# Integrated Urban Water Management (IUWM) Framework Codification in Architectural and Urban Design: The Case of Hashtgerd, Young Cities Project

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**Abstract**

Water scarcity is seen as a growing crisis that threatens societies, especially in arid climate regions. The climate change phenomenon and global warming have made policymakers reconsider their approaches towards water management issues in different sectors. Investigating sustainable management practices in the urban context, as one of the most important water-consuming sections is of great importance. In this study, after inquiring different features, principles, and means of sustainable urban water management, a framework of integrated urban water cycle management is codified to help architects and urban designers achieve or assess water efficiency in their design and planning. To reach this framework, principles of integrated urban water management and water sensitive urban design are asserted and practices are categorized into five sections: rainwater management, stormwater management, greywater management, blackwater management, and potable water management. Using this framework and based on the context of each project, a set of best practices are employed to form the integrated water management plan, although in some cases there is more than one correct answer. As a case study, the water management plan of the "Hashtgerd 35 ha. Young Cities project"-as an example of sustainable urban quarter pilot project in the Tehran-Karaj region- is assessed regarding the codified framework. Evidence from this research on water uses and systems' functions, shows that a significant reduction in potable water consumption per capita from 210 liters to 75 liters per day could be achieved in this project; after implementing best management practices within an integrated water management plan.

***Keywords:*** Water Scarcity; Climate Change; Integrated Urban Water Management; Water Sensitive Urban Design; Hashtgerd Young Cities Project

## 1. Introduction

Climate change, food crisis, population growth, and water shortage are issues that their probable consequences would affect human life greatly on earth. Middle East region is specifically vulnerable to climate change consequences. Results of a study show that the Middle East and particularly the Persian Gulf region will experience severe heat waves at the end of the present century that will endanger human existence in the region (Eltahir, 2016). It has also been predicted that as a result of droughts in the MENA region and growing stress on aquifers, 80 to 100 million people will be directly affected by water scarcity consequences by 2025 (Ibid.). In Iran, besides the frequent droughts during the last decades, a set of partial planning and comprehensive disintegrated managements have accelerated the water crisis in the country. Concentration on rapid socioeconomic developments regardless of the environmental impacts has increasingly stressed surface water bodies and underground reservoirs (Madani, 2014; Biniyaz et al., 2011). Recent studies show that the country's average groundwater table level is dropping approximately 50 cm annually due to over 5 billion cubic meters overexploitation from the aquifers (Noor, 2017). Although more than 90 % of the annual renewable freshwater use in the country allocates to an inefficient agriculture, increasing water usage in the urban sector due to the population growth and excessive consumption has severed the water stress. With a daily consumption of 250 liter/day per person, Iran is above the world average despite the limitations in water availability. This number reaches 400 liter/day per person in some urban areas like Tehran in the hot season (Madani, 2014; Mirmoghtadaee and Seeling, 2015). In this context, paying attention to sustainable development principles and employing environmentally friendly practices in urban water management can increase consumption efficiency and mitigate water stress. Adopting a proactive integrated water cycle management approach that harmonizes the socioeconomic development with the natural environment has grown to be the sustainable alternative for the dominating conventional urban water management systems. This approach with a holistic consideration of all

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forms of urban water, can commit to savings, secure sustainable water resources, and enhance urban ecology.
“The Young Cities Project” is an applied German-Iranian research project aimed at elaborating solutions and strategies for a sustainable, energy-efficient development of new urban developments in Iran as a contribution to a significant CO2 reduction (Seeling and Stellmacher, 2008). The Tehran-Karaj Region in particular is facing a formidable rise in consumption at the same time as resources are becoming ever scarcer. Thus it becomes even more important to use the remaining resources in a sustainable way. Hashtgerd New Town is one of the rapidly growing cities near Tehran, where illustrative energy efficient infrastructure systems are to be developed and implemented as the case study for the young cities project (Inter3 GmbH, 2013; Eslamlou and Mirmoghtadaee, 2017). “Hashtgerd young city community project” is a 35 ha. planning area in the Tehran-Karaj urban development region and in the south of Hashtgerd New Town that explores energy and resource efficient, climate responsive solutions for urban form, architecture, landscape and transportation planning, water and energy management, as well as consideration of environmental assessment, and public participation. As the main pilot project for Young Cities Project, the entire area of this site has been designed from urban infrastructure to housing scheme and public space. In other words, it is the site of realization of the particular measures and innovations developed by the research groups of the project (Pahl-Weber et al., 2013). The project was carried out jointly by Technische Universitat Berlin (TU Berlin) as the German lead partner, and the Building and Housing Research Center (BHRC) as the Iranian lead partner, but supplemented on both sides by a wide range of actors from research, economy, and civil society (Seeling and Stellmacher, 2008).

The current study aimed at assess and optimize the proposed water management plan of the Hashtgerd project based on the integrated urban water management approach, and measure the per capita water-saving resulted from implementing best practices.

## 2. Integrated Urban Water Management

Devising centralized systems for water supply, sanitation, and drainage in cities were developed rapidly in European and American cities to boost resiliency toward 19th-century epidemics (Harremoes, 1997; Chocat et al., 2001). In general, urban water management goals are to guarantee access to potable water, services, and sanitation infrastructure, stormwater and wastewater management, protecting resources, restraining water-related diseases, and reducing the risk of water-related phenomena like flood, drought, and landslide (Bahri, 2012). However, Conventional systems contained many adverse economic and environmental impacts associated with this traditional approach to water service provision which was primarily based on conveyance, and centralized treatment and disposal systems (Mitchell, 2006; Mouritz, 1996). These adverse impacts, especially on the natural environment and water resources, necessitated a paradigm shift from conventional management systems to an integrated approach. Integrated urban water management (IUWM), offers a set of principles that underpin better coordinated, responsive, and sustainable resource management practices (Bahri, 2012; Jacobsen et al., 2013). It contextualizes the water sources, water supply, wastewater, and stormwater within an integrated urban water framework to understand the dynamic interactions between the various components of the urban water system (Bahri et al., 2016). Mitchell (2006) summarizes the principles of IUWM as considering all parts of the water cycle, considering anthropogenic and ecological requirements for water, considering the local context, including all stakeholders in the planning and decision-making process, and striving for sustainability. A recently developed term in the sustainable urban water management domain which specifically involves architecture and urban designer professionals are Water Sensitive Urban Design (WSUD), which combines the functionality of water management with principles of urban design and planning (Hoyer et al., 2011). WSUD is seen as a component of Integrated Urban Water Management, as the process of integrating water cycle management with the built environment through design and planning (Sharma et al., 2016; Morgan et al., 2013). In the broad context, WSUD is the integrated design of the urban water cycle, incorporating water supply, wastewater, stormwater and groundwater management, urban design, and environmental protection (Joint Steering Committee for Water Sensitive Cities, 2009). It considers the management of entire water systems (drinking water, stormwater runoff, waterway health, sewerage treatment, and re-cycling) (Hoyer et al., 2011). Based on the given definitions, aspects of the urban water cycle can be identified and discussed in five categories within the WSUD approach: rainwater, stormwater, greywater, sewage, and potable water. In order to devise a framework for urban designers and planners, IUWM general principle and best management practices are discussed in each section. It is important to note that designers and planners should be part of a multidisciplinary team consisting of key stakeholders working on an IUWM plan considering all environmental, social, and economical aspects of every planning scenario that is in line with IUWM general practices (Maheepala et al, 2010). In case that system boundaries are not limited to the city boundary, other specialists should be engaged in the planning process besides urban practitioners. Figure 1, illustrates components of an integrated urban water management scheme. Interactions between urban water cycle components and WSUD show a close relationship between WSUD elements, where adopting best practices in one aspect might also meet other components management objectives. Considering the whole urban water cycle, an IUWM scenario can be devised by employing best practices that are further discussed in the following for each aspect.

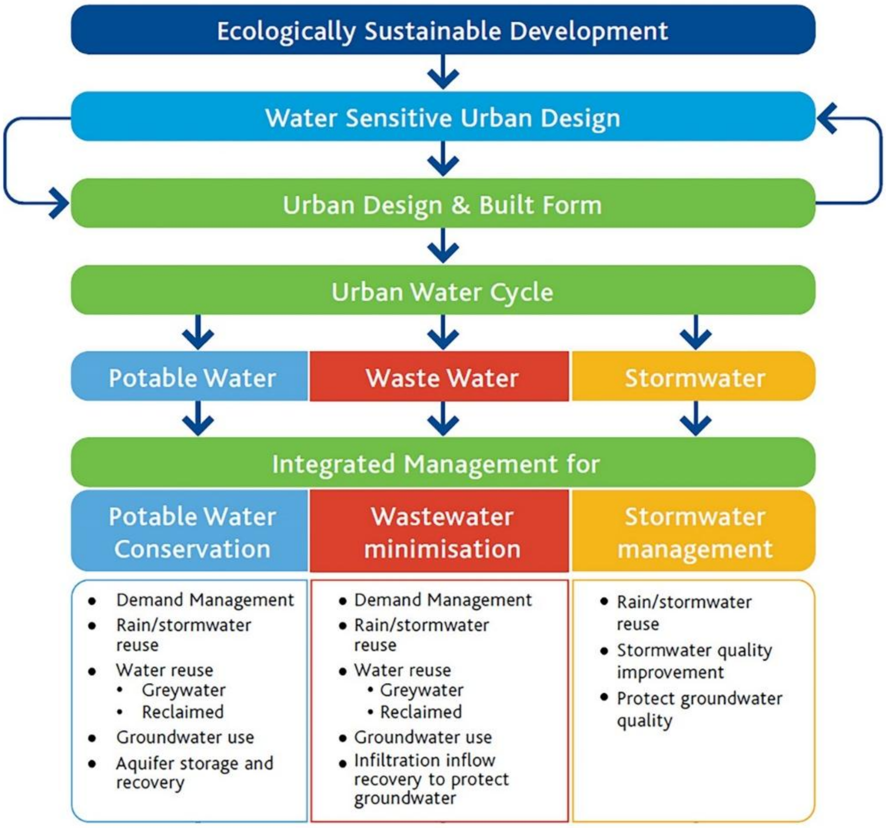


Fig. 1. Interactions between ESD, WSUD and the urban water cycle, demonstrating urban water cycle aspects and general objectives within an integrated management plan. (Source: City of Melbourne WSUD guidelines, 2013)

In rainwater and stormwater management, some principles are mentioned to utilize alternative resources for fit to purpose uses, protecting urban streams by reducing run-off volumes, and reducing loads of stormwater pollutants (Joint Steering Committee for Water Sensitive Cities, 2009). City of Melbourne WSUD guidelines (2013) defines rain/stormwater reuse, stormwater quality improvement, and protecting groundwater quality as principles in stormwater management. These objectives are generally achieved by using decentralized management practices called blue-green infrastructure, which have been clearly listed and discussed by several studies and guidelines (Hoyer et al., 2011; Joint Steering Committee for Water Sensitive Cities, 2009; EPA, 2015; Kookhaei and Masnavi, 2014). Regarding wastewater management and in the sustainable paradigm, wastewater is a resource that should be captured and reused effectively, rather than a nuisance that should be disposed of after treatment (Pinkham, 1999). In this new approach, reclamation and reuse are vital elements, and small/decentralized systems have occasionally proven to be more sustainable than bigger/centralized collection and treatment plants (Ibid). It has also been emphasized on wastewater minimization, which can be achieved through demand management and wastewater reuse (City of Melbourne WSUD guidelines, 2013). Due to differences in pollutant loads, household wastewater is separated into blackwater, and greywater (that requires a lower level of treatment compared to blackwater). On-site greywater treatment has become an interesting option due to instant availability of the reclaimed water for subsequent reuse (Noutsopoulos et al., 2017; Tolksdorf and Cornel, 2017). Natural treatment systems (constructed wetlands) have proven to be efficient, ecological, and low-cost options for greywater treatment (Paulo et al., 2013; Morel and Diener, 2006; Ramprasad and Philip, 2015; Morteza et al., 2011; Khalighi et al., 2011). Actions regarding potable water management generally include employing demand reducing measures, such as water-efficient fittings and appliances and measures like using low water consuming plants for the greenery (xeriscaping). It is argued that using water-efficient devices can solely reduce potable water consumption by 40 percent (Landcom, 2009). Table 1, summarizes the integrated urban water management general practices based on the discussed results, and introduces design and management measures that can be employed by designers and planners in an IUWM-based planning process. Further information of the measures regarding their design considerations and construction details can be obtained from the noted references.

Table 1
Integrated urban water cycle management aspects, general practices, and measures (Hoyer et al., 2011; Joint Steering Committee for Water Sensitive Cities, 2009; EPA, 2015; Allen et al., 2010; Landcom, 2009)

| Aspect | IUWM General practice | Design and Management Measures |
|---|---|---|
| **Rainwater Management** | Decentralized Harvesting | ○ Green Roofs<br>○ Rain Barrels and Cisterns<br>○ Permeable Pavements<br>○ Bioretention Areas<br>○ Vegetated Swales/ Dry Swales<br>○ Curb and Gutter Elimination<br>○ Vegetated Filter Strips<br>○ Sand and Organic Filters<br>○ Constructed wetlands<br>○ Riparian Buffers |
| **Stormwater Management** | Decentralized Management by Blue-Green Infrastructure | |
| **Greywater Management** | Decentralized Treatment and Reuse | ○ Direct Use Systems<br>○ Physical and chemical Treatment Systems<br>○ Biological Treatment Systems |
| **Blackwater Management** | (Semi)Centralized Treatment and Reuse | ○ Physical and chemical Treatment Systems<br>○ Biological Treatment Systems |
| **Potable Water Management** | Demand Management | ○ Water Efficient Fittings<br>○ Water Efficient Appliances<br>○ Xeriscaping |

## 3. Methodology

Since IUWM is an emerging approach, few studies have tried to report a transparent process for adopting its principles into planning of urban water systems. Maheepala et al. (2010), and Jeffcoat et al. (2009), both have recommended subsequent key activities as the IUWM-based planning process to find practical and achievable solutions. Maheepala et al. (2010), perceives the process of applying IUWM principles to urban water planning as a cyclic and spiral process with five key activities and three phases (see Figure 2). Key activities are defined as (Ibid):

1. Convening a key stake holder group responsible for the effective delivery of the IUWM plan.
2. Agree on objectives (based on the problem statement), measures, criteria and methods of analysis.
3. Understanding the current system (to identify potential opportunities to resolve the recognized problem)
4. Assess (base case and alternatives) system Performance (environmental, economic, and social) by quantifying the factors and select portfolios
5. Implementation planning that engages decision makers and stake holders with the final outcomes.

In this framework, the five main activities are repeated in each phase with each activity leading into the next, but the depth of analysis of each activity increases as the process progresses from the centre of the spiral to outwards (Maheepala et al., 2010).

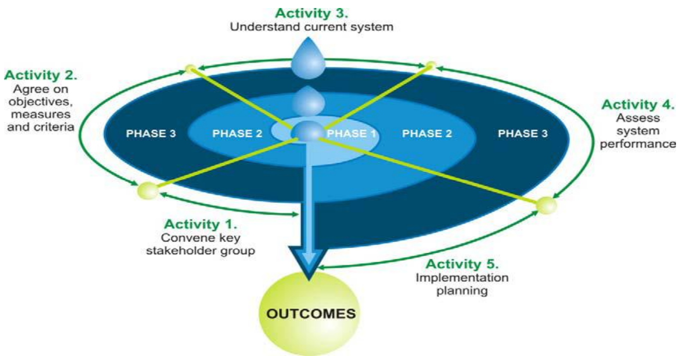


Fig. 2. The IUWM Planning Framework (Source: Maheepala et al., 2010)

Current study focuses on using discussed IUWM principles to assess the Hashtgerd young city project's proposed water management plan and optimize it by offering water management options that are in line with IUWM principles. Although problem statement and objectives that have shaped the existing water plan seem viable, practices to achieve desired set of objectives contradict with the IUWM general practice in occasions. In cases that IUWM best management practices have been suggested in the existing scheme, current study is aimed at assess system performances by quantification of the measures. Runoff water management, wastewater management, and potable water management are three sections in which best practices are discussed (Figure 3).

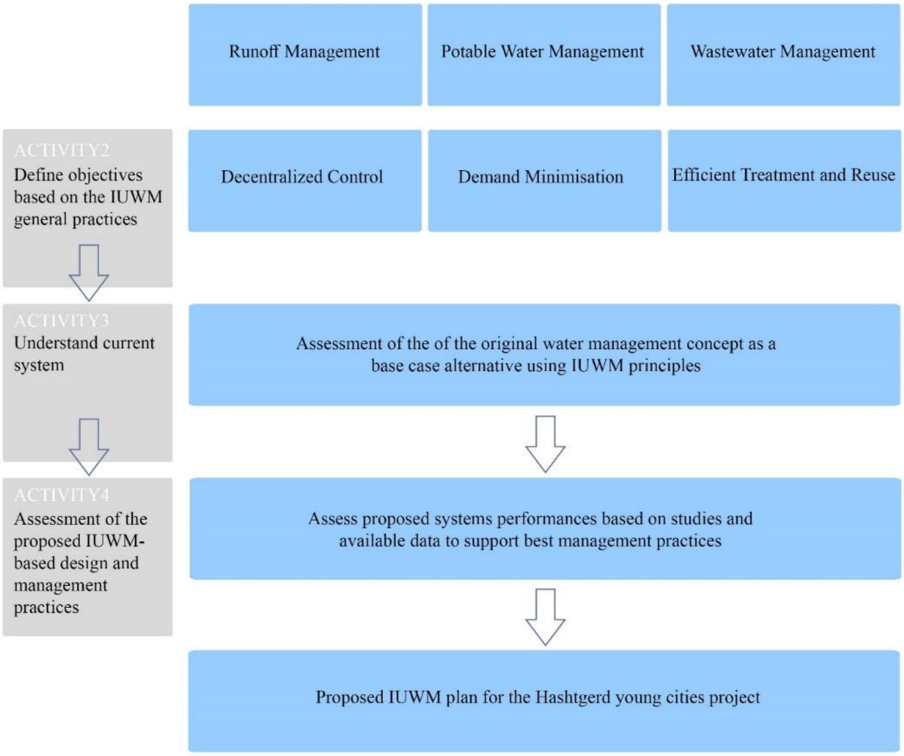


Fig. 3. Flow diagram of the methodology adopted for the present study

In order to present specific schemes for rainwater collection, wastewater treatment, and demand management measures, existing data such as annual rainfall, systems treatment efficiency, and fittings consumption efficiency have been employed. In the end, the total reduction in water consumption is calculated after implementing best management practices. Figures for household water consumption per capita and consumption in each household sector have been assumed based on data released by local authorities. These figures are also vital in calculating greywater supply and demand numbers.

## 4. Research Findings and Discussion

### *4.1. Assessment of the hashtgerd young cities project water management concept based on the iuwm approach*

Developing an integrated and sustainable water supply and wastewater disposal concept in Hashtgerd New Town has been the project's aim in water management plan. The next step was to test how transferable the experiences from the pilot project are onto the whole city and other regions of Iran (Inter3 GmbH, 2013). This approach to the Hashtgerd project's planning concepts as the best planning practices in Iran semi-arid new town developments emphasizes the importance of sustainability assessment of the proposed water management concept. The proposed water management plan for the project is based on saving water and energy by reducing water consumption, and saving water and energy by recycling wastewater in wetlands (Pahl-Weber et al., 2013). In this plan, blackwater and greywater are collected in separate sewers. Greywater is treated in constructed wetlands and then reused for irrigation and drainage, and blackwater is treated in a central treatment plant. Stormwater and rainwater are collected along roads and conveyed into infiltration pits where after a mechanical pre-treatment are allowed to infiltrate into the surrounding soil (Ibid.). Although proposed plans in wastewater and demand management that are based on treatment-reuse and using water-saving devices conform to IUWM principles, assessment of systems' functions and their commitment to water saving is not cleared. The proposed water plan in stormwater and rainwater management is based on the conventional approach of centralized collection and mechanical treatment, which contradicts IUWM emphasis on using blue-green infrastructure for decentralized/in-situ control and treatment.

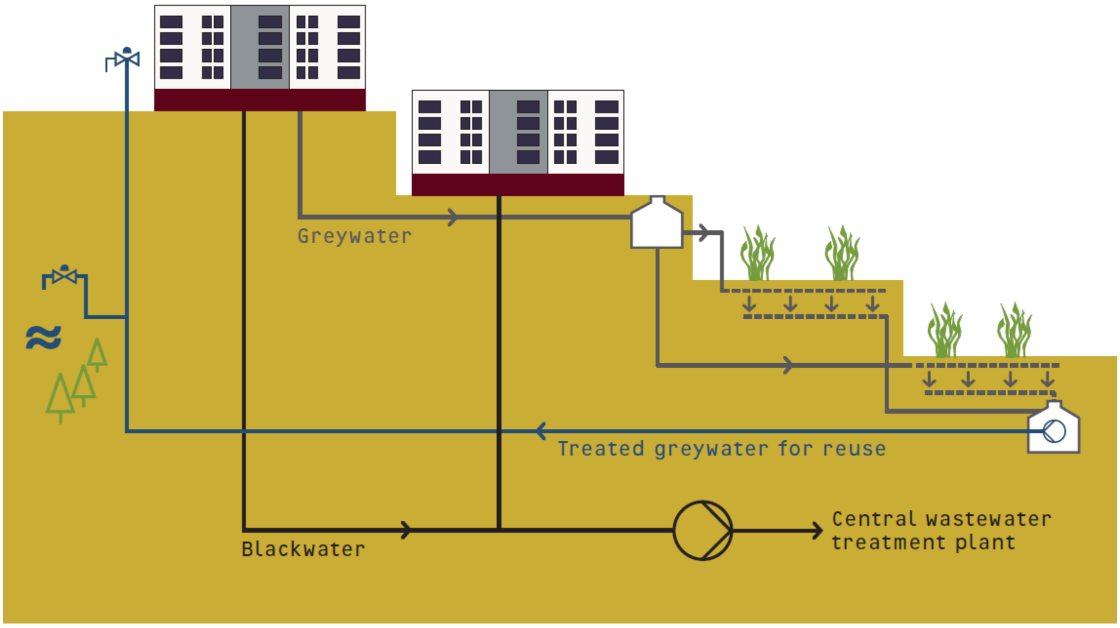


Fig. 4. Proposed wastewater concept (Source: Pahl-Weber et al., 2013). Besides the irrigation, treated greywater can also be used to meet indoor usages. The proposed concept does not provide data regarding the estimated savings.

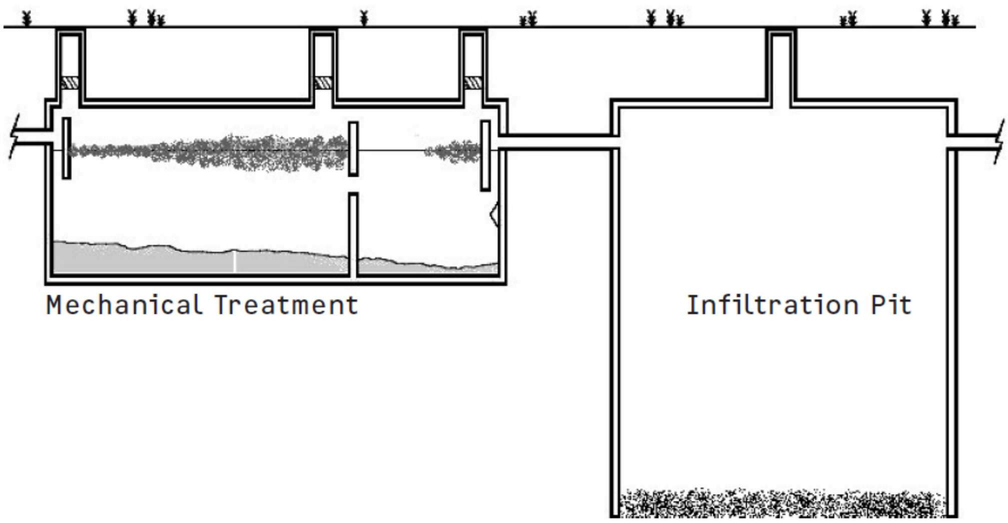


Fig. 5. Proposed rainwater treatment system (Source: Pahl-Weber et al., 2013). The proposed system is based on the conventional conveyance and centralized mechanical treatment approach that contradicts the IUWM principles.

In the following, best practices in an integrated water management plan for the Hashtgerd project and their commitment to ultimate water savings are discussed in mentioned three sections.

*4.1.1. Stormwater runoff management*

Based on studies, Hashtgerd plain suffers from overexploitation which has led to constant groundwater table level drop (144 mm annually) and subsequent land subsidence. With annual precipitation of 240 mm in the site, groundwater recharge is measured 7 mm annually, considering the fact that the evaporation rate considerably exceeds the recharge rate in the region (Saadati et al., 2009). This shows the imbalance in utilization and emphasizes on the importance of employing efficient practices to increase groundwater recharge.

Based on the importance of protecting aquifers and considering the multifunctionality of decentralized vegetated systems in control, treatment, and infiltration of runoff, swales and rain garden (bioretention) systems are suggested as the best practices in stormwater management. In this plan, rainwater collected from rooftops is conveyed to rain gardens located in the center of each block, where can gradually infiltrate into the permeable planted soil. Runoff originated from road surfaces is directed to vegetated swales and conveyed into marginal rain gardens. Overflow is led into the stream located in the western margin of the site, improving natural habitat and aesthetics. Figure 6, illustrates the runoff management plan for a typical residential block in site proposed by this study.

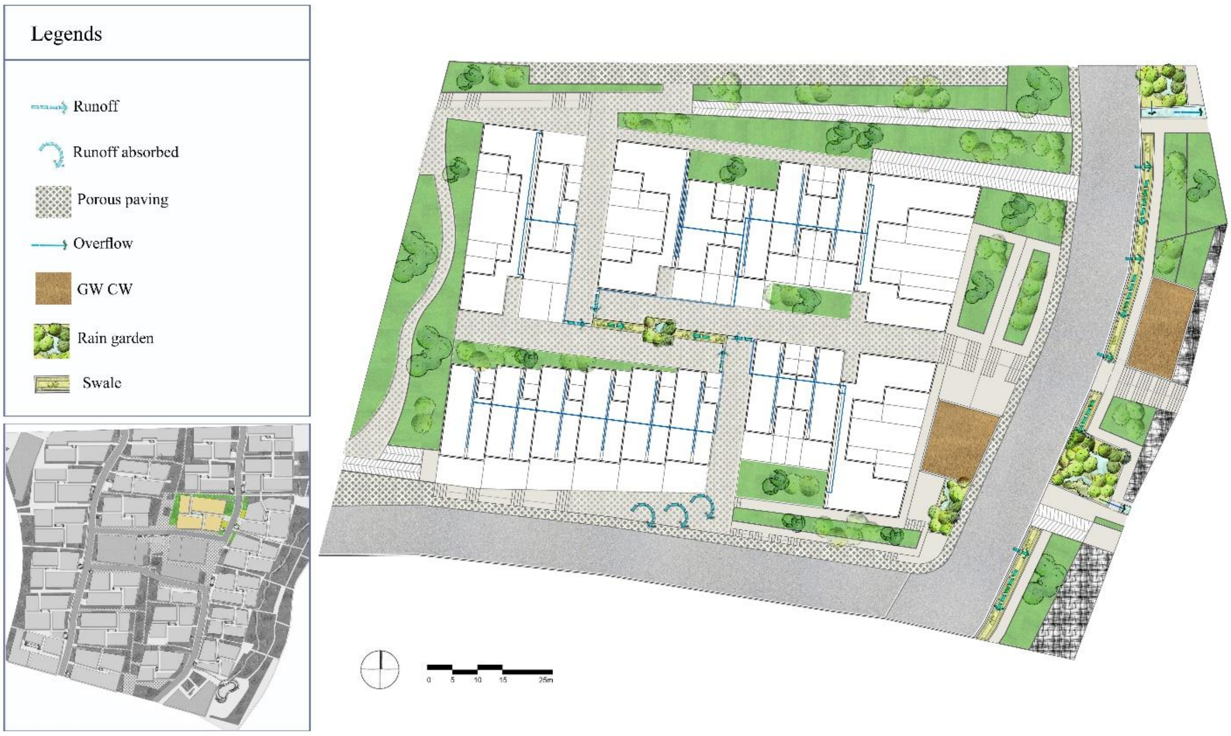


Fig. 6. Proposed runoff management plan based on the IUWM approach for a typical residential block demonstrating employed best design and management practices. Rainwater is collected from rooftops and conveyed into a central rain garden. Runoff originating from roads is directed into swales, and ultimately into marginal rain gardens. Porous paving, allows for infiltration across the paved surfaces in the site (Source: research findings, base map provided by Pahl-Weber et al., 2013).

In order for the runoff to be directed into swales, roads and pedestrian walkways must be slightly sloped towards them. Vegetated swales help slow runoff, facilitate infiltration and filter pollutants as runoff flows through the system (EPA, 2015). In this scheme (and also in the original plan), greywater treatment constructed wetlands have also been improvised beside the roads. Here, potential overflow of the constructed wetlands can be directed into swales and rain gardens. Figure 7, demonstrates a section of the proposed road design, including constructed wetland and swale details.

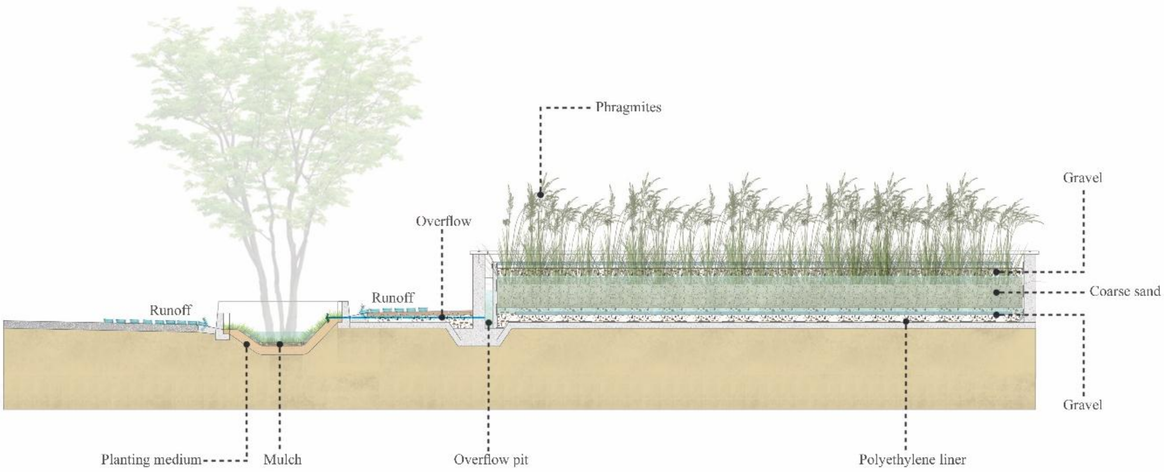


Fig. 7. Road and pedestrian walkway design section demonstrating WSUD components. Overflow from greywater treatment constructed wetlands (GW CW in Figure 6) is directed to vegetated swales (Source: research findings).

*4.1.2. Potable water management*

Showers, toilets, and faucets are devices in which using water-efficient fittings and saving solutions would result in significant consumption reduction (Landcom, 2009). Based on the existing data, water consumption per capita in Hashtgerd is estimated to be 210 liters per day (Water and Sewerage Department of Alborz Province). Based on the performance assessments, employing water-efficient showerheads, 6 liters toilet flush tank, and water-efficient taps can reduce total consumption by 33 percent, falling to 141 liters per capita per day. This number will decrease further by about half, after reusing treated greywater for fit to purpose water uses. Table 2 demonstrates water consumption per capita by household uses which has been assumed based on an average of available studies and Iranian ministry of energy water consumption unofficial reports. Acquiring Hashtgerd authentic water uses data was beyond the scope of this study, and requires employing consumption monitoring devices.

Table 2
An assumption of household water uses based on the daily water use of 210 liters per capita in Hashtgerd new town. After implementing water efficient fittings and appliances, a total saving of 33% is achieved. In absence of available authentic data, water uses data have been assumed based on Landcom (2009); and Iranian ministry of energy water consumption data. Water saving performance of efficient fittings and appliances are based on Landcom (2009).

| Household water uses | Per capita per day Liters (no water-efficient fittings) | Per capita per day Liters (using water-efficient fittings | Water saving % |
|---|---|---|---|
| Shower | 70 | 28 | 30 |
| Toilet | 42 | 24 | 43 |
| Washing basins | 18 | 9 | 50 |
| Kitchen sink | 21 | 21 | |
| Washing machine | 28 | 28 | |
| Air conditioning | 7 | 7 | |
| Drinking and Cooking | 10 | 10 | |
| Irrigation | 14 | 14 | |
| Total | 210 | 141 | 33 |

*4.1.3. Wastewater management*

The removal efficiency of a greywater recycling system comprised of a vertical flow constructed wetland and mechanical pre-treatment is measured to be above 90 % for major pollutants (Ramprasad and Philip, 2015; Morel and Diener, 2006). The effluent of such system can be reused for a range of indoor and outdoor purposes (Ibid.).

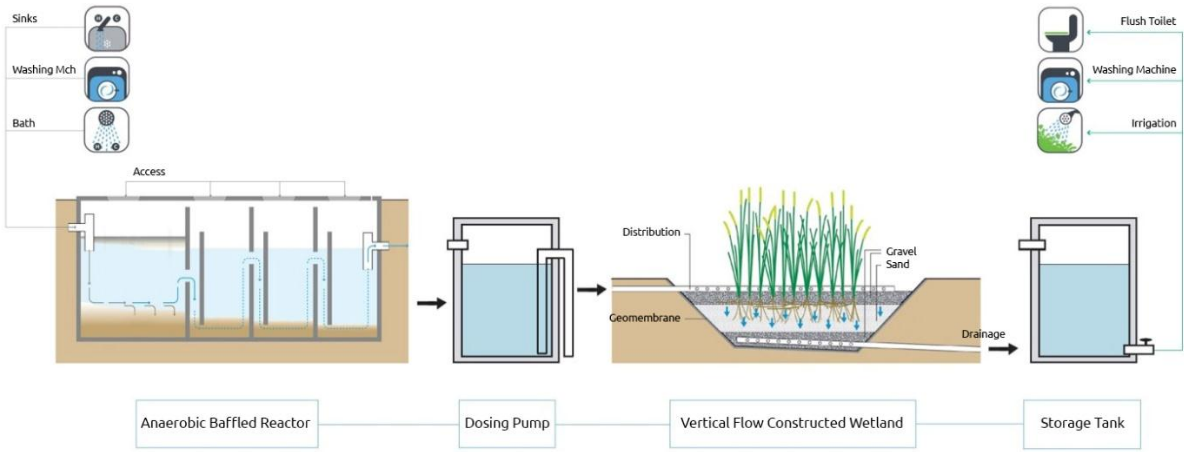


Fig. 8. Schematic of the proposed greywater treatment and recycling system for each residential block based on the system performance and sustainability measures, including greywater supply and treated greywater demand (Source: research findings)

In the suggested treatment system (Figure 8), sinks, washing machine, and shower are the suppliers of greywater which are estimated to comprise 61 % (86 liters per capita per day) of a total 141 liters daily water consumption per capita based on calculations (after implementing water-saving devices). This number conforms to the studied share of household greywater supply of the total consumed water that is between 50-80 % (Siegrist et al., 1976; Gross et al., 2007). Suggested demand purposes for treated greywater are irrigation, washing machine, and toilet flush tanks which comprise 47 % (66 liters) of the daily consumption and can be wholly met by treated greywater supply. Table 3, demonstrates potable water and treated greywater shares in meeting household water demands based on previous discussions. With treated greywater meeting 47% of the total water demand, demand for potable water would decrease to 75 liters of the total 141 liters per capita per day.

Table 3
Calculated demands for treated greywater and potable water in residential blocks. Greywater supplies are marked with * in the table. As mentioned before, greywater supply exceeds greywater demand number and can wholly meet treated greywater demand uses.

| **Household water demand by uses** | **Per capita per day (liters)** | **Consumption share %** |
|---|---|---|
| **Potable water:** | **75** | **53** |
| Air conditioning | 7 | 5 |
| Shower* | 28 | 20 |
| Drinking and Cooking | 10 | 7 |
| Washing basins* | 9 | 6 |
| Kitchen sink* | 21 | 15 |
| **Treated greywater:** | **66** | **47** |
| Irrigation | 14 | 10 |
| Toilet | 24 | 17 |
| Washing machine* | 28 | 20 |
| **Total** | **141** | **100** |

Based on this data, recycling greywater for the mentioned purposes would solely reduce tap water consumption by 47 percent. Figure 9, demonstrates water supply and demand for potable water, greywater, and blackwater in typical residential buildings. As it has been depicted, a dual supply system for potable and treated greywater is a necessity in the plumbing scheme. This dual piping should also be considered for the system outputs, including greywater that is treated in the demonstrated system, and blackwater that is collected via the sewer system. As a third input component to the building system, rainwater is collected via roof drains and directed into rain gardens located in each block for groundwater recharge.

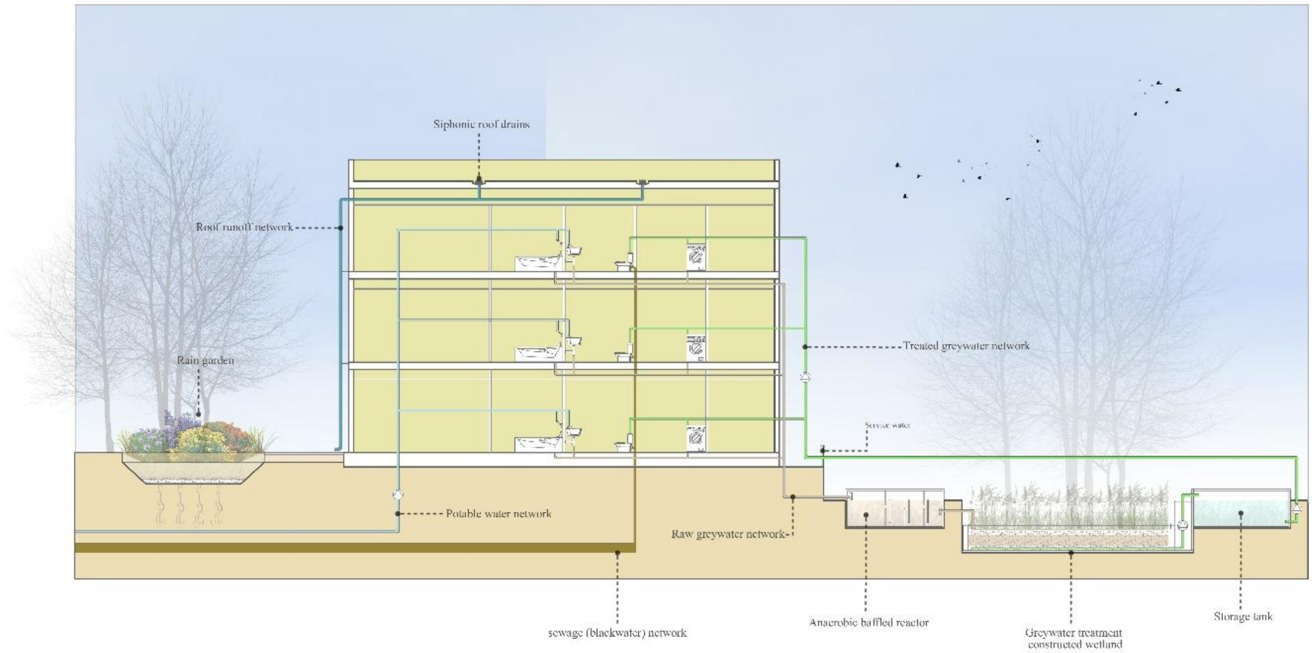


Fig. 9. Block section demonstrating water supply and demand in buildings, treatment and reuse system, rainwater harvesting by roof drains and rain garden detail (Source: research findings)

### *4.2. Concluding the iuwm plan for the hashtgerd project*

Table 4, concludes the proposed water management concept based on the IUWM approach in contrast to the project’s original water management concept.

Table 4
Hashtgerd Young Cities Project proposed water management concept based on the IUWM approach (Source: research findings)

| Aspects | IUWM-based Objectives | Original Management Concept<br><br>Source: Pahl-Weber et al., 2013) | IUWM-based Management Concept |
|---|---|---|---|
| **Rainwater Management** | Harvest and decentralized groundwater recharge | Groundwater recharge in centralized infiltration pits | Conveyance of the harvested rainwater into decentralized rain gardens for groundwater recharge |
| **Stormwater Management** | Decentralized control | | Decentralized management by employing swales, rain gardens, and permeable paving |
| **Greywater Management** | Treatment and reuse | Treatment in vertical flow constructed wetlands and reuse for irrigation | Treatment in vertical flow constructed wetlands and reuse for irrigation and fit for purpose indoor uses (enhancement and assessment of the proposed system of the original plan) |
| **Blackwater Management** | Treatment and reuse | Treatment in centralized Hashtgerd plant and reuse for irrigation | Treatment in centralized Hashtgerd plant and reuse for irrigation |
| **Potable Water Management** | Demand minimization | - | Employing water efficient fittings and appliances |

Implementation of an IUWM plan consisting of WSUD components such as swales, rain gardens, and constructed wetlands can ultimately improve the aesthetics of urban spaces and bring citizens closer to nature. It can also support flora and fauna in urban habitat, reducing the gap between natural and urban settings (Figure 10 and 11).


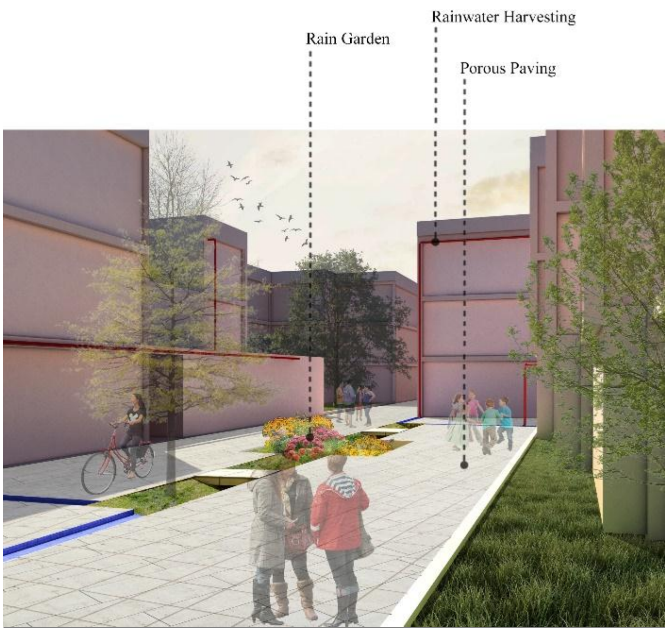


Fig. 10. and 11. Project’s neighborhood public spaces after implementing WSUD components

## 6. Conclusion

This study sought to organize the aspects, objectives, and best design and management practices of the integrated urban water management approach in order to enable architects and planners to implement WSUD practices effectively. Practices were categorized into five sections: rainwater, stormwater, blackwater, greywater, and potable water management. While stormwater management practices can be employed by urban planners to manage run-off water more efficiently and create multi-functional urban infrastructure, wastewater and demand management practices can significantly reduce potable water consumption. The results of the case study showed that after implementing water-efficient fittings and appliances and using reclaimed greywater for certain purposes, potable water consumption per capita decreases from 210 liters to 75 liters per day, with an approximately 65 percent decrease in consumption. Although all these aspects must be considered in order to form an integrated plan, based on the context of each project one of the urban water cycle elements might be identified as the main component of the problem statement and emphasized in strategic planning. For instance, in arid urban areas where precipitation is rare and freshwater resources are scarce, recycling wastewater and demand management are crucial, while in wet climates or regions where receive considerable amounts of rainfall and flood is frequent, stormwater management is the planning priority.

It’s important to note that achieving an IUWM plan requires full implementation of an IUWM-based planning process that is based on an IUWM planning framework considering all stakeholders, problem statement and objectives, understanding the context, assessment of the proposed systems, and implementation planning. In such a framework, architects, urban designers, and planners can be defined within the key stakeholders group working on the urban water management portfolio. Designing rainwater harvesting systems and integration of greywater treatment systems into design are aspects that can directly involve architects, especially if certain codes necessitate addressing them within a strategic planning framework. Beyond the scale of single buildings, stormwater management and water infrastructure proposals are specifically within the expertise of urban designers and planners. The current study can be regarded as a framework for designers and planners who are involved in an IUWM planning process, rather than a full implementation of the mentioned process for the specific Hashtgerd project.

The results of this study can also be used in new towns development strategic planning in Iran, based on the fact that developing new towns is one of the macro policies of the Iranian government. Planning blue-green infrastructures that are based on decentralized/in-situ water management can increase urban spaces aesthetics, livability, and economic engagement in such development schemes, besides the ecological functions. In wastewater management, separate collection of greywater and blackwater, and construction of a dual piping system in buildings that delivers drinkable and non-drinkable water is a requirement for wastewater minimization, a matter that should preferably be foreseen in the design phase. Greywater treatment by decentralized natural systems can provide a reliable and permanent water supply for purposes such as indoor usages and irrigation to improve urban greenery, which is specifically beneficial in arid regions. Based on the complexities, centralized, or semi-centralized treatment plants are still considered as the best practices for blackwater management in urban developments.

In the final analysis, legislation in urban water management based on the IUWM approach seems an important step to secure water efficiency in urban areas. Water efficiency in single buildings can be assessed by clear measures (rainwater harvesting, greywater reuse, or employing water efficient fittings) in a point-based system, as it has been addressed in the LEED system. However, only 5 out of the 69 possible points in LEED are directly associated with water efficiency. In Iran, such a point-based system can be defined within the National Building Regulations for water efficiency in buildings, based on the IUWM principles. The prerequisite for such legislation and incentives is developing national guidelines on IUWM practices by a team of experts. Such localized guidelines can also be used in adopting water sensitive urban design practices in new towns developments and urban restoration projects.

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