Demonstration Plan Outline

Demonstration Title: Demonstration in Istanbul - conceptual scheme for rainwater harvesting and grey water management

SEVENTH FRAMEWORK PROGRAMME

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COLOPHON

Title
Report on the demonstration in Istanbul - rainwater harvesting system for a building or a group of buildings which will be also coupled with grey water collection-treatment and reuse

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Document history

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1	A. Baban	Draft	27 May 11	Draft
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Summary

The PREPARED project aims to distribute the experience of the cities, produced knowledge, and results of R&D of the project to city utilities through demonstration plants/activities. Therefore, a pilot plant on rainwater harvesting systems and grey water collection-treatment and reuse will be implemented in TUBITAK Campus and the outcomes will be tested conceptually in a selected case study area in Istanbul.

Rainwater harvesting may be considered as a partial solution for the cities suffering from water stress along with the grey water segregation-treatment – reuse concept. This model is applicable to suitable buildings or residential areas in urban environment. In this context, the presented task includes demonstration of the concept for selected case study buildings. The scope covers the implementation of a suitable system for treatment, collection of data for grey water, rainwater, treated effluents, technology assessment, sanitation, and economical feasibility aspects.

Moreover, stormwater characterization from roads and pavement areas, rainwater monitoring throughout storage, assessment of promising reuse alternatives as well as the positive and negative impacts of these alternatives are considered in this study. The study involves comprehensive monitoring of the collection-storage-treatment system(s) for environmentally meaningful parameters for climate change impact perspective. The study focuses on PAH and PCB measurements, evaluation of the results and mitigation measures along with the monitoring of conventional parameters for water reuse.

Evaluation of the rainwater and grey water management systems with a perception of development of alternative water resources, pollution control and mitigation, climate change impact issues, public acceptance and feasibility is accomplished. The outcomes of the study provide a base for technical information on grey water-rainwater valorisation, applicable monitoring implementation practices for cities which will presumably suffer from climate change impacts and water stress. The results may constitute a tool for technical personnel, decision makers, planners water utilities, consumers and various stakeholders such as treatment equipment manufacturers.

Contents

1 Introduction

The Work Area 1 (Utilities alliances-Test and demonstration of PREPARED climate-proof solutions portfolio) in the PREPARED project is aims to promote the implementation of outcomes and knowledge transfer through demonstration in city utilities. WA1 consist of three demonstration alliances, on "adaptation to water scarcity and quality changes", "adaptation to extreme rainfall events", "integrated approaches to enable climate change adaptation". The demonstration in Istanbul will present a conceptual scheme for rainwater harvesting and grey water management as part of the work package of demonstration alliance on "adaptation to water scarcity and quality changes".

Istanbul is a large city with a population of 13 million. Hence, water supply and sanitation are of particular concern. The majority of resources are located in Asian side in contrast to the urban density. Although, there have been many precautions and adaptation plans developed in the city, such as linking the water reservoirs for operational flexibility, construction of new pipelines at high costs for transfer of water from an adjacent basin and water saving campaigns, Istanbul has always faced with water scarcity problem in the history. In addition to those problems and efforts, recent studies shows that Mediterranean Region will be suffering more from water scarcity in the future as a result of climate change impacts. Domestic water use constitutes the major part of water consumption in Istanbul. Therefore, household water reuse practices and utilization of rain water may considerably reduce the fresh water consumption and contribute to sustainable use of the water sources and adaptation of the cities to adverse impacts of climate change.

Grey water (GW) and rain water (RW) may be considered as reliable water resource alternatives as long as appropriate measures are taken for compliance with hygienic requirements. Technical options for GW and RW treatment and reuse are tested at the pilot implementation site for Istanbul. The local conditions and the specific objectives are appraised. Technical options for GW incorporate characterization, collection, treatment and reuse opportunities. Besides, for RW characterization from various sources, collection, treatment, storage and reuse options are carried out and assessed. GW and RW pilot implementation activities are conducted at the TUBITAK Marmara Research Center campus. Meanwhile, monitoring and characterization studies are performed in Environment Institute (ENVI) Laboratories.

GW generated from two buildings in TUBITAK-MRC premises are utilized for assessment for GW segregation, collection, treatment and reuse options. The roof of one of the buildings is used for RW collection, characterization, treatment and reuse studies. The water quality parameters which have been focused on for the pilots are associated with the national and international reuse standards and regulations.

A case study area is selected within the Istanbul metropolitan vicinity in order to test the results of the pilot studies conceptually. Relevant data is

collected from the selected site to facilitate the assessment. Moreover, storm water samples from roads and paved areas are collected and analyzed for the parameters which are assumed vital for the environment, including PAH and PCB within the selected case study area. As a result of the pilot studies and conceptual up scaling practices in the case study area, the demonstration in Istanbul will constitute a conceptual scheme for RW harvesting and GW reuse to mitigate water scarcity and quality change as an example for regions under water stress.

2 Demonstration participants and responsibilities

The participants of the Demonstration activities include TUBITAK, ISKI, KWB, IRIDE. In addition to that, the outcomes are shared within the other relevant partners.

TUBITAK Marmara Research Center (MRC) Environment Institute (ENVI), Dr. Ahmet BABAN (ahmet.baban@mam.gov.tr, tel: +90 262 677 2904)

- Provision of the facilities for the pilot, buildings, GW and RW sources,
- Design and implementation of the RW/GW collection-treatment-reuse systems,
- Running and monitoring of the systems in line with the scope and the priorities set for Istanbul and developed schedule,
- Assessment of the pilot study results,
- Accomplishment of the modifications if necessary in accordance with the assessment,
- Contribution to the technology modifications and improvement for GW/RW systems for the point of urban water management to tackle with water scarcity,
- Conceptual upgrading of the system for the case study area selected in Istanbul,
- Establishment of close contacts with the utility by organizing meetings,
- Arrangement of dissemination activities within the PREPARED partners especially sharing the parallel issues or concerns.
- Organization of a "demonstration day" for the other utilities involved

Istanbul Water and Sewerage Directorate (ISKI), Orhan Cemal GOKTAS (ogoktas@iski.gov.tr, tel: +90 212 301 3620)

- Provision of relevant data, especially for the selected case study area in Istanbul,
- Providing appropriate areas for representative stormwater sampling activities,
- Taking part in the assessment phases of the pilot results
- Collaboration with ENVI regarding the pilot activities, take part in assessment study discussions, meetings
- Supporting demonstration and dissemination activities among the partners or stakeholders in Istanbul,
- Supporting organization of the "demonstration day" for the other utilities involved

Kompetenzzebtrum Wasser Berlin gGmbH (KWB), Dr. Gesche Grützmacher (gesche.gruetzmacher@kompetenz-wasser.de, tel: +49 030 53653 813) and Iride

Acqua Gas SpA (IRIDE), Dr. Nicola Bazurro (Nicola.Bazzurro@irenacquagas.it, tel: +39.010.5586865)

- Following the progress and the compliance with the objectives of the pilot implementation studies,
- Contribution to the assessment of the results, comments on future pilot implementation studies in accordance with the outcomes,
- Making the connections with the results of the other pilot studies.

3 Description of the deliverable being demonstrated

The deliverable (D5.1.1) where the demonstration activities are based upon focuses on an integrated urban water management concept. In this manner investigation of innovative water resources for regions under water stress is emphasized. RW harvesting and GW management are regarded as alternative water resources for Istanbul and other regions under water stress.

The demonstration site consists of GW and RW technology implementations in the TUBITAK-MRC premises, which will be conceptually upgraded to an area covering 200.000 buildings in Istanbul. The conceptual scheme of the demonstration is illustrated in Figure 1.

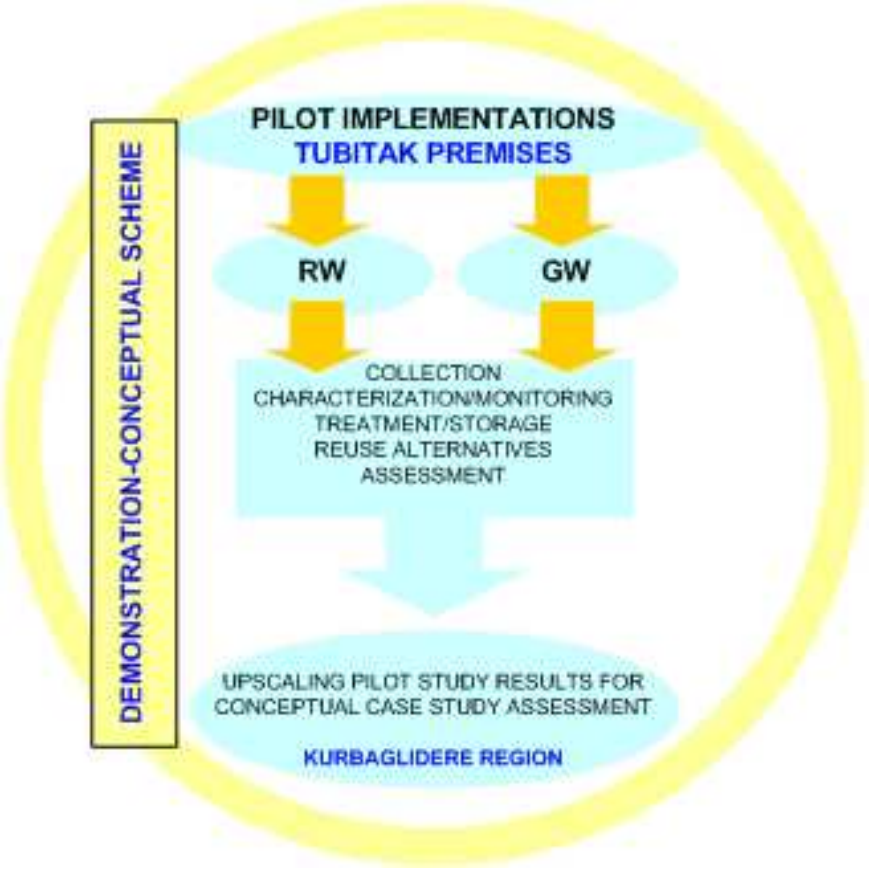

Figure 1. Conceptual scheme of the demonstration

The details of pilot implementation are illustrated in Figure 2. The aim of the pilot study is the investigation and assessment of GW and RW as resilient alternative water resource. The suitability of the system for mega cities is technically tested.

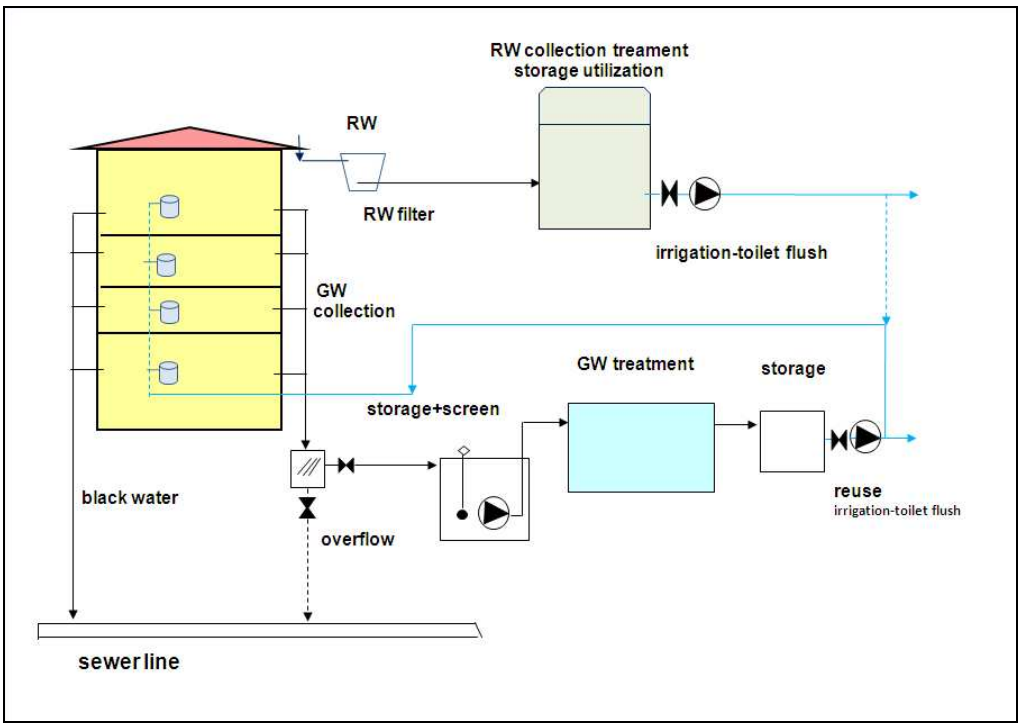

Figure 2. Pilot implementation for GW and RW - outline

4 Demonstration Experimental Design

4.1 Performance Objectives

Water quality/Hygienic considerations

Guidelines which are proposed by UK Environmental Agency (2008) for the water quality of non-potable water from RW and GW are mainly taken into consideration for compliance monitoring and assessment purposes. In this manner, EPA guidelines are also referred in this report (EPA, Guidelines for Water Reuse, September 2004).

Applicability

Optimization of operation with respect to efficiency, operational ease, energy/economics, assessment of the suitability of the approach for the special features of Istanbul is aimed.

Assessment of the advantages/disadvantages of both GW and RW systems in return will form a base for system scale-up for large application practices.

Acceptance (Utility/Public)

The outcome is intended to facilitate, testing and understanding of the utility and public perception for the local implementation cases of RW and GW reuse systems.

4.2 Demonstration Site Description

GW treatment and reuse experiments

Table 1 illustrates the GW technology options to be tested at pilot implementation area along with their functional purposes.

Table 1. GW treatment and reuse components tested at the pilot site

Options	Definition	Functional notes
GW segregation	GW of 2 buildings each consisting 14 apartments	GW consists of showers, washing basins, washing machines and kitchen 2 separate piping connections for GW and black water (BW) for transportation to the pilot site, overflows where necessary
Screening,	coarse and fine screens	Removal of coarse and fine materials from GW for the further smooth treatment operations
Biological treatment	Rotating Biological Contactor (RBC)	Biological oxidation of organic compounds, nutrient removal by nitrification and denitrification, removal of suspended solids (SS)
Filtration	anthracite-sand	SS and organic matter removal, color removal, polishing
Disinfection	UV	Destruction of harmful microorganisms
Reuse components	Irrigation (gardens), etc.), toilet flush, some cleaning requirements	Assessment of reuse practices
Monitoring parameters	Assessment of reuse potential	Comparison of the results with reuse standards

RW collection – treatment – utilization experiments

The RW system to be operated as pilot experiment is introduced in Table 2.

Table 2. RW collection treatment and utilization components

Options	Definition	Functional notes
Rainwater collection	Building roof, flat	RW collection practices
RW storage	Storage tank	Water quality changes throughout storage, measurements for quality and quantity for assessment studies.
RW treatment components	Pre-filtration-filtration, post-filtration	Testing the RW quality, assessment of the suitability of the proposed system, Istanbul example.
Reuse components	Irrigation, toilet flush, cleaning	Compliance monitoring, risk assessment
Monitoring parameters	Environmental, hygienic, reuse potential	Potential to mitigate water scarcity, system adoption, dissemination results

4.3 Physical Setup and Operation

GW treatment and reuse experiments

The designed GW pilot system to comply with the various reuse requirements is illustrated in Figure 2. In addition, the technical specifications of the relevant GW pilot system are listed in Table 3. The monitoring parameters and schedule for GW are summarized in Table 4.

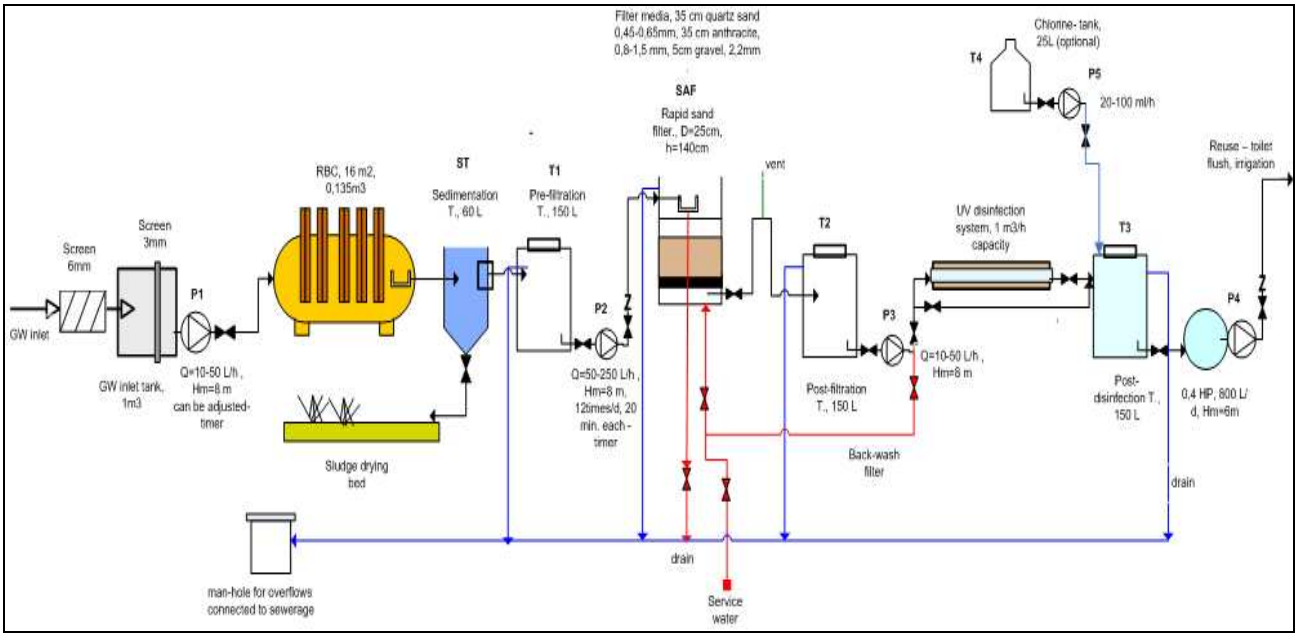

Figure 2. Process flow sheet for GW treatment – reuse pilot experiments

Table 3. Technical information/description of items for GW treatment-reuse

Item/no	Type/material	Item description	Auxiliaries	Operation notes
Screens	Bar and mash screens, 6mm and 3mm openings	steel	Placed in inlet manhole, 1m3 in volume	Manual cleaning, monthly
P1	Feeding pump	Q=10-50L/h, Hm=8m	Timer, fittings and piping	Adjusted by timer,
RBC	Rotating biological contactor, steel structure, PVC discs	36 discs, 16 m2 total surface area, 2-3 rpm (rotation speed)	Inlet/outlet chambers	Rotation speed control
ST	Sedimentation tank, plexiglass	V=60L, conical bottom for enhanced sedimentation	Inlet-outlet structure, sludge disposal valve, piping and fittings	
SAF	Sand-anthracite filter	Further suspended material removal, polishing of biological treatment effluent	Inlet-outlet structure, filter backwash, system, piping and fittings,	Intermittent operation

UV	disinfection	UV disinfection system, 1 m^3/h, 30mJ/cm2, 35 W capacity	Inlet-outlet connections	-
Container, T1	PE	Storage for pre-filtration, V=200L	Inlet-outlet, overflow connection	-
Container, T2	PE	storage for post filtration, 100L	Inlet-outlet, overflow connection	-
Container, T3	PE	storage for post disinfection/ treated water reuse, V=200 L	Inlet-outlet, overflow connection	-
Container, T4	Chlorine storage tank, PE	container, 10% NaOCl, V= 25L	Connection to P5	-
Pump, P2	Filter feeding pump	Q=50-250 L/h, H=8m	Fittings, timer	adjusted by timer, 12times/d, 20min. each operation
Pump, P3	Post filtration-disinfection pump	Q=10-50L/h, H=8m	Fittings, timer	adjusted by timer,
Pump, P4	Post disinfection – reuse	Q=800L/d, H=6m	Fittings, timer, level switches	Level switch operated
Pump, P5	Dosage pump for chlorine disinfection	Peristaltic pump, Q=20-100 ml/h,	Inlet-outlet connections, PLC operating system in connection with post filtration pump	Continuous feeding with P3 operation period
Platform for RBC	Steel structure	Elevation of RBC to facilitate gravity flow	none	-
Platform for SAF	Steel structure	Elevation of SAF to facilitate gravity flow	none	-
Piping and fittings, overflows (general items)	Piping for raw/treated GW and overflows, mainly PVC	To sludge drying bed (existing), overflow to existing sewerage system manhole, connection to irrigation faucets and toilet flush	PVC pipes and relevant fittings	Designed for continuous operation
Electrical connections	Power panel and general connections			

Table 4. Monitoring plan for GW pilot experiments

Parameters	Sampling points	Monitoring schedule	Notes
pH TSS, mg/l COD_T, mg/l BOD_5, mg/l NO2-N NO3-N TKN TN, mg/l TP, mg/l Oil and Grease, mg/l Conductivity, ms/cm Escherichia coli (n/100ml) Enterococci (n/100ml) Total coliforms (n/100 ml) Fecal coliforms (n/100ml) Turbidity (NTU) Residual chlorine, ppm Detergent, mg/l Flow temperature	inlet (after screen) RBC outlet (after sedimentation) RBC outlet (after disinfection)	COD, SS, F.col., T.col., pH, Temp., Colour weekly, Flow weekly, Other parameters monthly	Biofilm weight and thickness will be measured for RBC at steady state operation conditions

RW collection – treatment – utilization experiments

The designed RW pilot system to comply with the various reuse requirements is illustrated in Figure 3. In addition the technical specifications of the relevant RW pilot system are listed in Table 5. The monitoring parameters and time schedule to monitor the RW system are given in Table 6.

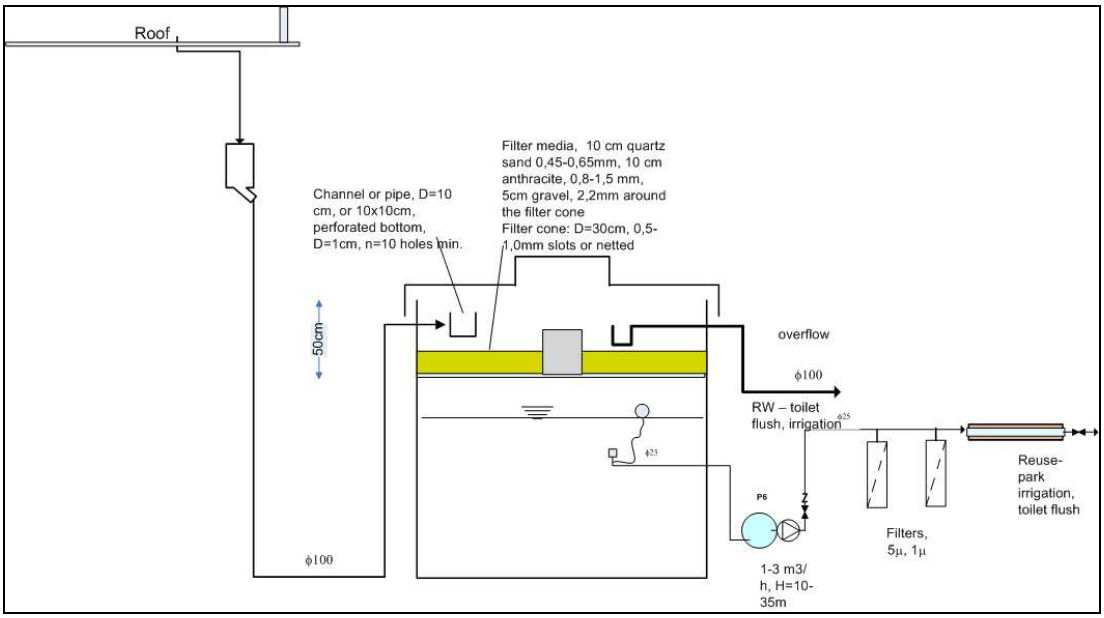

Figure 3. RW pilot experiments process flow sheet

Table 5. Technical information/description of items for RW pilot experiments

Item/no	Type	Item description	Auxiliaries	Operation notes
RW storage T	Modification existing tank (10 m3)	Rainwater filter (sand, gravel, anthracite filter), inlet box and filter nozzles, storage of filtered rainwater	Inlet and outlet connections, inlet RW distribution channel, overflow pipe connection, hose and float for suction line	Continuous filtration and storage of rainwater
Pump, P6	Transferring filtered RW for irrigation/toilet flush etc. purposes	Q=1-3 m3/h , H=10-35m	PVC pipes and relevant fittings, hydrophore vessel for keeping the pressure at desired operation level	Manuel/intermittent operation for RW utilization
Cartridge filters	5µ and 1µ filters	RW filters placed on the pipe (replaceable)	Cartridge filter holders	Continuous operation in line with P6
UV	Disinfection	UV disinfection system, 1 m^3/h, 35 W	Inlet-outlet connections	-
Piping and fittings, overflows (general items)	Piping for RW and overflow connections, mainly PVC	Irrigation and/or toilet flush connections		
Electrical connections	P6 and UV			
Total				

Table 6. Monitoring plan for RW harvesting pilot experiments

Parameters	Sampling points	Monitoring schedule	Notes
Escherichia coli (n/100ml) Enterococci (n/100ml) Total coliforms (n/100 ml) PAHs (µg/l) PCB SS (mg/l) Colour (Pt-Co) Conductivity (µs/cm) TOC (mg/l) COD (mg/l) Turbidity (NTU) pH	inlet (before screen) outlet (after UV disinfection) storage tank	During rain events (inlet) monthly (outlet) Weekly TColi, Turbidity (storage tank and outlet)	In accordance with the preliminary stage analysis and assessments, collaboration with the partners the sampling and analysis schedule can be revized

Monitoring for RW from roofs and storm water (roads/pavements)

Monitoring is aimed for determination of the characteristics of RW from roofs and storm water from residential areas, roads and pavements of Istanbul. The samples representing the rainwater from roofs are collected from the roof of the lodging building used for pilot implementation experiments in MRC premises.

The stormwater samples are taken from the selected case study area in Istanbul. These samples are collected from the man-holes in the area in order to obtain information on overall stormwater run-off characterization. The monitoring parameters and the sampling schedule are listed in Table 7 and 8 in more detail.

Table 7. RW from roofs and Storm water monitoring components

Options	Definition	Functional notes
Rainwater sampling and analysis – MRC premises, pilot implementation	-Building roof (MRC), by RW sampler - From the roof outflow sample representing first flush and consecutive rain period separately	Wet deposition and roof effects are assessed.
Storm water analysis – selected case study area (roads/paved areas)	Sample collection and analysis, from the case study area (man-holes, sampling points), volume proportional (if possible) and/or grab	Using sampling buckets from man-holes.

Table 8. Monitoring plan for RW from roofs and storm water

Parameters	Sampling points	Monitoring schedule	Notes
Fecal coliforms (n/100ml) Total coliforms (n/100 ml) PAHs (µg/l) PCB SS (mg/l) Colour (Pt-Co) Conductivity (µs/cm) TOC (mg/l) COD (mg/l) Turbidity (NTU) pH	Roof outlet Pavements/roads	During rain events, Total of 4 representative seasonal samples, for 3 years	In accordance with the preliminary stage analysis and assessments, collaboration with the partners the sampling and analysis schedule may be revised

4.4 Schedule

The proposed time schedule of the relevant activities is indicated in Table 9.

Table 9. Time schedule for Istanbul-pilot implementation studies.

1.2.5			YEAR 2											YEAR 3											YEAR 4										
			13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	33	34	35	36
	GW treatment and Reuse																																					
	1) Conceptual GW treatment scheme	MRC	X	X	X																																	
	2) System set-up	MRC				X	X	X																														
	3) Starting operation	MRC							X	X																												
	4) Monitoring*	MRC									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	5) Performance Assesment and Reporting	MRC				X														X	X														X	X	X	
	Rainwater Collection, Treatment, Utilization																																					
	1) Conceptual RW scheme	MRC	X	X	X																																	
	2) System set-up	MRC				X	X	X																														
	3) Starting operation	MRC							X	X																												
	4) Monitoring**	MRC									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
	5) Performance Assesment and Reporting	MRC				X														X	X														X	X	X	

*Weekly; COD, SS, F.col., T.col., pH, Temp., Colour
Flow weekly
Monthly; BOD5,NO2-N,NO3-N,TKN, TN,TP, Oil and Grease, Conductivity, Enterococci, Residual chlorine,Detergent

**Weekly; TColi, Turbidity (storage tank, outlet)
Monthly; Escherichia coli, Enterococci, Total coliforms,PAHs, Colour, Conductivity, TOC, Turbidity (inlet and outlet)

4.5 Performance Assessment and reporting

The performance assessment of the designed systems is accomplished by long term comparison of the results with respect to reuse criteria. Environmental, technical, economical and social aspects will be considered throughout the assessment process. The results may also be utilized for the conceptual upgrading of the system for the selected case study area in Istanbul.

Reporting period for the assessment study is proposed as 6 months. The first report will be delivered in April 2012.

References

UK Environment Agency January 2008, Reference number/code GEHO0108BNPN-E-E, Harvesting rainwater for domestic uses: an information guide.

EPA, Guidelines for Water Reuse, September 2004, EPA/625/R-04/108