FA (dry)	5	2
3.2T	Ce + FA (dry)	5	2
3.3T	Ce + FA (moistened)	5	2
3.4T	Ce + FA (moistened)	5	2
	total	20 kpl	8 kpl


Figures 45-46. Jätkäsaari II - preparations for the quality control soundings and test pit digging.


Figures 47-48. Jätkäsaari II - test pit. Settlement plates installed 9n May 2013.

In January 2013, the Quality Control testing started in the Dog Park, Espoo. During the stabilisation work, the following quality control actions were carried out:

- Working practice for overseeing the mixing of binders - the machine operator of the contractor controls visually that the binder is mixed evenly to the stabilised material.
- The amount of used binder is confirmed by weighing on the scales used in binder tanks and the total amount delivered to the work site.
- The designer was at the construction site and followed the construction process, photo- and video-documented the work progress.
- The contractor kept a record of the stabilisation process. The record included information on the stabilisation block: width and length, stabilisation depth and date, amount of the binder used, other observations made by the machine operator including stones, boulders, stubs and water conditions.
- Quality control soundings – to make sure that the material is strengthening.

  In addition to soundings, the stabilised structure was examined by making test pits. The issues tested on the samples taken to the laboratory included strength properties, variation of strength and spreading of binders, frost susceptibility and water permeability. The test pits were conducted with an excavator to each test pit to the objective depth. The used field test methods were:
- Excavation of test pits and reporting
- Photograph documentation and depth profiling
- Pocket vane shear apparatus (hand held)
- Hand held penetrometer testing
- NITON XRF (hand held)
- Sampling for laboratory - defining water content, pH and block samples

In total, 10 test pits were excavated. Documentation includes remarks about the condition of the test pit, possible slope failure and remarks based on visual and smell observation about the stabilisation processes. Possible anomalies are reported. Each test pit was photographed in

each depth level. The excavation proceeded step by step every 0.5 meter. The tested material was lying on the grab of the excavator. The sampling and test pit depth was verified with a measuring instrument and photographing.

Figures 49-52. Dog Park - quality control testing in 2013 and 2014.

In 2014, Quality Control tests were carried out in the Jätkäsaari pilot site. These included laboratory tests investigating the quality of the stabilised soils and soundings.


Figures 53-56. Quality control tests in Jätkäsaari in 2014.

Based on the experience gained during carrying out the Absoils project pilot applications, it can be concluded that surplus clays and dredged sediments constitute potential materials for construction use. The laboratory and field tests' results show that the surplus clays can be used in construction by modifying the material so that the strength and the modulus of the material are enhanced.

The laboratory test and the in-situ stabilisation results show that the alternative binder materials such as fly ash and flue gas desulphurisation gypsum can be used to replace cement in stabilisation, without reducing the compressive strength of the structure.

Laboratory tests are an important part in the utilisation process of surplus soft soils as their properties vary a lot and different binders work in different ways depending on the material properties. Quality control during construction phase and afterwards allows to verify the laboratory test results in real conditions and provides an important data that can be utilised in future applications. The results of the quality control tests concerning the pilot applications are included in the Final Report on Piloting Action as they are part of the construction process and in this way the target audience receives a holistic picture of the piloting process.

Another part of the Verification Action was the LCA/LCC studies which started in 2011 by gathering the data provided by the implementation of the Absoils project pilot applications and lasted until the end of 2014. The study was carried out by Ramfi with the use of the data supplied by the partners.

The LCA (Life-cycle assessment) and LCC (Life-cycle costing) are decision support tools which quantify the ecological and economic aspects of products which in the case of ABSOILS are the pilots of the project. The model for the LCA is the available standard procedures of EN ISO 14040:2006. The LCA was carried out as a simplified version or as the Streamlined LCA.

The purpose of the LCA was to determine and compare the potential environmental impacts of different alternatives. Primary attention was paid to the depletion of natural resources and global warming potential. The consumption of energy of the studied processes is the major reason for the global warming potential, and the choice of materials for the depletion of natural resources.

The purpose of the LCC was to compare the alternatives qualitatively and to show that the use of stabilised surplus soils can be a cost-efficient investment. Instead of carrying out calculations for life cycle periods after the initial construction, the project participants have decided to provide a qualitative assessment as the actual life cycle costing method would be significantly too uncertain to obtain reliable results. In addition to short qualitative information about the future use and behaviour of the structures, also some external environmental costs were calculated.

When the environmental costs (LCC) are examined, the following issues have to be noticed:

- The environmental costs of the different alternative structures describe only the average costs from greenhouse gases in Finland. The results do not allow to draw conclusions on the basis of environmental costs.
- As the environmental costs differ a lot regionally, it is not possible to draw direct conclusions on the superiority of other structure alternatives.

- These environmental costs tell only the differences between the presented alternative structures.
- The regional emphasis among the emissions vary a lot, e.g. the costs for particle matters in the capital region is 233 417 eur/ton and in the municipalities with less than 10 000 inhabitants, the cost is only 7 974 eur/ton.

The full results of the LCA/LCC studies are presented in the **Final Report on Verification Action** which is attached as Annex 10.

5.1.6 Action 6: Modelling

This action was carried out by Ramfi. The project partners gave advice and commented upon the work progress. The **Final Report on Action 6** is attached as Annex 11 and the **PP presentation on the RMSS system** is attached as Annex 12.

The RMSS (Regional Material Service System) is in the phase where all the software functions are ready. The interface of the mapping part and database has been tested in several demo versions, as well as in some projects.

The RMSS can be used at one city level or as a communication tool for several municipalities. Until now, the most encouraging user experience has come from city of Tampere. The RMSS has been tested in Tampere and we have got very essential feedback of the system. Tampere has SAP (ERP software) –system where they wanted to integrate RMSS. In this way, the RMSS would be part of the larger resource planning software ecosystem. In autumn 2013, Ramboll made a very close co-operation with city of Tampere and improved RMSS so that now it meets all the expectations. In spring 2014, the city of Tampere ordered mobile version for the abandoned soils data management handling from the one IT service company.

Though the RMSS –software is already quite sophisticated, its users seem to be the weakest point. Based on the RMSS test experience there should be at least one or two committed person responsible for managing the abandoned soils in the city organisation. Organisation changes have already affected the efficiency of the RMSS usage. In Tampere, the RMSS responsible person has changed several times and this has caused interruption to the RMSS because this employee has been the only one who knows how to use it.

In many cities, most of the soil information is not documented accurately and in hectic everyday work is handled by phone or e-mail. So abandoned soils data management should always be updated so that everyone can rely on it. The most effective way to introduce RMSS to city organisation would be to document present day workflow and then implement RMSS to it together with all the counterparts. Developing mobile connection to RMSS will meet these challenges and will make data information more accurate.

The RMSS demo projects were also carried out in the Helsinki city area. After testing the RMSS in Helsinki and having several work meetings it was to come in to the conclusion that RMSS system structure could become essential tool in the future. There are 2-3 people in the city if Helsinki who are responsible of managing the abandoned soils. Most of the soil information is documented by Excel and in hectic everyday work mass transportation is handled by phone or e-mail. This works fine at the moment, but there could be need for more sophisticated system like RMSS.

Based on the Helsinki city officials' comments, the RMSS has to be seen in the wider context meaning that it has to cover at least Helsinki metropolitan area or even Uusimaa region. The system would be more like a bulletin board showing the larger picture what is going on and what will happen in the area concerning abandoned soils. The time frame for using RMSS would be from few months up to one or two decades. This way the RMSS would serve different cities by delivering the information for planning land use more efficiently, create co-operation between cities and this way saving money.

In conclusion, the RMSS is ready to take in to the use. Experiences from the cities of Helsinki and Tampere show that there is a need for this kind of data management software, but it needs extra effort to start using it. Also, there should be clear economical and practical benefit to change from old way of doing things to new way.

The link to the RMSS service in Helsinki is: http://is.ramboll.fi/absoils/

The sign-in is: absoils the password is: absoils-2012

It has been agreed that the works on the implementation of the RMSS system will be carried out in the framework of the UUMA project after the end of the Absoils project.

http://www.uusiomaarakentaminen.fi/briefly-english

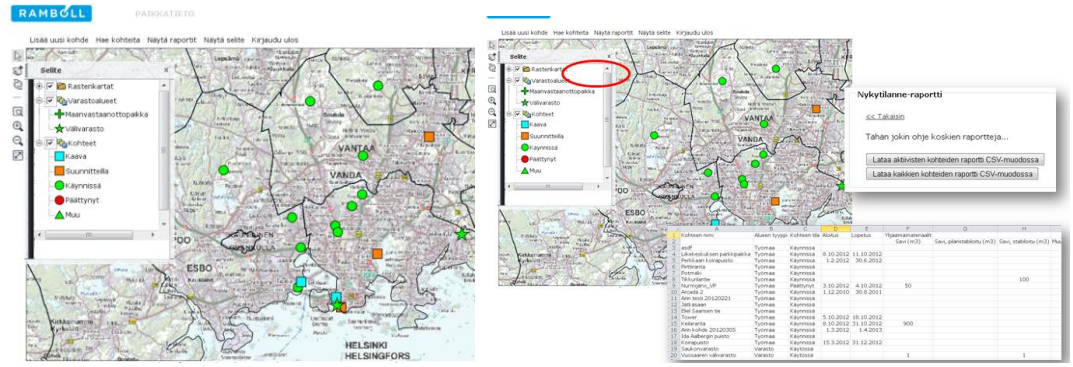


Figure 57. The RMSS system.

5.2 Dissemination actions

5.2.1 Objectives

The aim of the Dissemination Action has been to disseminate and communicate the results of the project to the target group and stakeholders of the project so that the knowledge gained during the project can benefit the whole Europe and in the long-run lead to the improved situation in the management of surplus poor quality soils and fly ash as binder in the process of soil stabilisation.

5.2.2 Dissemination: overview per activity

In the application of the Absoils project, there were no dissemination activities planned as sub-actions (tasks) in Actions 1-6. Dissemination tasks were part of a distinct Action 7: Dissemination, as presented above. The dissemination programme has included:

Planned activity	Was the objective reached	Reactions and feedback	Partner responsible
Project webpage	YES	LIFE webpage was set and has been updated by Ramfi. The page will remain operational after the end of the project. The page contains the description of the project, info on its implementation stages, deliverables and gallery of pictures.	Ramfi
LIFE notice boards at piloting sites	YES	LIFE notice boards were erected at all the pilot sites.	Biomaa/ Lemminkäinen
DVD presentation about the different stages to convert abandoned soils into earth construction aggregates and to construct different applications with converted aggregates	YES	The materials for the video were collected during the whole duration of the project and it was planned to produce it during the last year of the project. The video was presented to selected stakeholders and received positive feedback. It is currently placed on the project website. It was originally planned to carry out this action with the use of external assistance but filming and editing was made by Ramfi as it was seen more doable due to pilot schedules and the need to actually understand what needed to be filmed and the overall cost-effectiveness. The feedback of the viewers has been positive. The video is seen as interesting source of information on the methodologies and environmental benefits that can be reached with the application of the solutions tested by the Absoils project. Annex 22.	Ramfi
DVD presentation about the RMSS	YES	The DVD presentation was planned to be carried out in 2013 but it was produced in spring 2015 so that it can include all the updated information on the RMSS situation development. Annex 23.	Ramfi
European Guidelines on the methods to convert abandoned soils into useful earth construction materials and to use them in the construction of different applications	YES	The materials were collected during the whole duration of the project and carrying out this task in a satisfactory way was one of the reasons of asking for the project extended duration. The partners were involved in the process of information providing and feedback. The initial reaction of the stakeholders has been positive and the **International Guidelines** are seen as an important source of information. Attached as Annex 13.	Ramfi
Slide presentation (ppt) about the project methods and results to be used in conferences,	YES	The initial slide presentation on the project was prepared at the beginning of 2011 and after that the PP- presentation was updated and tailored to the needs of the events	Ramfi

seminars and Roadshows;		where the project results were presented. The final version of the project presentation is available at the project website. The presentations on the project have always gained much interest and attention from the audience. Attached as Annex 14.	
Roadshows for specific target groups run in Scandinavia, Baltic Countries and Central Europe during 2013, 2014 (4-6)	Four road shows were organised in Finland, so the objective concerning the amount of the events was reached. However, it was originally planned that Rudus would organise road shows in other countries. The aim was to propagate the use of fly ash. Since it was not possible to use as much fly ash in the project as originally planned, Rudus was forced to give up the road show events abroad. As a contingency action, the project was presented at some international events not originally planned, such as: the Simm-ccities conference (www.simmccities.com) and workshop (Sustainable and Innovative Material Management for the Construction in Cities) in Stockholm on the 25-26th of April 2013. The event was devoted to reuse of construction and demolition waste and industrial by-products mainly for civil engineering purposes. The conference gathered several participants from 8 countries in the Baltic Sea region and the EU. The Absoils posters and a stand were presented at the 8th International SedNet conference, 6-9 November 2013, Lisbon, Portugal (http://www.sednet.org/	Absoils Roadshow (1) in Kuopio took place on 29th of January 2013 and focused on the presentation of the Absoils project and its results as well as on the issues concerning recycled construction materials in Finland in general. The event gathered about 50 participants from various private and public organisations. A Roadshow (2) for the Estonian visitors was organised in April (4.4.2014). This event gathered about 15 participants. Its aim was to present the achievement of the Absoils project and discuss the ways how the project experience can be utilised in Estonia. Absoils Roadshow (3) took place in Turku, on the 19th of August, 2014. The event gathered about 45 participants. Absoils Roadwhow (4) took place during the Mass Stabilisation Conference in Lahti, 22-24.4.2015 The feedback from the participants of the events was very positive. The project was found interesting and its results very useful as an example to follow. The technical and environmental details and the quality control data were of the special interest.	Ramfi, Rudus

	conference2013.htm) - a platform for sharing the experience gathered during the stabilisation of dredged sediments in Helsinki (the example of the Jätkäsaari project pilot). The project was also presented in the form of a PP presentation during the following international events: - Fly Ash Conference in Berlin (April 2015) - SIMMS seminar in Gothenburg (12, 2014);- Biomass Conference in Graz, Austria (1.2014). - International Ash Seminar in Sopot, Poland (10, 2012)		
An international workshop in Finland in 2014	YES	Planning for the Absoils International Seminar started in winter 2013/2014. Cooperation with another project – the Simm-Cities from Sweden - took place in order to ensure the participation of international guests. The networks of the Simm-Ccities project allowed for the participation of the guests from Sweden, Estonia, Norway and the Netherlands (46 participants). The event took place on the 11th and 12ve of September, in Helsinki. The city of Helsinki was also strongly involved in the preparations and allowed the seminar to be organised in the city premises, in Jätkäsaari. The event received very positive feedback from the participants and resulted in new networking activities among them.	Ramfi
Layman's Report	YES	In the original application, the plan was to produce 3000 paper copies of Layman's report only in English. However, it was decided that in order to save paper, 300 paper copies is sufficient and the report will be mainly disseminated in the electronic form. The report is in Finnish and English (attached as Annex 15 and 16.	Ramfi
Articles in professional magazines during 2013 and 2014 (2)	YES	The methodology and the pilot activities carried out in the framework of the Absoils project were described in the article devoted to the use of surplus soils in Finland (RIA /Rakentaminen, Edunvalvonta, Ammattitaito 4/2014) attached as Annex 17) In 2013, an article on the Absoils project and the methods applied was published in the Viherpäivät magazine. (attached as	Ramfi

		Annex 18) In the previous years, the project was also mentioned in the Viherympäristlehti 6/2012. However, the copy of the article is not available.	
Conference papers about the project (4-6 relevant conferences)	YES.	The target was exceeded and 7 articles on the project and its achievements were produced and presented at relevant international conferences. The list of the articles is below.	Ramfi Biomaa/Lemminkäinen Rudus
Press releases about the project in 2011, 2012 and 2014	YES	Press releases on the project and its development were sent to the press three times during the project's implementation time. The most interest was evoked by the first release which was connected to the Kick-off event in September 2011. As a result, the project director was interviewed on the radio (Uusimaa radio channel as part of the news) and in later on regional TV station (Uusimaa) produced news on the challenges of surplus soils and the solutions proposed by Absoils.	
Local events to present the pilot activities to the public	YES	The complete list of the events and networking activities is presented below. The project received positive feedback from the audience.	Ramfi, Rudus, Lemminkäinen

The list of events and networking activities in Finland and abroad:

Date	Event	Comments
28.9.2011	ABSOILS project – the kick-off event; Helsinki	PP presentation plus discussion; Road-show posters
28.9.2011	radio interview/ Uusimaa regional radio channel	broadcasted as part of the News
29.8.2011	Absoils presentation at Geo-technology days in Helsinki	PP presentation
20.9.2011	Helsinki MARA legilsation seminar (ashes) where Absoils presented (1 day)	oral presentation
27.10.2011	YGOFORUM seminar; Helsinki	http://www.ygoforum.fi/lahtinen.pdf; PP presentation
2.11.2011	MASS seminar; Helsinki	PP presentation
21-22.11.2011	Baltic Inert Material Management Symposium; Stockholm, Sweden	http://bimms.org/presentations-day-1/ PP presentation
20.12.2011	TV interview; Uusimaa regional news	7 pm. Channel 2
18.1.2012	Energy industry meeting; Helsinki	oral presentation
19.1.2012	Constructing sector days; Hämeenlinna	http://www.kiinko.fi/var/ezwebin_site/storage/kiinko_files/852014.pdf PP presentation
29.2.2012	Ramboll International Mass stabilisation group	PP presentation
23.3.2012	Surplus soil masses workshop (Helsinki, Vantaa, Espoo)	oral presentation
25.4.2012	Forest Industry seminar in Helsinki	PP presentation
29.6.2012	European meeting of the Ash	PP presentation

	Producers in Helsinki	
16.8.2012	UUMA meeting in Pasila (Finnish Transport Agency)	oral presentation and networking
17.8.2012	Forest research seminar in Lepää (Fly ash from biomass)	oral presentation and networking
9-12.5.2012	NGM – Nordic Geotechnical Meeting in Copenhagen. Denmark	paper in the proceedings, Oral presentation (PP) during the event http://www.ngm2012.dk/Scientific%20programme
31.5-1.6.2012	12th Baltic Sea Geotechnical Conference 2012 in Rostock, Germany	paper in the proceedings Oral presentation (PP) during the event (on Friday 1.6) http://www.12bsgc.de/conference-time-schedule-June-1.htm
31.5-1.6.2012	WASCON – 8th International Conference on the Environmental and Technical Implications of Construction with Alternative Materials in Gothenburg (Sweden)	paper delivered in the proceedings Oral presentation (PP) during the event http://www.swedgeo.se/templates/SGIStandardPage 2198.aspx?epslanguage=EN
9.10.2012	YGFORUM 2012	2 pp presentations
24-26-10.2012	International Ash Seminar in Sopot, Poland	100 two-page flyers distributed to the participants, networking and discussions concerning Absoils project http://www.unia-ups.pl/news.php?readmore=49
1.11.2013	networking event with stakeholders in Tampere	oral presentation and networking
13.12.2012	RYMSHOK group meeting in Helsinki	oral presentation and networking
29.1.2013	Absoils Roadshow in Kuopio	pp presentation on the project; event in collaboration with the national UUMA programme
10.1.2013	By-product seminar in Oulu	oral presentation and networking
7.2.2013	AEL seminar in Tampere	oral presentation and networking
17.4.2013	HKR stabilisation days in Helsinki	oral presentation and networking
20.4.2013	UUMA seminar in Kokkola	oral presentation and networking
6.8.2013	Networking event in the Finnish Transport Agency in Helsinki	oral presentation and networking
15.8.2013	UUMA seminar in Oulu	oral presentation and networking
25-26.4.2013	Simm-ccities conference and workshop (Sustainable and Innovative Material Management for the Construction in Cities)	www.simmccities.com pp presentation on RMSS, pp presentation by the city of Helsinki mentioning the project oral presentation of the project and networking benchmarking and discussions on the RMSS
22.8.2013	Finnish Geotechnical Society seminar concerning soil reinforcement, Helsinki	pp presentation
26-28.8.2013	XXVIII International Baltic Road Conference in Vilnius, Lithuania	article published in the proceedings pp presentation
23.10.2013	Dissemination of Absoils results during a meeting with Arizona Chemicals, Kajaanin ELY and FR	pp and oral presentation, discussions, plans for the use of the results in other parts of Finland, and other sectors

	Oulu and Kuopio	
6-9.11.2013	The 8th International SedNet conference, Lisbon, Portugal	http://www.sednet.org/conference2013.htm abstract sent to the conference, poster presentation
18-17.1.2014	Biomass Conference in Graz, Austria	PP presentation http://10times.com/central-european-biomass-conference
10-11.4. 2014	South Baltic Conference on Dredged Materials in Dike Construction in Rostock, Germany.	paper and PP presentation http://www.dredgdikes.eu/en/south-baltic-conference-on-dredged-materials-in-dike-construction-3024
4.4.2014	Roadshow 2, Helsinki, port of Vuosaari	PP presentations and discussions
19.8.2014	Roadshow 3, Turku, Finland	PP presentations and discussions
7.5.2014	dissemination/networking meeting with Erityisjäte representatives in Lahti	oral presentation and discussion on the use of the project results
3-5.6.2014	Networking and dissemination during the Green Week in Brussels/ on Tue 3.6. participation in the LIFE waste platform.	networking and one-pager of the project (100)
11-12.9.2016	Absoils international seminar (presentation on Absoils LCA/LCC and workshop participation)	5 PP presentations on Absoils project results and field-trip to the pilot site in Jätkäsaari http://projektit.ramboll.fi/life/absoils/documents.htm
9.10.2014	International conference on material recycling/participation and networking, in Tallin, Estonia	sharing Absoils flyers with participants (60 participants from various countries)
4-6.11.2014	AvniR LCA-conference in Lille, France	Paper and presentation on Absoils LCA/LCC results
2-3.12.2014	Optimass seminar in Gothenburg in Sweden	Dissemination of Absoils projects results / PP presentation and discussion, networking
9.4.2015	Mass stabilisation meeting in Espoo (with UUMA project)	Dissemination of Absoils results and networking / oral presentation, discussion
22-24.4.2015	Road Show 4 during the international Mass Stabilisation conference in Lahti	Road show 4. 3 PP presentations, poster and stand
27.4.2015	UUMA2 seminar in Helsinki	Presentation of the Absoils results/ PP presentation
28-29.4.2015	Fly Ash conference in Berlin, Germany	Absoils project's results PP presentation
2.6.2015	networking events of LCA experts in Helsinki	oral presentation, networking
8-13.6.2015	Wascon 2015 conference in Santander in Spain	http://wascon2015.geruc.es/wascon2015-event-program/ Article and PP presentation of the LCA/LCC results of the Absoils project

– Use of LIFE logo

The LIFE logo was/has been used on all the materials produced by the project and the purchased equipment.


Figure 58. LIFE logo on a presentation shown in Gothenburg in 2014.
Figure 59. LIFE roll-up banner during a road-show in Kuopio, 2013.

Figure 60-61. LIFE logo on the stabilization mixer purchased by Biomaa.

– Erection of notice boards

The LIFE notice boards containing the information on the project including the EU LIFE number and the partners were erected in the pilot sites.



Figures 62-64. LIFE notice board erected at various pilot sites.

– The project website in Finnish and English is operating via the services of Ramfi. The information was updated regularly. The site will remain functional after the end of the project. The address of the site is:

http://projektit.ramboll.fi/life/absoils/index_eng.htm
http://projektit.ramboll.fi/life/absoils/index.htm

Figure 65. The website of the Absoils project.

- The list of all articles presented during relevant international conferences and included in conference proceedings:

  1. Niemelin, T., Ronkainen, M. , Forsman, J., Kreft-Burman, K. and Suominen, M. 2015. Streamlined Life Cycle Case Studies: Utilising Surplus Soils in Civil Engineering Applications in Three Different Pilot Cases. WASCON June 10-12th 2015. (Attached as Annex 40)

  2. Niemelin, T., Ronkainen, M. , Forsman, J., Kreft-Burman, K. and Lahtinen, P. LIFE CYCLE CASE STUDY: UTILISING SURPLUS SOILS FOR CONSTRUCTING AN URBAN AREA IN A FLOOD PRONE ZONE. avniR conference, France , 2014 (Attached as Annex 39)

  3. Lahtinen, P.,Forsman, J., Kiukkonen, P., Kreft-Burman, K. and Niutanen, V. 2014 MASS STABILISATION AS A METHOD OF TREATMENT OF CONTAMINATED SEDIMENTS. South Baltic Conference on Dredged Materials in Dike Construction. Rostock, 10-12 April 2014 (Attached as Annex 38)

  4. Forsman, J., Kreft-Burman, K., Lindroos, N., Hämäläinen, H., Niutanen, V., Lehtonen, K., EXPERIENCES OF UTILISING MASS STABILISED LOW-QUALITY SOILS FOR INFRASTRUCTURE CONSTRUCTION IN THE CAPITAL REGION OF FINLAND – CASE ABSOILS PROJECT, Baltic Road Conference, Vilnius 2013 (Attached as Annex 37)

  5. Ollila, S., Forsman, J., Lahtinen, P., Niutanen, V. and Lehtonen, K., ABSOILS – Sustainable Methods and Processes to Convert Abandoned Low-Quality Soils into Construction Materials. NGM 2012, Denmark 2012 (Attached as Annex 35)

  6. Kreft-Burman, K., Lahtinen, P., Ollila, S., Forsman, J., Niutanen, V., Lehtonen, K., Absoils - Sustainable Methods and Processes to Convert Abandoned Low-Quality Soils into Construction Materials, WASCON conference, Gothenburgh, Sweden 2012 (Attached as Annex 36)

  7. Forsman, J., Korhonen, O., Havukainen, J., Kreft-Burman, K., MASS STABILISATION IN CONSTRUCTION OF SOFT SUBSOILS AND IN ENVIRONMENTAL GEOTECHNICS AT CITY OF HELSINKI Rostock 12 th Baltic Sea Geotechnical Conference, 31 May – 2 June 2012 (Attached as Annex 30)

- Audio-visual products:
    - Photographs are attached in the electronic form (on CD-rom) Annex 19
    - The project two-pager in English is attached as Annex 20 and the Polish version is attached as Annex 21.
    - The International Guidelines are attached as Annex 13.
    - The video on the Absoils project is attached in the electronic form as Annex 22, and the video on the RMSS system is attached as Annex 23.
    - The conference posters are attached in the electronic form as annexes:
      - avniR conference poster (2014): Annex 24
      - SedNet conference poster (2013): Annex 25
      - Poster concerning Absoils pilot operations and the project itself (presented at various events): Annex 26 (Dog Park pilot), Annex 27 (Arcada2 pilot), Annex 28 (Absoils project).

Figure 66-69. Photos from dissemination events.

5.3 Evaluation of Project Implementation

The main objective of the project was to carry out at least four practical civil-engineering applications based on abandoned soils which allow for the verification of the feasibility of challenging surplus soft soils as construction materials for important infrastructure applications. This objective was reached.

In order to fulfil the obligation to carry out pilot applications in four different categories, i.e., flood barrier, noise barrier, supporting bank, and landscape construction, the number of pilot sites was increased (more than 4 pilots) as none of them represented one category only and all of them were cross-category type.

The project team had asked for time extension in January 2014 because at that time it was foreseen that the noise barrier application would only be possible to be carried out in the framework of the Jätkäsaari III pilot and this activity was scheduled for the end of 2014/ beginning of 2015. Two trial barriers were constructed at this site in January 2015 and supplied the project with reference data.

As for the Honkasuo pilot, the experience gained while carrying out material recipe development and planning of this pilot application has been incorporated into the International Guidelines as it deals with a new type of soft soils, namely a combination of clays and peat. However, the start of construction works in this site will happen outside the Absoils project, so the utilisation of the gained experience and lessons learned will take place during the Absoils After-LIFE period.

5.3.1 Cost efficiency of actions

In general, the cost efficiency of actions has met the expectations and in some cases, as in the experience gathered due to the implementation of the pilots, the dissemination activities and the impact of the project on the process of legislation development in Finland, the expectation were exceeded.

The only issues concerning cost efficiency where the project expectations were not fully met deal with the use of fly ash as binder in the process of stabilisation.

It was originally planned that the poor quality abandoned soils would be transformed into construction materials by the application of stabilisation technology with a high use of fly ash and the FGD (flu gas desulphuristation gypsum). Since Rudus is a major player in the fly ash generation sector in the area of concern for the Absoils project, it had been planned that the involvement of this partner would be strong both in case of the expertise and the fly ash supply for the needs of the pilot applications. However, it had turned out not to be the case. There were a few factors hindering the use of fly ash in the scale predicted in the project proposal. The pilot sites are owned by the cities involved in the project (Helsinki, Vantaa, Espoo) and the last word concerning the materials to be used was up to them. Although the use of fly ash was strongly recommended by the project team, the need to apply for the environmental permit and the length of the permitting process were the major impediment for its use. Fly ash was used in two pilot applications, but in a much smaller degree than had been originally planned. This issue was covered in the progress reports and in the amendment letter as in the case of Rudus, this meant mainly some considerable decrease in the external assistance and consumables categories, as most planned actions related to the fly ash storage, transportation, etc. did not take place.

Since it was not possible to use fly ash in the pilot application in the degree expected in the project application, there was a need to replace it with a commercial binder, in this case - cement. This has naturally had an impact on the costs of carrying out the pilot applications and this increase is mostly visible in the consumables category of Biomaa/Lemminkäinen.

5.3.2 Comparison of results achieved against the objectives

Task	Foreseen in the revised proposal	Achieved	Evaluation
Consortium agreement	01/09/2010	YES	The Consortium Agreement was signed and attached to the Inception Report (31.1.2011). The agreement constituted the basis for the cooperation among the project partners. The agreement had to be amended with the change of the project partner (Biomaa fused with Lemminkäinen) and signed again. The updated version was delivered to the Commission in August 2014. Apart from the new partner/ signatures no other changes were made in comparison to the original agreement.
Inception Report	15/12/2010	YES	The Inception Report was delivered to the Commission on 31.1.2011 and was accepted. Its creation allowed the partners for the assessment of the original project plans and updating planning for the implementation of the project actions.
Report on Preparations Action	15/12/2010	YES	It was delivered to the Commission and it was realised that some of the preparations for the pilot arrangement would have to continue as part of the action 2 and 3. Attached as Annex 1.
Report of civil-engineering and environmental survey	30/11/2012	YES	It was realised that the original deadline had to be extended as not all the pilot sites were known/agreed upon/confirmed by that time. In practice, the pilot arrangements were on-going throughout nearly the whole duration of the project. It has been learned that in the case of a long project and many pilot applications to be carried out, there might occur changes independent of the project team. By this deadline the preliminary version of the report was delivered. The Action was continued as part Actions 3 and 4. The Report of the civil-engineering and environmental survey is attached as Annex 29.
Paper submitted to one conference	31/03/2011	YES	This action was bit delayed and the abstract of the article was submitted in September 2011 (Rostock) and the paper was submitted in February 2012. It has been learned that scientific papers can be written only if the pilot applications provide the partners with data. For this reason, it is advisable in the future to plan no paper submission in the early stage of the project, and more submissions in the later stage. Annex 30.
Written instruction for the implementation of Pilot Applications 2011	31/05/2011	YES	The written instructions for the implementation of the Pilot Applications allowed for the successful implementation of the pilots. Attached as Annex 3 and Annex 4.
Written instructions for the quality control and follow-up of Pilot	31/05/2011	Completed as part of above activity	It was realised that although in the project written instructions for quality control were planned to be a separate document, in practice

Applications 2011			they had to be included as an integral part of the written instructions for pilot applications as this task was later carried out as such. Exist as part of Annex 3 and Annex 4. The instructions were the basis for the implementation of the project pilot applications.
2 Press releases about the project (2011)	01/08/2011	YES	One press release was sent out in 2011 (Annex 31), the other one was sent out later, in 2012 in connection to the start of Dog Park pilot in Espoo. Annex 32. The most media interest was attracted in connection to the Kick-off event in 2011. This resulted in radio and TV-interviews.
Intermediate Report 1 on Materials	30/08/2011	YES	This task was continued throughout the whole project duration until the completion of the Final Report on this activity in 2015. The report is attached Annex 2.
Progress Report Nr 2	15/09/2011	YES	Numbering changed as the first report was skipped.
Carbon Footprint report Nr 1	15/09/2011	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity. Annex 33
Monitoring Report Nr 1	15/09/2011	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 34.
Intermediate report 2 on Materials	28/02/2012	YES	This task was continued throughout the whole project duration until the completion of the Final Report on this activity in 2015. The report is attached Annex 2.
Technical Report on Pilot 2011	28/02/2012	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 9.
Progress Report Nr 3	30/03/2012	YES	The report was delivered with 15 days delay which was allowed by the Commission
Paper submitted to 2 conferences	31/03/2012	YES	Papers on the pilot activities of the Absoils project were submitted to the NGM (Annex 35) and WASCON 2012 (Annex 36)conferences.
Written instruction for the implementation of Pilot Applications 2012	30/09/2012	YES	The instruction were created in 2011 and updated in 2012 for the Dog Park and Jätkäsaari II. Delivered as Annex 5 and Annex 6. The instructions allowed for the construction and QC activities in the project pilot applications.
Written instructions for the quality control and follow-up of Pilot Applications 2012	30/09/2012	Completed as part of above activity	It was realised that although in the project written instructions for quality control were planned to be a separate document, in practice they had to be included as an integral part of the written instructions for pilot applications as this task was later carried out as such. Exist as part of Annex 5 and Annex 6. The instructions were the basis for the implementation of the project pilot applications.
Written instructions for the implementation of Pilot Applications 2013	30/11/2013	YES	The instruction were created for Jätkäsaari III (Annex 8)and Honkasuo (Annex 7).The instructions allowed for the construction and QC activities in the Jätkäsaari site and partially in the Honkasuo site (site preparation). The instructions will be implemented in 2016 with the start of the construction works in this site.

Written instructions for the quality control and follow-up of Pilot Applications 2013	30/11/2013	Completed as part of above activity	It was realised that although in the project written instructions for quality control were planned to be a separate document, in practice they had to be included as an integral part of the written instructions for pilot applications as this task was later carried out as such. Exist as part of Annex 7 and Annex 8. The instructions were the basis for the implementation of the project pilot applications.
Intermediate report (3) of Materials	30/11/2013	YES	This task was continued throughout the whole project duration until the completion of the Final Report on this activity in 2015. The report is attached Annex 2.
Midterm Report with Payment request	30/11/2012	YES	The report was delivered to the Commission.
Carbon Footprint report Nr 2	30/09/2012	YES	Delivered with Midterm Report. This task was continued throughout the whole project duration until the completion of the Final Report on this activity. Annex 33
Monitoring Report Nr 2	30/09/2012	YES	Delivered with Midterm Report. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 34.
Technical Report of Materials	31/5/2015	YES	The report is attached Annex 2.
Technical Report of Pilot 2012	28/02/2013	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 9.
Progress Report Nr 4	15/03/2013	It was requested to skip this report and merge it with the next progress report.	Permission was granted.
Paper submitted to 4 conferences	31/03/2013	YES	The overall target was exceeded as by the end of the project 7 conference papers were submitted. The papers are attached as the following Annexes: Annex 37, Annex 38, Annex 39, Annex 40.
Progress Report Nr 5	15/09/2013	YES	The report was submitted as a merged version of report 4 and 5.
Carbon Footprint report Nr 3	15/09/2013	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity. Annex 33
Monitoring Report Nr 3	15/09/2013	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 34.
DVD presentation about the RMSS	01/04/2015	YES	The presentation is attached in the electronic form on a CD-rom as Annex 23.
Article in a professional magazine	30/09/2013	YES	The copy is attached as Annex 18.
Progress Report Nr 6	15/03/2014	It was requested to merge it with the Progress	Permission was granted.

		Report 7	
Draft of Verification Report to External Experts	31/01/2015	YES	The External Expert's opinion is attached as Annex 41.
Press release for the workshop	01/08/2014	YES	The press release is attached as Annex 42.
DVD presentation about the project, its methods and results	01/04/2015	YES	The video presentation is attached as Annex 22. It is in the electronic form on a CD-rom. It is also place on the project web site.
Progress Report Nr 7	15/09/2014	YES	The report was delivered to the Commission.
Carbon Footprint report Nr 4	30/09/2014	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity. Annex 33
Monitoring Report Nr 4	30/09/2014	YES	The report was delivered. This task was continued throughout the whole project duration until the completion of the Final Report on this activity which is attached as Annex 34.
Article for a professional magazine	15/5/2015	YES	The copy is attached as Annex 17.
Completed slide presentation	15/6/2015	YES	The presentation is attached as Annex 14.
European Guidelines	15/6/2015	YES	The International Guidelines are attached as Annex 13. The name was changed in order to make a bigger impact and not to narrow down the target audience to the European countries. The results and the methods applied in the Absoils project are applicable in all the countries where soft soils create geotechnical problems.
Layman's report	15/6/2015	YES	The version in English is attached as Annex 15 and the Finnish version as Annex 16. According to the original plan, 3000 paper copies were to be printed but due to the environmental reasons (saving paper) and the popularity of the electronic media, this number was decided to be diminished. In the case more paper copies of the report will be needed, they will be printed on the expense of Ramfi.
Final Verification Report	15/6/2015	YES	The Report is attached as Annex 10.
Modelling Action Report and System Description	15/6/2015	YES	The Report is attached as Annex 11 and the slide presentation on the RMSS system is attached as Annex 12.
Dissemination Report	15/6/2015	YES	The Final Dissemination Report is attached as Annex 43.
After LIFE-period			
Final Report with payment request	30/9/2015	YES	
After-Life communication plan	30/9/2015	YES	The After-Life Communication Plan is attached as Annex 44 (in English) and Annex 45 (in Finnish).
Final Carbon Footprint report	30/9/2015	YES	The Final Carbon Footprint report is attached as Annex 33.

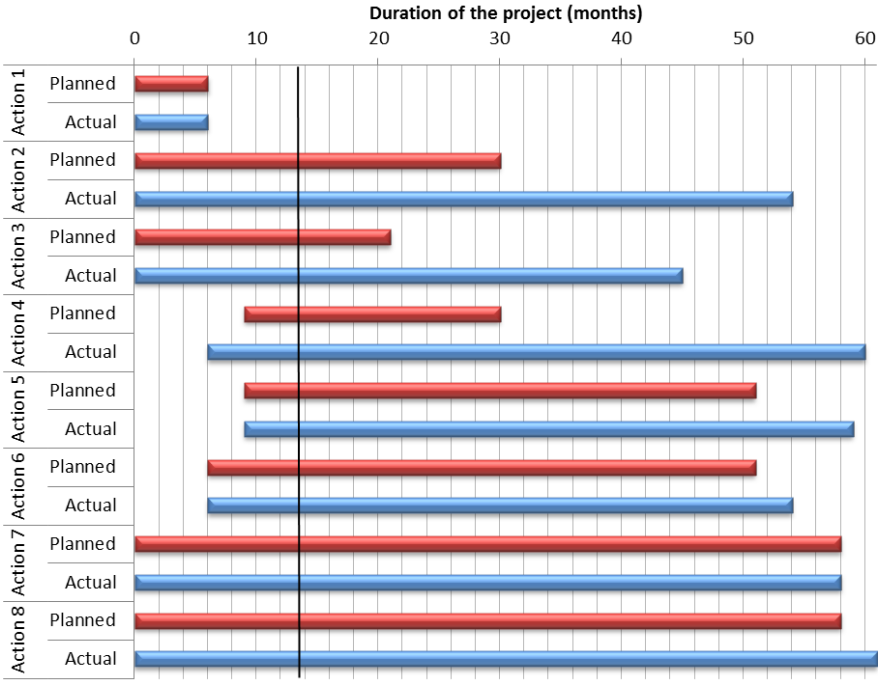


Figure 70. The Gantt chart of the implementation of the project actions.

The immediate results of the dissemination activities of the project is the interest of the stakeholders in the solutions piloted by the project and its impact on legislative change. The changes which will become more apparent in the future is the change of attitude of the stakeholders that will lead to more sustainable and efficient management of surplus soils. Indicate which project results have been immediately visible and which results will only become apparent after a certain time period.

The expansion of the project duration was very important for the active dissemination of the project results, especially to a wide international audience that took part in the Mass Stabilisation Conference and the Absoils Roadshow in April 2015, in Lahti, Finland. About 200 stakeholders took part in the event.

5.4 Analysis of long-term benefits

The most important impact on the environmental problems targeted have been reached by the implementation of the Applications and Piloting Actions.

The completed piloting actions (Arcada 2 and Jätkäsaari I and II) allowed for the stabilisation and utilisation of 142 000 m^3 of the abandoned soils and sediments and decreased the need for landfilling of this amount.

Additionally, about 40 000 m^3 of rock aggregate material was recovered in the Arcada 2 pilot site by processing and reusing. This, in turn, diminished the need for virgin rock material.

The stabilised masses from Jätkäsaari I and II were removed from the stabilisation basins and used for various construction purposes.

- Part of masses was used for the construction of an adjacent park.

- Another part was transported to a site of Helsinki called Vuosaari and used for the Vuosaari landfill filling and for landscaping purposes in the Ida Aalberg park.

Jätkäsaari also allowed for carrying out a trial field for the use of fly ash in the stabilisation process of the sediments. This is very important considering the future permit process for similar applications in Helsinki.

Figure 71. Plans for the utilisation of stabilised sediments freom Jätkäsaari II for landscaping purposes in the Ida Aalberg park (2012/2013).


Figure 72-73. Jätkäsaari II sediments applied in Ida Aalberg park.

The Pirttiranta pilot application allowed for the use of 4 000m^3 of abandoned soils.

The Dog Park allowed for the stabilisation of about 15 000 m^3 of abandoned clays. It also allowed for the use of fly ash and FGD which is very important from the point of view of permit applications.

The Jätkäsaari III pilot permits for the utilisation of the 90 000 m^3 of dredged soft sediment for various future engineering applications, thus allowing for the saving of the virgin materials that would have to be otherwise used for the construction of noise barriers.

The so-far expected non-renewable materials savings allowed by the application of the Absoils project's solutions in the Honkasuo pilot are about 45 000 m^3.

According to the LCA results of the studied pilots, by substituting part of the cement with fly ash or with other industrial by-product, the environmental impacts can be significantly decreased. Cement manufacturing consumes a lot of energy and natural resources. In Finland, cement manufacturing constitutes 1,2 % of all greenhouse gas emissions. The environmental impacts from cement manufacturing are centralised especially to the area where the main ingredient, limestone, is quarried. Moreover, cement transportations and high temperatures (~1400-1500 °C) in rotary kilns generate a lot of airborne emissions and consume a lot of energy.

The utilisation of surplus soils significantly decreases the depletion of natural resources, energy consumption and global warming potential. In Finland, the annual use of natural aggregates is approximately 22 ton/person. There is a shortage of rock material in the capital region, so the natural aggregates are transported from other counties. The transportation distances can be over 30 km. Transportation of 1 ton of natural aggregates consumes 7 kWh energy. As 1 kWh energy produces approximately 0,27 kg CO_2 emissions, 1 km more of a transportation distance results in 7 million kg of CO_2 emissions . The amount of surplus soils generated annually in Helsinki is approximately 100 000 – 150 000 m^3. The landfill capacity for surplus soils has been exhausted and part of the surplus soils are transported outside Helsinki. As the results of this study indicate, stabilisation of soft surplus soils that allows for their utilisation as earth construction materials is an environmentally feasible solution.

The project was a response to the central aspects of the Waste Framework Directive and has contributed to the development of environmental policies in Finland and Europe with respect to better resource efficiency.

Through the Materials, Applications and Piloting actions, the Absoils project has provided valuable information on how to tackle the issue of abandoned soils in the Uusimaa region. This information of also of a great value to the environmental permit authorities as a reference point for processing future cases of similar type. In the long run, this should make the environmental permitting less timely and in general, the use of secondary materials more common.

Within the Management and Dissemination actions, the project team members have taken an active role in disseminating the information on the project and its objectives in discussions with various stakeholders both in Finland and internationally. This continually increases the level of knowledge and raises the awareness of the importance of solving the issue of abandoned soils. The project has received a very positive feedback from the Ministry of Environment and the representatives of the cities involved, as a pioneering initiative in this field.

In the long term (until 2025) the civil-engineering materials based on abandoned soils will be accepted and become an established practice in Europe followed by significant environmental and economic benefits. Obsolete landfilling and transports of abandoned soils will be reduced and the converted civil-engineering materials will replace a remarkable part of natural aggregates from non-renewable sources involving heavy long-distance transports. Consequently, atmospheric releases of greenhouse gases will be notably reduced and the quality of the landscape and groundwater will be improved. Based on rough estimates costs of

landfilling may be reduced by more than 27000 M€/a and costs of construction by close to 3500 M€/a in Europe.

It is estimated that 4 million tons of surplus soils will be re-used in the capital region of Finland as the know-how on surplus soil utilisation possibilities improves all the time. As the utilization of surplus soils will eventually be an established method instead of landfilling, it is estimated that reduction of greenhouse gases (as CO_2 equiv.) may be approximately 1,2 million tons CO_2 yearly in Finland. Only in Helsinki, it is estimated that by surplus soil utilization, approximately 100-200 million euros can be saved every year.

The project is addressing problems encountered in most of the European countries although the project was carried out in Finland and with "Finnish types of abandoned soils". The countries where the project results and the applied methodology (mass stabilisation) are replicable in the most easy way include the countries with similar geological conditions, such as Sweden, Estonia, Latvia, Lithuania, Poland, Germany. Outside Europe, the project results can be replicated in such countries as Canada, the USA, Japan. The results considering the use of fly ash and FGD as construction materials can be replicated in all the countries where fly ash is produced both in Europe and globally. The project results concerning the utilisation of dredged sediments can be replicated in all the countries where sediments are dredged in the port development activities.

The most important outcomes of the project allowing the replicability of the results are the International Guidelines and the Final Report on Pilots.

By the influence of ABSOILS results, a national programme called UUMA2 was established in 2013. The goal of the UUMA2 programme is to promote the use of recovered materials in groundworks and thus decrease the use of untouched natural resources and the environmental effects of groundworks.

The Final Table of Indicators of the Absoils project is attached as Annex 46.