Ethiopian Institute of Architecture Building Construction and City Development/**EiABC**/

Application of curb extension for sustainable stormwater management of local streets in waterlogging lands: The case of residential areas in Addis Ababa.

by

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Master's Thesis Submitted to Addis Ababa University for the Partial Fulfillment of Master of science degree in Urban Design and Development.

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This is to certify the thesis prepared by Tsega Beyene Dehine, entitled: Application of curb extension for sustainable stormwater management of local streets in waterlogging lands: The case of residential areas in Addis Ababa, submitted to Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), Addis Ababa University for partial fulfillment on the requirements for the Degree of Masters of Science in Urban Design and Development complies with the regulation of the university and meets the accepted standard with respect to originality and quality

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Declaration

I, the undersigned, declare that this thesis prepared for the partial fulfillment of the requirements for the degree of Master of Science in Urban Design and Development entitled "Application of curb extension for sustainable stormwater management of local streets in waterlogging lands: The case of residential areas in Addis Ababa." is my original work and has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged.

Tsega Beyene Dehine

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Confirmation

This thesis can be submitted for examination with my approval as a university advisor.

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Abstract

The application of sustainable stormwater management system in waterlogging areas of urbanized catchments is the most effective method that helps to control surface stormwater runoff caused by recurrent and extreme rain events. Applying a bio-retention system for flood reduction through infiltration and evapotranspiration processes will help to create an attractive urban street with better environmental performance. Since cities are becoming more impervious, the stormwater runoff increases and will affects the downstream land and water bodies by flooding. In Addis Ababa, applying a sustainable stormwater management system is a timely act due to the ongoing rapid urbanization and increment in impervious surfaces that result in stormwater runoff that causes flooding and surface water pollution. In this regard, innovative and flat terrain considerate design responses are needed in low-lying plains with difficulties to apply conventional pipe-based drainage systems. The design intervention will reduce the waterlogging effect occur due to extreme rain events. The objective of the research is to apply curb-extensions as a bio-retention system for sustainable stormwater management of waterlogging local streets in the low-lying residential areas of Addis Ababa. Specifically, the study identified areas affected by peak stormwater flow that creates a waterlogging problem over local streets of the case study area. A sustainable design solution is proposed by considering the infiltration, retention, and evapotranspiration capacity of curb-extensions. The study identified flooding and waterlogging areas in the city, at the river catchment, and in the study, site using hydrological and spatial data. Using ArcGIS-based hydrologic analyst tools, blue spots located along the flow direction of the streams identified as depressions usually experienced an overflow of stormwater and waterlogging. To minimize the risk of waterlogging, a sustainable design solution as a curb extension system designed by estimating the water balance from the actual water holding capacity of natural depression (blue-spot) and the stormwater runoff generated from the catchment area that naturally drained into the specific blue-spot. The curb-extension system was designed as a bio-retention and streetscape element by modifying the native soil, gravel fill, water intake plants on the top of the system for infiltration and retention purpose. In this regard, the designed curb extension will substantially manage the highest intensity of precipitation (40 mm/hr) of 10 years of rain event from IDF curve of Addis Ababa. The design reduces the volume of stormwater runoff from 22.895 m3 to 8.477 m3, which is 62 % of runoff. The study concludes that if the municipality of Addis Ababa develops a curb-extension system over the local streets of the entire neighborhoods affected by waterlogging, the flooding problem will be reduced substantially with more greening & environmental benefits. The system will also contribute to the reduction of downstream flooding by minimizing stormwater runoff flowing into the Akaki river system. As a multifunctional drainage design facility, the system has the potential to create a green street that helps to improve the standard of living and boost the environmental quality of the area. Finally, the study recommended further study on the upscaling of proposed curb-extension by developing more empirical and experimental settings as a pilot project. The pilot projects will help the city to consider the curb-extension system for the greening, drainage design, and urban planning practices. Moreover, the tests and demonstration works will justify its competency for improving the livability and livelihood of the local people within urban settings that were frequently affected by waterlogging.

Keywords: Blue spots, peak runoff, IDF curve, bio-retention, infiltration.

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I would like to thank the staff of the Akaki Kality sub-city office for the overall assistance to provide infrastructural and land surface data. Moreover, thanks to the local community members for their willingness to locate flood-prone and waterlogged areas. In this regard, I appreciate the contribution of Akaki Kality woreda 07 local community members.

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Acronyms

EPA	The U.S. Environmental protection Authority
UDS	Urban drainage system
μm	Micrometer
mm	Millimeter
Cfs	Cubic feet
UN	United nations
DEM	Digital Elevation Model
USGCRP	U.S. Global change research program
GIS	Geographical information System
QGIS	Quantum Geographical information System
IDF	Intensity duration frequency
RS	Remote Sensing
U.S units	United states customary units
S.I units	International system of units.
CSO	Combined sewer overflow
ITRC	Interstate technical and environmental regulatory Council
LSM	Landscape based storm water management

Chapter I: Introduction

In urban and developed areas, impervious surfaces such as pavement and roofs prevent precipitation from naturally soaking into the ground. Instead, water runs rapidly into storm drains, sewer systems and drainage ditches and can cause flooding, erosion, turbidity (or muddiness), waterlogging, storm and overflow, and infrastructure damage. However, stormwater design and "green infrastructure" capture and reuse stormwater to maintain or restore natural hydrology's (Kazak et al, 2018).

Green infrastructure can successfully be implemented in lowland areas to manage urban waterlogging, runoff, and flooding. Although the use of green infrastructure practices on the lowest slopes must be considered early in the planning and design phases, design approaches are available to customize green infrastructure practices that are appropriate for use on a range of lowlands (Soils,2014). Implementing green infrastructure components is a significant strategy to improve water quality and helps to acquire multiple community benefits. Stormwater management by green infrastructure consider as structural or non-structural practices that mimic or restore natural hydrologic processes within the built environment. Common green infrastructure practices include permeable pavement, bio-retention facilities, and green roofs (Soils, 2014). These practices complement conventional stormwater management practices by enhancing infiltration rate, storage competence, and evapotranspiration throughout the built environment and managing runoff at its source.

The unmanaged runoff caused by a combination of excessive rainfall, poor external drainage, poor internal drainage of the surface cause waterlogging with the inability of the soil to infiltrate much water. Presently practiced drainage measures cause water pollution, environmental and infrastructure degradation. Bio-drainage, in which the property of transpiration of trees is used to strike a water balance and check the rise of groundwater table above critical depth, can be an option to control waterlogging (Kapoor, 2000). Bioretention features/curb extensions/ has a major significance to practice these drainage measures. As many natural processes occur within these curb extension cells, infiltration, storage by retention can reduce runoff volumes and attenuates peak flows. The vegetation and the soil composition biological and chemical reactions occur in the mulch and soil matrix filter the stormwater through vegetation and soil (Lukes & Kloss, 2010).

1.1. Background of study

Stormwater curb extensions can be used in a variety of land uses from highly urbanized commercial streetscapes to low-density residential streets. Currently, curb extensions are applied to use in steep slope conditions for capturing runoff from upstream catchments. They also serve as stormwater tools to help maintain the hydrologic balance of an area using withdrawal of groundwater by plantations to avoid waterlogging and pick flows with the rise of groundwater table that helps maintain the water balance of the site (Fabry et al, 2010).

With various ongoing developing cities in Ethiopia, Addis Ababa is considered as one of the urbanized areas in the country. From the city development procedure, the impact of imperviousness causes increasing runoff as a serious environmental problem affecting the city. During the rainy season, many residential areas of the city are flooded and waterlogged disturbing infrastructure outline and sometimes claims the lives of people. An increase in the built-up structure, river buffer degradation, poor solid waste management, and low coverage of stormwater drainage structures are the causes for the occurrence of floods in the city (Assefa & Mpyanga, 2016).

Considering the surface flooding the groundwater table also have an impact on the waterlogging and flooding problem (Abiye et al, 2009). The groundwater depth map of the Addis Ababa area is prepared from April/May 2000 boreholes inventory data shows lower groundwater table at the central and the Southern part of the town. Especially at some places of Filwoha, Lideta, and Kality areas exhibits artesian groundwater conditions. The confinement at the central part of the town varies from 23 to more than 100 meters. The confinement is maximum along elongated strip north-south direction (Filwoha, Lideta, Mekanisa, Lafto, Kailty) and the confinement decreases both in the eastern and western direction from this elongated strip. Most of the shallow groundwater area at the north of the town is unconfined. A large proportion of the central part of the town is under confined groundwater conditions with groundwater depths varying from 0 to 40 meters. The depth of the groundwater in general, increases in the south direction. There are also deep groundwater areas more than 120 meters depending on the topography of the area (Abiye et al,2009).

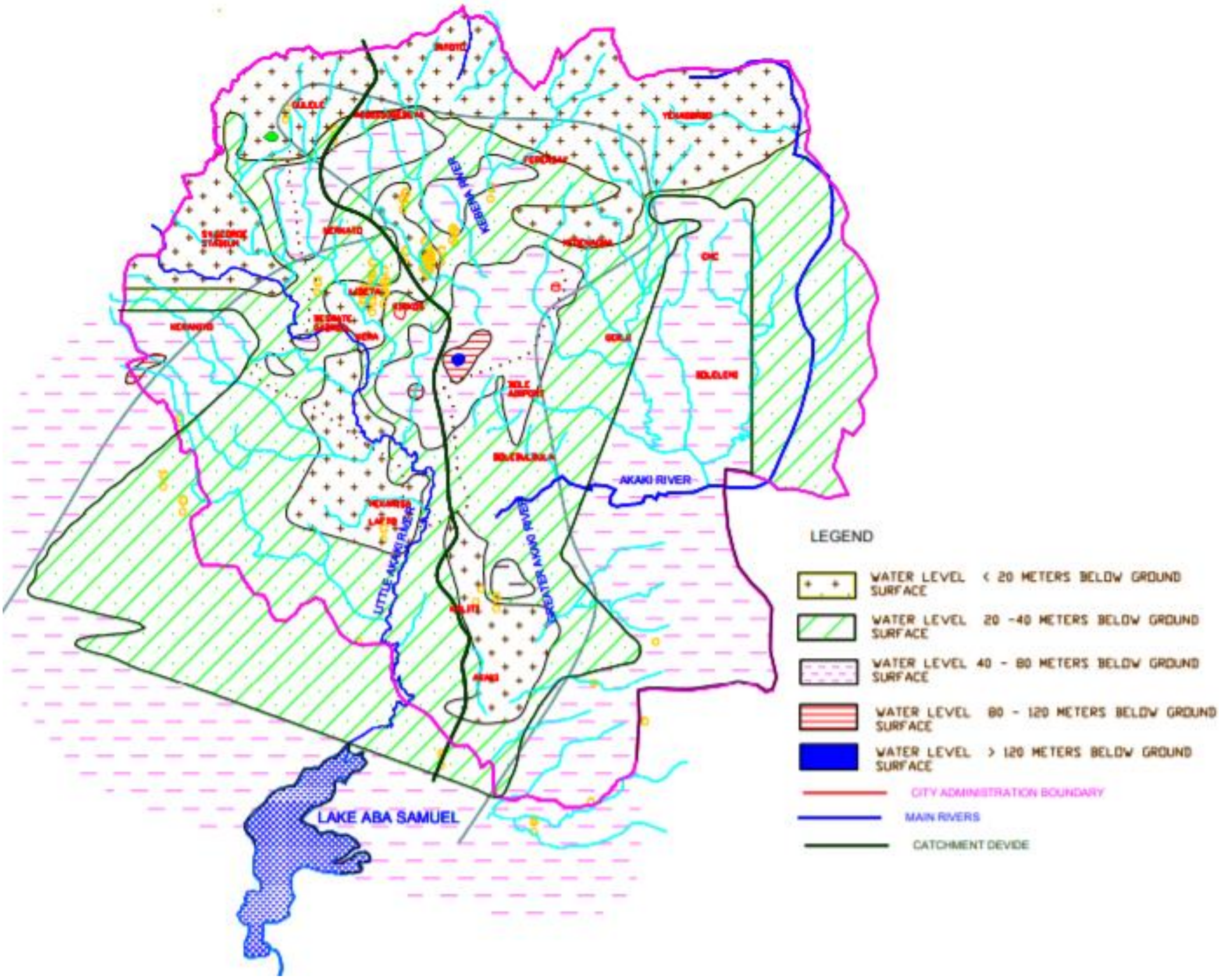


Figure 1: Groundwater depth of Addis Ababa (Source: Borehole inventory data of AAWSA,2000).

The southern sites with definite depth of groundwater table have a combination of low permeability subsoils, thin topsoil's which also with a low permeability character (Engida,2001). There are types of soil most susceptible to waterlogging effect particularly they occur on low slope areas. Mainly sandy and heavy textured clayey soils have these waterlogging effects. The sandy surface of soils enhances water infiltration while the clay subsoil can inhibit drainage within the profile. Sandy topsoil's store less water and lose less water by evaporation than do clayey soils. Clay soils are waterlogged when the water ponds on the surface and saturates the soil outline from the top downwards. Whereas Sandy soils saturate from the clay subsoil upwards (Cox & Mcfarlane, 1995). Such sites with these soil characters and with a high level of unconfined aquifer waterlogged even in years of low rainfall especially, in areas where there are infrastructural problems. In Addis Ababa these problems mainly occur on local roads with poor material finishing and workmanship.

1.2. Problem statement

Urbanization has a negative impact on the natural drainage pattern and increases urban floods in cities and towns of our planet. Densely populated towns and cities with less green infrastructures, face waterlogging and flooding during heavy rainfall. These are common phenomenon mostly in developing nations (Anisha and Hossain,2014). The stormwater generated from heavy rainfall due to lack of planned stormwater management system and poor infrastructure development considering the topography of the area causes waterlogging at low land areas. The hydrological and environmental processes that occur in the catchment area can be affected by the urbanization of the area due to the increase of imperviousness on the surface. The increase in impervious areas leads to a higher runoff peak flow even for a short duration of low-intensity rainfall causing flooding.

In urbanized catchment of residential areas, mainly pervious roads face the problem of waterlogging. Presently practiced drainage measures on the roads cause flash flooding and infrastructure degradation. Considering the site there are some fluctuations in the water table level from season to season. Otherwise, the groundwater system over a period of time reaches a state of equilibrium and remains fairly stable. With the advent of flooding when a large quantity of water is brought from the outside area, the state of equilibrium is disturbed and the groundwater table no longer remains stable. Depending upon the quantity of net incremental recharge, the groundwater table starts rising and continues to do so until a new balance is reached. As long as the balance is not reached, the water table continues to rise and may come up to the ground surface or rise even higher, causing waterlogging. Ultimately, evaporation from the ground surface in a waterlogged area and the surface of formed water pools along with other withdrawals strikes a balance with the quantity of recharge (Kapoor, 2000).

On the lower surface of the site waterlogging intensity close to the soil surface perched water levels rise, and the water levels stay long close to the surface. Moreover, the waterlogging intensity differs from time to time and it reaches its highest peak during the wet time of the year (Cox & McFarlane,1995). These waterlogging effect causes a major distraction on the infrastructure system of the urban development. In Addis Ababa mainly local cobblestone roads in residential areas experience such problems. Patches are created due to stagnant water on the roads making those very risky and the roads remain unrepaired for many days, creates blockage on the drain. The major waterlogging problem is related to stormwater generation in residential areas developed over low-lying plans. Groundwater table have an impact on the stormwater accumulation on paved surfaces & streets. Lack of sustainable waterlogging solution in lower slop areas, specifically for the local streets of neighborhoods causes major waterlogging problem which causes ineffective balance of surface and groundwater systems. Considering these research fissures the aim of the present study design green infrastructure curb extension on low land sites of Addis Ababa on the local streets of the residential area to achieve water balance, to avoid waterlogging and property damage. These are taught by managing the site slope character (which controls runoff volume), water immersing intensity of the road (considering soil character), and also considering the vegetation typology (uses to control groundwater table through evapotranspiration). These help to gain well-performed road infrastructure with no drainage and waterlogging problem and with better environmental performance.

1.3. Objective of the study

General objective

To evaluate the applicability of curb extension for sustainable stormwater management on streets developed over low slope area of Addis Ababa with waterlogging Problem.

Specific objective

- To map areas with waterlogging problems in Addis Ababa city and identify a local street as case area.
- To design curb extension as a sustainable waterlogging management system and peak runoff solution for local street.
- To estimate the efficiency of the curb extension that reduces stormwater runoff and waterlogging intensity.

1.4. Research question

- Where do waterlogged areas found in Addis Ababa city and what's their general characteristics?
- What kind of sustainable curb extension design needed considering the site rate of runoff and logging intensity which is established over a local street with waterlogging problem?
- On what level effectiveness the design curb decreases the stormwater runoff and waterlogging intensity?

1.5. Significance

The study focused to solve waterlogging problem considering the site stormwater runoff, waterlogging intensity, slope, and infiltration capacity. It has a major relevance towards:

- The local communities and direct users of the infrastructure. The study helps to improve the drainage system into a green nature-based solution.

- To the local planners and authorities on the design implication. Which the study helps to provide a sustainable way of managing waterlogging in terms of cost and effectiveness for the long-term base.
- For policymakers at the local and city level. Considering it as a guideline for the planning of sustainable nature-based drainage system.
- For Academia, as a reference for other research purposes.

1.6. Scope

Since the study covers Addis Ababa site with the case area of Akaki Kality sub-city, analyzing the peak stormwater runoff rate and risk evaluation taken place on the local road. Thematically the research is focused on surface and groundwater hydrology of urbanized portion of low-lying plains with roads surface condition, soil type, and vegetation study for the design that are used for testing the applicability of curb extensions.

1.7. Limitation

To perform these designs and its analysis steps there are some unfavorable conditions:

- It's hard to manage the overall Addis Ababa region numerical value because of the high number of bulky data it has to be analyzed.
- Hard to find the advanced DEM data with 5m cell size to gain an exact number of quantification and measuring during data analysis.

1.8. Work Flow

The research structure layout considering the existing facility data input and the qualitative analyzed out puts.

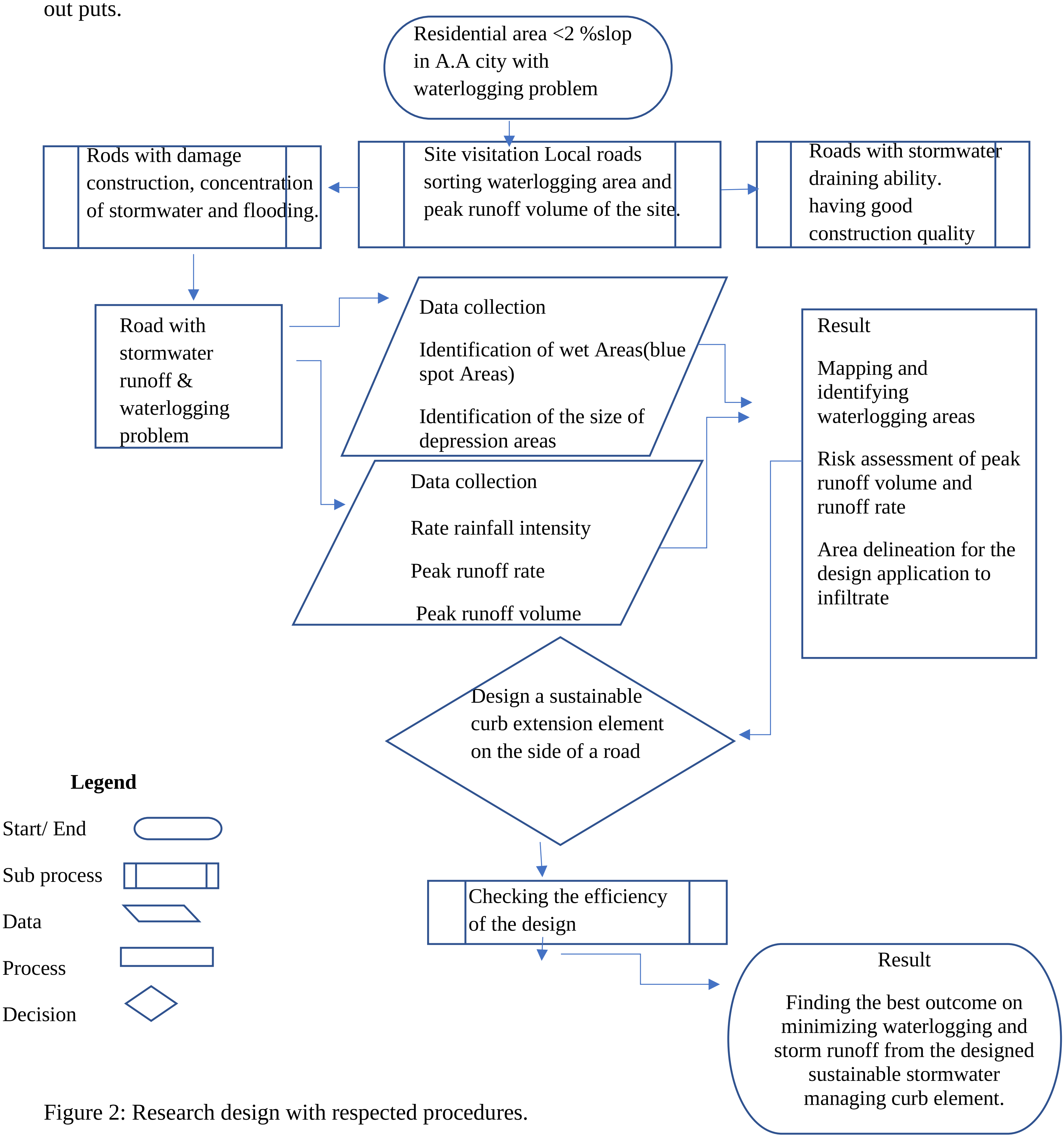


Figure 2: Research design with respected procedures.

Chapter II: Literature Review

2.1. Definition of concept and terms

Urbanization:

Urbanization plays a significant role to progress and develop the human civilization because it radically changes the basic foundation of the ingredients of social, economic, political, and cultural structures of society and the country as well (UN, 2011). Sustainable development can be acquired with the implementation of successful urban planning but a city or town even a country can be gradually unsuitable for a living if, the urbanization process is unplanned and haphazard. The United Nations announced in 2007 that people have passed a long transition period of urbanization where 50% of the world population has been living at the first time in cities from rural areas and it is predicted that only 66% of the world population will be urbanized in 2050 (UN, 2011).

In context to developing countries, most of the urban growth is unplanned, leading to rapid densification, and the associated construction of buildings resulting in a dramatic increase in impermeable areas due to paving and built-up areas. The demand for housing and commercial amenities naturally follows as a result of population growth. And the urbanization process adds roads, rooftops, parking lots, sidewalks, and other imperviousness to the landscape. The increase in impermeable areas caused by urbanization has a number of important impacts on the hydrological response from a catchment related to:

1.Increasing impervious surfaces and compaction of soil leads to a reduction in infiltration capacity of catchments.

2.Reduced surface (depression) storage capacity because impervious urban surfaces are much ‘smoother’ than natural surfaces.

3.Decreased evapotranspiration due to the loss in the natural retention capacity of soil, reduced vegetation wetting, and interception by plants.

A combination of these factors results in a loss of natural attenuation capacity and runoff from urban catchments is characterized by increases in run-off velocity (often measured as time of concentration), runoff volumes (i.e. the proportion of precipitation that becomes runoff), discharge rates, and flood peaks and development of flooded waters sink at certain areas (Bajracharya et al, 2015).

Stormwater runoff:

Stormwater runoff or overland flow is the portion of precipitation reaching the ground that does not infiltrate into soils, is not taken up and evapotranspiration by plants, nor is it dissolved into the atmosphere. It is an especially important component of the hydrological cycle in urban areas since it can cause both pollution and flooding risks to nearby waterways and their adjacent communities. Higher frequencies of more severe storms are likely to further increase the pollution and flooding risks posed by stormwater runoff, especially in urban areas (USGCRP, 2009).

Runoff can be directly correlated with specific land use. Runoff associated with a forested landscape will typically be less than runoff from an urbanized landscape. Stormwater volume and runoff rates are directly related to the impervious surface area in a watershed. Land development and urbanization typically increase impervious surfaces. An increase in peak runoff volumes generally results in the alteration of stream channels, natural drainage ways, and riparian habitats (Göbel et al, 2007).

The processes of urbanization exert multiple pressures on the hydrologic cycle. Specifically, increases in impervious surface result in increased hydraulic efficiency in urban catchments (Putnam 1972, Johnson and Sayre 1973), and can cause substantially decreased capacity for a given landscape or region to infiltrate precipitation with a concomitant increase in the production of runoff (Booth 1991, Hsu et al. 2000, Hey 2001), shorter times of concentration or lag times (Sauer et al. 1983, Rhoads 1995) and decreased recharge of water tables with a corresponding decline in base flows (Klein 1979, Smakhtin 2001).

Waterlogging:

Urban waterlogging, a representative type of urban flooding, refers to the phenomenon in which a rainstorm or a short-term period of heavy rain surpasses the capacity of the urban drainage system, which results in a waterlogging disaster. Due to global climate change and rapid urbanization, urban waterlogging has become a serious problem in urban areas worldwide. This has resulted in socio-environmental problems such as property damage, traffic paralysis, water pollution, and economic losses (Zhang et al, 2018).

An impervious surface is considered one of the main factors affecting urban waterlogging. Previous studies found that spatial pattern (composition and configuration) of impervious surfaces affected urban waterlogging. However, their relative importance remains unknown, and the scale-effect of the spatial pattern on urban waterlogging has been ignored.

Many factors are influencing urban waterlogging such as topography, land subsidence, irrational land use planning, and additional features. Among these factors, the increase in impervious surface area, extreme rainstorms, and poor drainage infrastructure were universally acknowledged as the three primary driving forces of urban waterlogging (Zhang et al,2018). A few studies explored the relationship between the impervious surface area and the spatial pattern of urban waterlogging risk spots in urban regions. Previous studies found that the composition of the impervious surface (the impervious surface area) reduced the total infiltration of water into the surface and, thereby, increased the surface runoff and peak discharge, which ultimately raised the associated risk of urban flooding. In addition, several studies showed that the spatial configuration of the impervious surface influenced surface runoff and the potential urban flood risk as well. However, most previous studies primarily highlighted the importance of the location of the impervious surface (e.g., upstream, midstream, or downstream) in an urban watershed or catchment to define the influence of the spatial configuration of the impervious surface. This may not be sufficient considering the high spatial heterogeneity in the urban context (Zhang et al,2018).

Sustainable urban storm management:

As a part of the land development process urban stormwater is managed by the construction of engineered stormwater facilities, such as storm sewers and detention basins. These construction processes are specifically designed to modify the natural hydrology of a site (Theis & Tomkin,2015). There are three basic strategies for stormwater management:

- Using techniques that encourage the infiltration of stormwater into soils to decrease the runoff volume before it reaches the sewer system (selective grading and plantation of vegetation to reduce the rate of flow from the site).
- Using techniques that encourage the temporary storage of stormwater on-site, instead of transporting the runoff stormwater off-site for centralized detention.
- Using techniques that also allow some degree of longer-term retention and treatment of the stormwater by natural processes before it is discharged, such as the construction of artificial wetland (Theis & Tomkins, 2015).

Vegetated curb extensions /Bioretention's/ .

Stormwater curb extensions are landscape areas that extend into the street and capture stormwater runoff. Conventional curb extensions (bulb-outs, chokers, chicanes) are commonly used to increase pedestrian safety and help calm traffic. A stormwater curb extension has the benefit of allowing stormwater to flow into the landscape space to manage the runoff volume and also shares the same attributes of the conventional curb extension. This landscaped space can be planned considering the physical characteristics of vegetated swales, planters, or rain gardens depending on the available space and specific site conditions (Fabry et al, 2010).

Stormwater curb extensions are particularly beneficial in retrofit situations because they can often be added to existing streets with minimal disturbance. The small footprint of stormwater curb extensions allows for an efficient stormwater management system that often performs very well for a relatively low implementation cost. Stormwater curb extensions can be applied in different land uses from low-density residential streets to highly urbanized commercial streetscapes. For use of green street applications, curb extensions should have check dams installed for street slopes over 2%. For streets slopes over 5%. The interior of the curb extensions should be terraced with check dams and performed as a series of planters. Stormwater curb extensions can be planted with a variety of trees, shrubs, grasses, and groundcovers depending on site context and conditions (Fabry et al, 2010).

2.2. Urbanization and waterlogging as a global phenomenon

It is considered that a waterlogging situation is an environmental hazard as well as a global issue (Bastawesy and Ali, 2012). Because of its challenging situation particularly in the low-lying areas. Sometimes waterlogged is found to create due to geological as well as structural control, morphological factors (Merot et al., 1995; Holden et al., 2009), and sometimes it is due to human-caused activities like haphazard construction of roadways, buildings, built-up areas, essentially in the urban areas (Li, 2012). Waterlogging may be permanent and sometimes maybe seasonal based on the time scale. Waterlogged areas are found in the low-lying areas with insignificant slope variation since water remains stagnant in there. The obstructions of the drains create as well as increase the problem of waterlogging (Hussain and Irfan, 2012).

Generally, when an area has low relief variation surrounded by highlands then their accumulated water of rains and/ or intruded water from rivers, canals, seas create a waterlogged environment. In this context surface soil (Hossain and Uddin, 2011; Maryam and Nasreen, 2012) is also important as it holds water and where surface water cannot penetrate the inner level from the ground level then there waterlogging is found. Groundwater level very near to the ground surface is also favorable for generating waterlogging over the land surface in an area. In the lower areas of the city, where relief variation is feeble there due to complex factors of the nature-human relationship waterlogged areas are found to be initiated in the low-elevated, low sloped areas with haphazard distributions of ridges.

For the proper land use management, it is necessary to measure and prepare maps on waterlogged areas. But it is a difficult task due to the physical complexity of the delineation of the waterlogged areas to the researchers, planners, and government authorities as well (Sahu, & Bengal, 2018).

2.3. Cause and effect of waterlogging in urbanized areas.

Along with the rapid development of the city, its flood discharge and storage facilities are also blindly constructed, lacking excellent planning and layout. The green space and surrounding roads of most communities are rarely designed to meet the needs of flood prevention and drainage. Also, the proportion of public green space and flood storage facilities are generally small and unevenly distributed. The position of green space is lower than roads, resulting in poor drainage and water storage. When the flood comes, it can't be discharged in time, which will make waterlogging. All of these are caused by not enough considerations in planning and design. The Major idea of urban planning and construction is reflected in the alteration of a large number of permeable surfaces into roads and buildings-based impermeable underlay surfaces. But the urban rainwater scheme should follow the strategic idea of rapid discharge into rivers, making the speed increased and the runoff greatly increased in the same intensity of rainfall (Wang, 2018).

In general waterlogging is caused by a combination of manmade and natural factors. Poor external drainage (runoff) and poor infrastructure developments can cause a major waterlogging and storm runoff problem in the urbanized area. And the existing factors that affect and considered during waterlogging problem are, excess rainfall (for the site), poor internal drainage (water movement in the soil profile), the inability of the soil to store much water, soil typology and its hydrological character, groundwater table depth of the area, the topographical character of the site, rainfall events considering dry and wet years and landforms considering the slop of the area (Cox & McFarlane 1990).

The rapid expansion of the city has brought about "cement" and "hard ground", resulting in a decrease in the urban pervious area and poor infiltration of rainwater on the ground. Which leads to stormwater runoff and waterlogging problems that affect the drainage and sewage management of the city. The road and transportation management by washing away the soil (erosion and scouring), by making the road body less resistant to traffic i.e., weakening the load-bearing capacity, by depositing soils (silting) which may block the passage of water, or by washing away the full sections of the road or its structures and also due to the stagnation of water it can cause spreading disease with water crisis.

2.4. Mitigation strategies for waterlogging.

Surface runoff and water stagnation were traditionally considered undesired water and was needed to be diverted as completely and as fast as possible from urban areas. Management of stormwater quantity for flood and waterlogging prevention was the prime concern, especially in the developing nations. However, subsequent paradigms on stormwater management diversified to include quality, ecosystem health, reuse (re manage), integration with urban design along quantity. The emergence of novel stormwater and waterlogging management approaches designed to minimize impervious cover and maximize infiltration of rainfall is known as Low Impact Developments (Guo, 2017).

Some of the principles based on causes of waterlogging in the light of recent experiences and lessons for sustainable city development are following:

- Creating a proper drainage system so that the water can shift away easily.
- There should be continuity of water flow among the rivers.
- A solid waste management system should be directed properly so that water can flow easily at its natural speed.
- Creating a proper way to manage the proper run-off of rainwater which creates waterlogging on the road.
- Initiate preparation of a comprehensive action plan for the sustainable recovery of the affected infrastructure (HASAN et al, 2000).

In detail, the sustainable strategies to deal with the increasing challenge of city waterlogging and stormwaters can be managed with planning for more green-infrastructure, using low impact development strategies, minimize impervious surfaces, encourage curb extensions and riparian buffers along roads and waterways, encourage tree planting especially in urban settings, promote landscaping with native vegetation to further reduce runoff and to increase infiltration rate to avoid waterlogging and on general governmental consideration coordinate planning of infrastructure, housing, and transportation under the new climate change regime(Guo, 2017).

2.5. Identifying Spatial and Hydrological Facts.

During the last decades, information technologies have been developed intensely and have changed a modern approach to problem-solving. Among them, GIS has drawn increasing attention. GIS is a system designed to capture, store, manipulate, analyze, manage, and ultimately present all types of geographical spatial data (Khatami & Khazaei, 2014). In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology (Foote and Lynch, 2009). Due to its influential skill of spatial data analysis, GIS has different applications and hence is of high interest in various fields of study. The need for a systematic approach for modeling, analyzing, and/or present huge amounts of data that spatially and temporally distributed could be answered by GIS. Water resources engineering as a multidisciplinary field requires modeling and examining spatially distributed data with different spatial resolutions. Therefore, GIS is indeed a suitable tool for solving water resources problems (Khatami & Khazaei, 2014).

Hydrology is one of the growing fields that recently include GIS, GIS-based models, and RS to solve different issues within the field. The major reason for such incorporation is linked to the fact that the hydrological cycle and its related procedures are dynamic systems whose elements are varying temporally and spatially. This creates a spatial dependency that could be easily covered by GIS which provides various spatial data as an input for different variables needed for hydrological models (Foote and Lynch, 2009). Involving a different kind of spatial data could become very helpful as there would be no requirement to make many simplifying assumptions. Generally, the application of GIS allows covering a greater extent of reality. Further, it could enhance the prospect of a 3D method approach for distributed models. For instance, the water movement could be monitored in several spatial locations and different directions. Such applications could be employed for a flood management or control system.

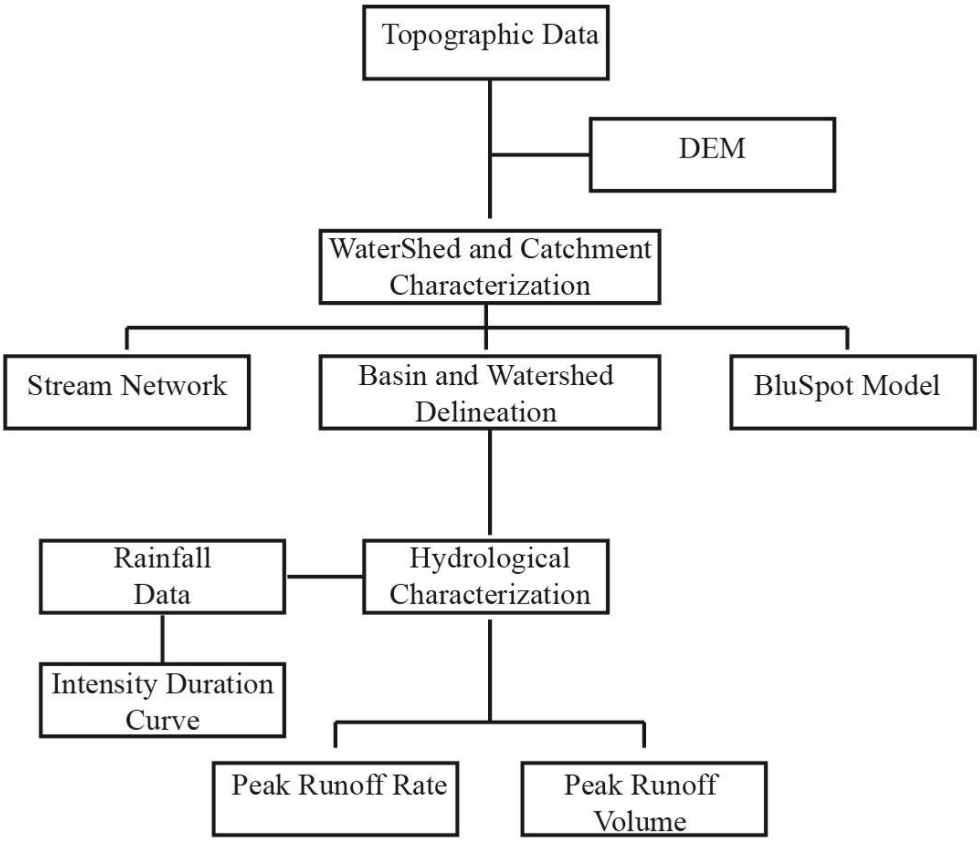


Figure3: The overall work layout using Spatial and hydrological data

2.5.1. Identifying Waterlogging Areas

Waterlogging area identified using the blue spot model, which is a development of screening method to assess flood risk on the surface of the catchment areas. These methods have the possibility of identifying flood sensitive areas on the road network. These flood sensitive areas refer as blue spots. They express as areas where flooding is expected to take place in case of extreme rainfall. The blue spots can be identified and delineated based on previous experience, but new spots will appear on the road network when precipitation increases. Steps taken to analyze the blue spot areas:

- Screening using terrain analysis all the depressions are identified. Assuming a surface runoff of 100% in the catchment means with no infiltration of rainwater into the soil (Zerger 2002). Low-lying areas where there is a danger of flooding due to the rising of groundwater table are identified. Ditches are included so that no flooding behind the ditches occurs unless water levels exceed their height.
- Rain sensitivity analysis took place for individual depressions: Flow paths and catchment areas for each blue spot are calculated, (Maksimović et. al. 2009). Simple calculation from contributing areas. "Risk map" with the amount of precipitation needed to fill low-lying areas. Assuming no drainage from depressions. Rain sensitivity analysis with impermeability of the catchment area of 20, 40, 50, 60, 80 & 100%.
- The hydrodynamic model of surface reservoirs and depressions provides a time-variable flooding prediction (Nielsen et al, 2011).

2.5.2. Identifying Peak Runoff Rate and peak runoff volume

Calculation of peak stormwater runoff rate from a drainage area is often done with the Rational Method equation Q=CiA. Calculations with the Rational Method equation often require the determination of the design rainfall intensity and the time of concentration of the watershed (Bengtson, 2011).

The Rational method is suitable for estimating peak discharges considering small drainage areas of take up to 200 acres (80 hectares) with no significant flood storage. The method provides a peak discharge value but does not provide a time series of flow nor flow volume (Bengtson, 2011).

Assumptions and Limitations

To use of the rational method as a hydrological analysis technique the following assumptions and limitations have to be considered:

- The method is used if t_{ime} of concentration for the drainage area is less than the duration of peak rainfall intensity.
- The calculated runoff is directly proportional to the rainfall intensity.
- If the rainfall intensity is uniform throughout the storm duration.
- If the frequency for the peak discharge occurrence is the same as the frequency of the rainfall taken place at that event.
- If rainfall is distributed uniformly over the drainage area.
- The rational method does not consider water storage mechanism in the drainage area. Available storage is assumed to be filled (Mark & Marek, 2011).

The Rational Method equation actually used to calculate peak stormwater runoff rate is: Q = CiA (U.S. units), or Q = 0.0028 CiA (S.I. units) where:

A = The area of the watershed (drainage area) that drains to the point for which the peak runoff rate is needed (acres for U.S. units) (ha for S.I. units)

C = Runoff coefficient for drainage area A. A physical interpretation is the faction of rainfall landing on the drainage area that becomes stormwater runoff. (dimensionless for both U.S. and S.I. units)

i = The intensity of the design storm for peak runoff calculation (in/hr for U.S. units) (mm/hr for S.I. units)

Q = The peak stormwater runoff rate from the drainage area, A, due to the design storm of intensity, i. (cfs for U.S. units) (m3 /s for S.I. units).

<u>Rational Method Runoff Coefficients</u>

Since the physical understanding of the runoff coefficient is the portion of the rainfall on the watershed that becomes surface runoff, its value must be between one and zero. The value of the runoff coefficient for a given drainage area depends primarily on three factors: the soil type, the land use, and the slope of the watershed (Bengtson, 2011).

	FLAT	ROLLING	HILLY
Pavement & Roofs	**0.90**	**0.90**	**0.90**
Earth Shoulders	0.50	0.50	0.50
Drives & Walks	0.75	0.80	**0.85**
Gravel Pavement	**0.85**	**0.85**	**0.85**
City Business Areas	0.80	**0.85**	**0.85**
Apartment Dwelling Areas	0.50	0.60	0.70
Light Residential: 1 to 3 units/acre	0.35	0.40	0.45
Normal Residential: 3 to 6 units/acre	0.50	0.55	0.60
Dense Residential: 6 to 15 units/acre	0.70	0.75	0.80
Lawns	0.17	0.22	0.35
Grass Shoulders	0.25	0.25	0.25
Side Slopes, Earth	0.60	0.60	0.60
Side Slopes, Turf	0.30	0.30	0.30
Median Areas, Turf	0.25	0.30	0.30
Cultivated Land, Clay & Loam	0.50	0.55	0.60
Cultivated Land, Sand & Gravel	0.25	0.30	0.35
Industrial Areas, Light	0.50	0.70	0.80
Industrial Areas, Heavy	0.60	0.80	**0.90**
Parks & Cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland & Forests	0.10	0.15	0.20
Meadows & Pasture Land	0.25	0.30	0.35
Unimproved Areas	0.10	0.20	0.30

Impervious surfaces in bold
Rolling = ground slope between 2 percent to 10 percent
Hilly = ground slope greater than 10 percent

Figure 4: Runoff coefficients for different surface materials (source: Runoff coefficient fact sheet,2011).

Rainfall Intensity

The rainfall intensity (I) is the average rainfall rate in in./hr. for a specific rainfall duration and a selected frequency. The duration is assumed to be equal to the time of concentration. These data can be found from the regional Intensity-Duration-Frequency (IDF) curves.

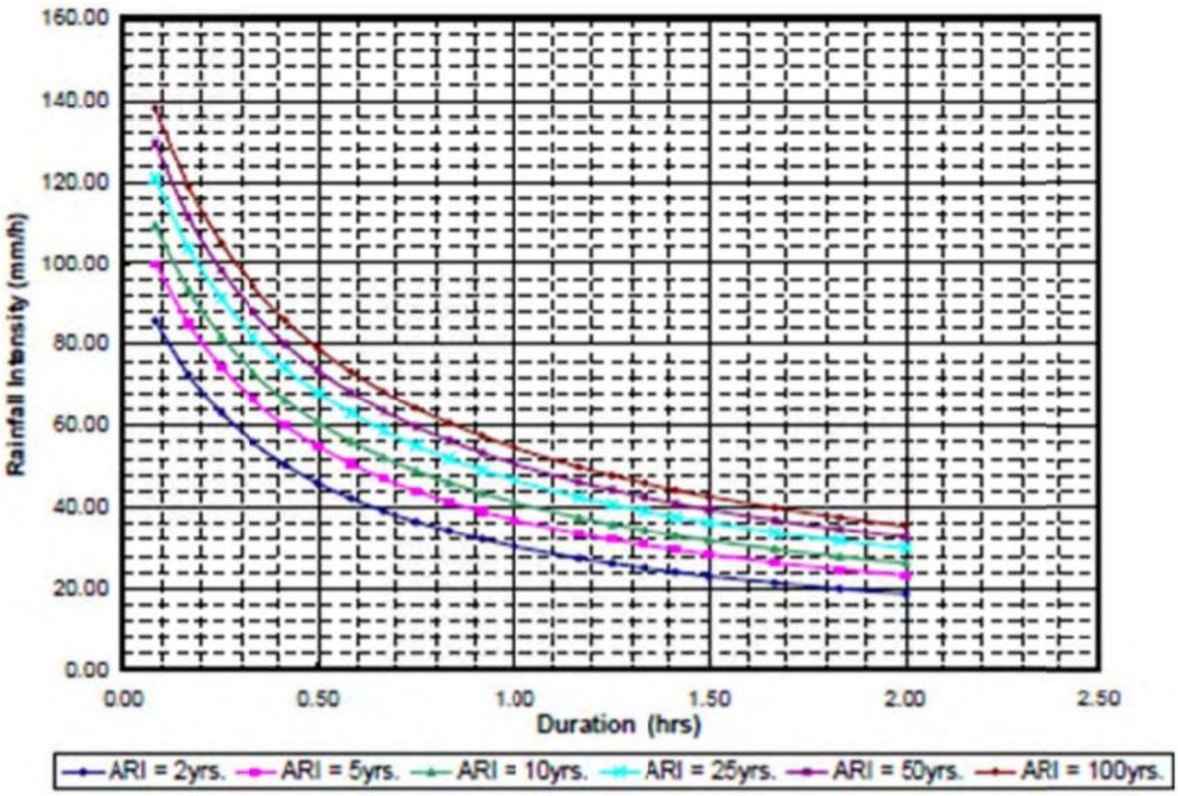


Figure 5: Intensity duration frequency curve Addis Ababa Bole Observatory
(Source: National Metrological Authority of Ethiopia,2002).

2.6. Resolving mechanisms of waterlogging and stormwater runoff using curb extension and bio drainage facilities.

Vegetated curb extensions, also called stormwater curb extensions, are landscaped areas that capture stormwater runoff in a depressed planting bed. The landscaped area can be designed similar to a rain garden or vegetated swale, utilizing infiltration, retention, and evapotranspiration for stormwater management (Vanaskie et al, 2010).

Infiltration technique on roadside curb extension /Bulb outs/

Infiltration is the process of entry of water into the soil by the vertical and descending surface layer or the passage of water from the surface into the soil. Water undergoes gravity and descends through soil profiles, then it precedes water storage and retention in soils. According to Angelotti Netto and Fernandes infiltration can be considered as the property of soil that reflects its physical conditions and structural stability. The process of water inflowing to the soils is important to recharge the aquifers, to maintain the base flow of rivers, the permanence of water in the river basin, and greater availability of water for the development and maintenance of the vegetation cover. Percolation is the process where water circulates in the soil, not following, as a rule, a downward flow. Once infiltered, the water begins to percolate in the aeration zone, reaching the saturation zone. When the water contribution finishes at the surface, the infiltration stops, the moisture inside the soil is redistributed going from the surface in the soil with lower water content, to the deeper layers. The Flow of water into dry soils is highest at the beginning of the rainy season when precipitation rates are higher than infiltration, then undergoes an exponential decrease until it reaches a constant input of water into the soil (basic infiltration).

The infiltration rate is described as the amount of water flowing through a unit area of the soil surface by a unit of time. Many of the problems related to erosion, mass movement, sedimentation, and water amount are affected by infiltration rates because the greater is the soil capacity to absorb rainwater, the smaller the runoff and, therefore, the lower the erosivity of this phenomenon.

The process of infiltration can be affected by some factors such as those related to:

- The type of soil which can be mentioned: texture, structure, porosity, organic matter content, clay type, retention capacity, and hydraulic conductivity
- Natural factors such as precipitation, humidity, changes in seasons and temperatures, and
- Surface factors that modify the water-air interface and causes changes in the water.

Table 1: Infiltration rate of soils (source: Mishra & Singh,2013).

Type	Description	Typical Infiltration Rate (in/hr) (1)
A	Sands, gravels	>1.0
B	Sandy loams with moderately fine to moderately coarse textures	0.5-1.0
C	Silty-loams or soils with moderately fine to fine texture	0.17-0.27
D	Clays	0.02-0.10

Groundwater conditions at the project site must be evaluated before selecting, siting, sizing, and designing infiltration measures. Infiltration may be precluded if less than10 feet (3.04 m) of separation is maintained between the lowest flow line or invert elevation of an infiltration structure and the seasonal high groundwater. In all cases, at least five feet (1.5 m) of separation must be maintained between the flow line or invert of an infiltration structure and the seasonal high groundwater or mounded groundwater levels (Bloorchian et al,2016).

Retention technique on roadside curb extension /Bulb outs/ due to void ratio

The soil water retention function determines the relation between the volume of water retained by the soil, expressed by θ, and the governing soil matric, or suction forces (Dane and Hopmans, 2002). These suction forces are typically expressed by the soil water matric head (strictly negative) or soil suction (strictly positive). These suction forces increase as the size of the water-filled pores decreases, as may occur by drainage, water uptake by plant roots, or soil evaporation. Also known as the soil water release or soil water characteristic function, this soil hydraulic property describes the increase of θ and the size of the water-filled pores with an increase in matric potential as occurs by infiltration. Since the matric forces are controlled by pore-size distribution, specific surface area, and type of physicochemical interactions at the solid-liquid interfaces, the soil water retention curve is very soil specific and highly nonlinear. It provides an estimate of the soil's capacity to hold water after irrigation and free drainage (field capacity), minimum soil water content available to the plant (wilting point), and root zone water availability for plants (Vereecken et al,2008).

Void ratio is defined as the void volume to the volume of the solid existing in the soil. It expresses by the term e. Here, the term Vs is soil solids volume and V_V is voids volume.

$$e = \frac{V_V}{V_s}$$

Void ratio is closely related to porosity. Porosity n is defined as the percent of void volume to the total volume.

$$e = \frac{n}{(1-n)}$$

<u>The significance on the properties of void ratio.</u>

- The parameter of soil volumetric change is found using void ratio value. Uniform and continuous samples were used to determine the void ratio.
- The void ratio value differs accordingly with its composition and density. The value is higher in the loose soil like sand and it comparatively lower in dense sand-like clay.
- The value for dense sandy gravel sand is around 0.3 and that of loose sand is around 0.6. In the case of the clayey soil, it can differ from 0.5 to 1.0 and the value of void ratio decreases with soil layer depth.
- Void ratio is the main factor that affects soil permeability. And permeability increases when there is a higher void ratio value.

<u>Evapotranspiration technique on roadside curb extension /Bulb outs/</u>

Evaporation and transpiration occur at the same time and there is no easy way of clarifying between the two processes. Apart from the water availability in the topsoil, the evaporation is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing of vegetation to the ground area. After the growth of the plantation (green element in the curb extension), transpiration becomes the main process. In the partitioning of evapotranspiration into evaporation and transpiration is plotted in correspondence to leaf area per unit surface of soil below it. At sowing, nearly 100% of ET comes from evaporation, while at full crop cover more than 90% of ET comes from transpiration (Abtew & Melesse 2012).

The evapotranspiration rate is normally expressed in millimeters (mm) per unit time. The rate expresses the amount of water lost from a green surface in units of water depth. The time unit can be an hour, day, decade, month, or even an entire growing period or year.

2.7. Classification and Design Elements of curb extension

Vegetated Curb Extensions ("Bump-Outs"): are planted areas that are extended into the parking zone of the street. They are designed with an opening in the curb that catches stormwater as it flows down the curb. The water is then trapped in a low planting area and is disbursed either through plant evapotranspiration or infiltration (Wise, 2008).

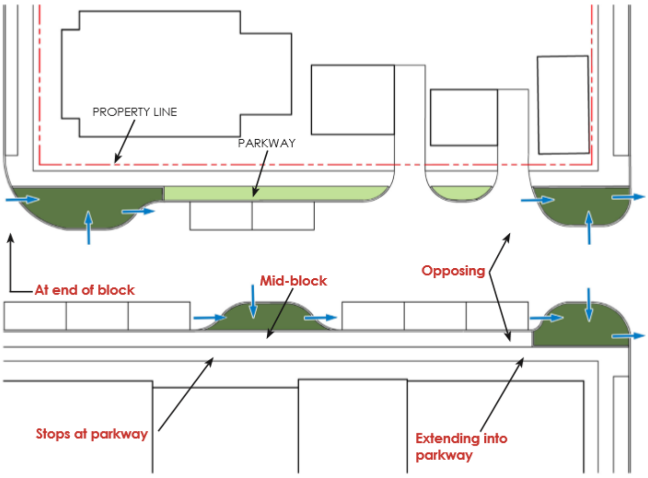
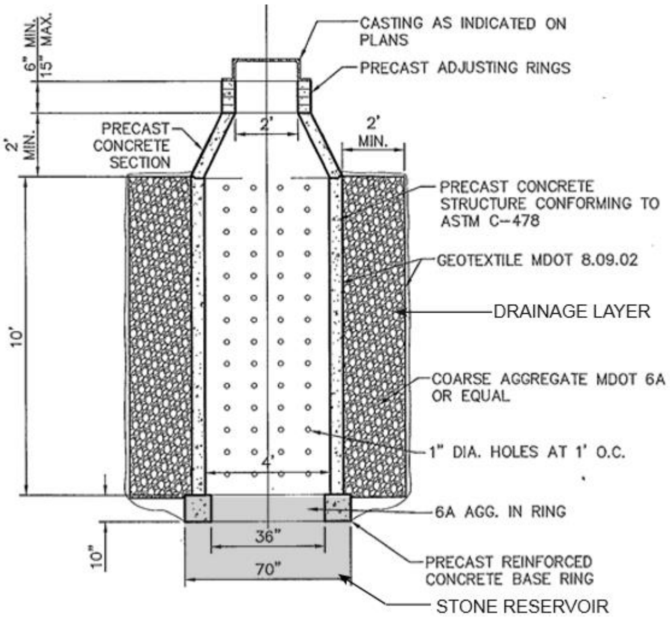


Figure 6: Vegetated curb extension Bump outs (Source: Wise, 2008).

Leaching (catch) basins: collect roadway runoff and provide the opportunity for stormwater to infiltrate instead of an outlet to a storm sewer pipe. There are several types of leaching basins, including basins that contain a porous bottom consisting of loose aggregate. This type of basin allows water to infiltrate into the ground underneath the basin. Another type of basin contains both a leaching bottom and orifice holes punched along the vertical walls of the catch basin to provide additional infiltration capacity



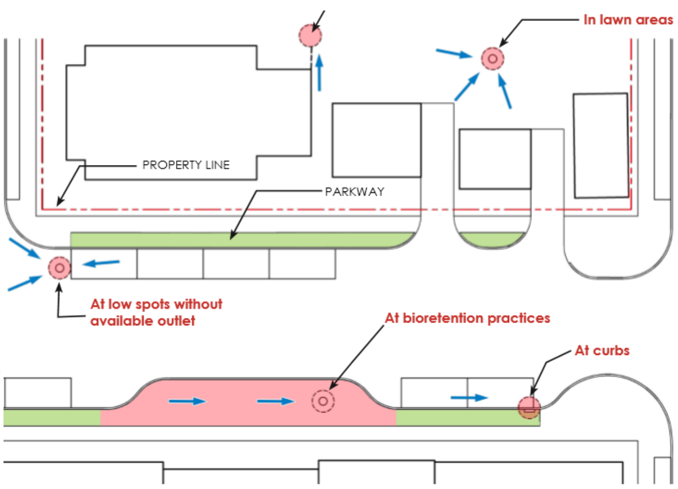


Figure 7: Leaching Basins with the plan layout (Source: Wise, 2008).

Linear bio-retention: is located between the curb/gutter or shoulder of the road and sidewalk (or street right-of-way). They can be designed with a curb-cut opening that allows stormwater to enter the linear bio-retentions from the gutters or with a grass filter strip with roads without curbs. The stormwater runoff is then captured in a depressed planting area and then either infiltrates into the soil or flows through an underdrain to the storm drain network (Wise, 2008).

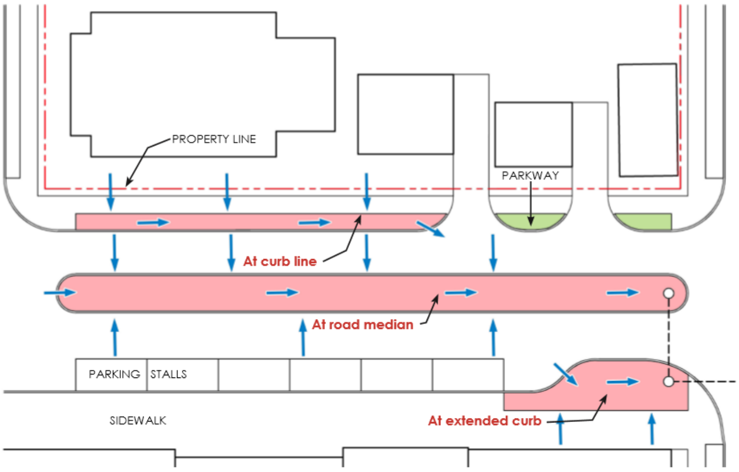


Figure 8: Linear bio-retention (Source: Wise, 2008).

A stormwater planter box: is a vegetated green infrastructure practice relying on specified soils and vegetation to treat and absorb stormwater that drains to it. It is different from other vegetated practices as it typically has concrete vertical sidewalls allowing it to be incorporated into congested street corridors or attached to the perimeter of a building. Planter boxes are often characterized either as flow-through planter boxes or infiltrating planter boxes. Infiltrating planter boxes have an open bottom to allow infiltration into the underlying soils. Flow-through planter boxes are completely lined and have an underdrain system to convey flow that is not taken up by plants to drainage areas (Wise, 2008).

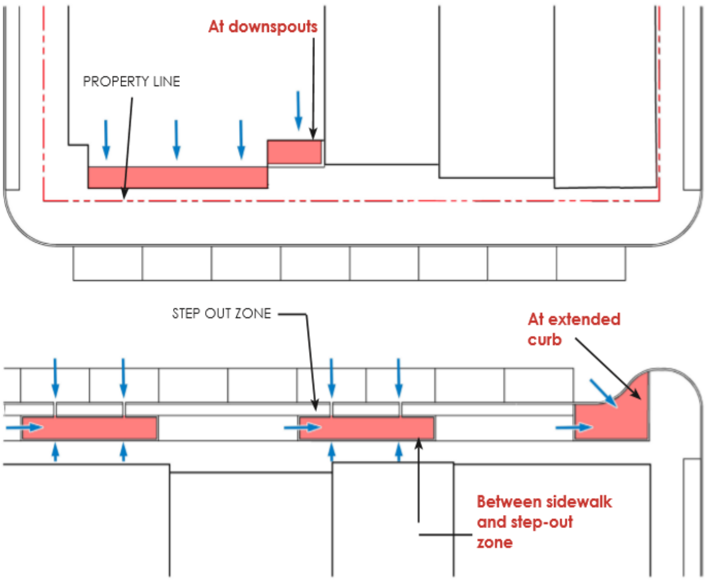


Figure 9: A stormwater planter box (Source: Wise, 2008).

2.7.1. Design Elements of Curb extension

Elements that are needed to be applied and considered when designing curb extension.

Curb Radii: Consultation with the pedestrian projects unit and district traffic operations or the area, is required if a curb radius greater than 7.0m.

Curb Taper Ratio: The minimum and preferred curb taper ratio is 3:2. A maximum curb taper ratio of 1:1 may be used to maximize available parking, minimize parking restrictions, or if there are site-specific restrictions.

Curb Taper Radii: The maximum and preferred curb taper radii is 3.0m. A minimum curb taper radius of 2.0m may be used to eliminate taper radii overlap where required.

Height: The favored height of the curb for a curb extension is 150mm. The smallest curb height of 100mm may be used where adequate drainage cannot be achieved using a 150mm curb.

Cross Slope :Curb Extensions should always slope towards the road. The preferred and minimum cross slope is 2.0%. The maximum cross slope is 4.0%. An absolute minimum cross slope of 1.0% may be considered where preferred grades cannot be met due to site conditions. Where the cross slope is less than 2.0%, the profile must be a minimum of 2.0% to ensure adequate drainage (Saneinejad & Lo, 2015).

Detailed layer of curb extension

Inlet of the curb**:** it sized and design to capture flow, prevent clogging and sediment accumulation and it guard against excessive inlet velocities

Pretreatment area**:** it captures large sediment (sometimes trash and debris), prevent erosion, level the barrier wall, have filter strips to avoid derbies, grass channels**,** sumps, hydrodynamic devices, screens, and baskets.

Primary Storage Area**:** Level soil surface and encourage even infiltration and reduce erosion (Li et al, 2019).

Vegetations on the curb: Have the ability of water uptake, stabilization, impeding Flow**,** filtration, infiltration, nutrient uptake, toxin uptake and pollutant breakdown (ITRC,2001).

Table 2: Transpiration rate of various plants (Interstate technical and environmental regulatory Council ITRC,2001).

Plant Name	Plant Type	Transpiration Rate
Perennial rye	Lawn grass	0.27 in/day
Alfalfa	Agriculture crop	0.41 in/day
Common reed	Wetland species	0.44 in/day
Great bulrush	Wetland species	0.86 in/day
Sedge	Wetland/prairie species	1.9 in/day
Prairie cordgrass	Prairie species	0.48 in/day
Cottonwood	Tree (2 year old)	2-3.75 gpd/tree
Hybrid poplar	Tree (5 year old)	20-40 gpd/tree
Cottonwood	Tree (mature)	50-350 gpd/tree
Weeping Willow	Tree (mature)	200-800 gpd/tree

Soil: A special or engineered soil specified by the particular practice, it have to be chosen for specific porosity and infiltration of stormwater may have special characteristics to treat or absorb nutrients and other pollutants client

Soil characteristics:

Porosity: void space of soil.

Infiltration: movement of water through the soil.

Field capacity: the proportion of void space that stays wet due to surface tension after the water drains by gravity.

Witting point: a point at which plants can no longer withdraw water fast enough to keep up with transpiration.

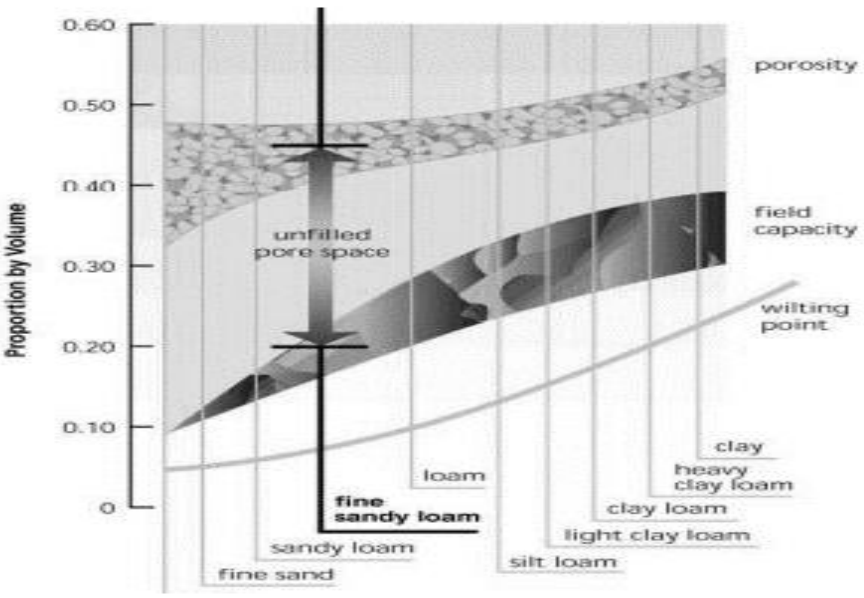


Figure 10: Soil characteristics proportionated by volume and porosity (FISRWG,1988)

Outlet and Overflow:

Water needs a way to get out, affected by the location and elevation. The mulch and topsoil should stay in the curb element

Supported Sides: Compact materials under the sidewalk and roads. use light fluffy soil in Bioretention

Sloped terrain: found within each cell, soil, and aggregate are level, maximizes storage, promotes infiltration. Between cells of the sloped terrain, it separating the wall, it promotes overflow from one cell cascades to the next one downstream, can be constructed as a continuous swale. The system used for conveyance, not just storage, reduced storage volume and it increased the likelihood of surface flooding downstream (Givoni,1998).

Aggregate Storage: Can be used to increase storage volume, open-graded aggregate, load-bearing, crushed concrete, increase pH for years, impedes vegetation growth. Aggregate water storage reservoir has 30 to 40% void space and has a level bottom surface to promote even infiltration. (Lin,1971).

Table 3: Aggregate porosity (source: Lin,1971).

Soil type	Coefficient of uniformity, c_u	Range of void ratio, $e_{min} \div e_{max}$
Fine and silty sand	≤ 2	0.55÷0.80
	(2;4)	0.50÷0.85
	≥4	0.40÷0.85
Medium and coarse sand	≤ 2	0.55÷0.80
	(2;4)	0.50÷0.80
	≥4	0.40÷0.80
Gravel and sand-gravel mix	≤ 2	0.55÷0.70
	(2;4)	0.50÷0.70
	≥4	0.40÷0.70

2.7.2. Performance of curb extension

The hydraulic performance of curb inlets

The urban drainage system was built to efficiently convey the runoff that happens due to precipitation out of the urban area to prevent overflow and local flooding, which can cause property damage and affect traffic and human safety. Curb inlets effectively seize surface runoff into the underground drainage system or bio-retention facilities. As an important and typical practice, road bio-retention facilities, which combine green/gray infrastructures to facilitate road runoff control through infiltration and storage, remove certain contaminants and sediments, and decrease roads local flood inundation risk, are widely used all over the world (Li et al, 2019).

There are three types of curb inlets commonly applied along urban streets. The undepressed curb inlet has one cross slope for the road, gutter, and curb inlet. The continuously depressed curb inlet is placed in the gutter of a street with a steeper cross slope than the road cross slope. The locally depressed curb inlet has adjacent depressions in the gutter before and/or after the inlet for effective flow interception (Li et al, 2019).

Measuring waterlogging intensity
When measuring waterlogging intensity, we need to know how close to the soil surface these perched water levels increase, and how long it stays close to the surface. We also need to know at what time of the year (seasonal factor) soils waterlog relative to the recharge rate and infiltration rate that may occur due to plantation and permeability of the surface.

Measuring waterlogging intensity by summing the daily values (in centimeters) of groundwater levels within 30 cm of the soil surface. Therefore, three days with the water level 20 cm from the surface (10 cm above the 30 cm threshold) has a waterlogging intensity of 30 cm. days (3 days x 10 cm). This is correspondent to one day with the water level at the soil surface (1-day x 30 cm). This method of measuring waterlogging intensity is called the SEW^ index (sum of excess water above 30 cm). Surfaced water levels in the soil vary rapidly in response to rainfall. Once soil profiles are wet and it reaches its maximum capacity to infiltrate the water, small amounts of rain cause the levels to rise markedly (Cox & McFarlane,1990).

2.8. Parameter for the selection of site and application requirement of curb extension.

To delineate a problem to the point of the site with a waterlogging problem and to sustain the application of a sustainable stormwater management (vegetated curb extension) there are some steps and guidelines that need to be followed:

Parameter for selection of the site:

- Areas that are categorized as low lands in Addis Ababa Based on slop analysis.
- Areas that have higher groundwater table (found within 2 m and less from the surface) based on water shade analysis.
- Developed areas that have the nearest groundwater table witch experience high flooding and waterlogging risk.
- An area that has large waterlogging intensity through the year analyzing the annual rainfall (recharge rate).
- Area(street) with low imperviousness, infiltration rate, and high stormwater runoff, considering the soil and pavement character.
- Street with damaged infrastructure (drainage and road system) due to high stormwater runoff and the existence of a water pool on the surface.

Parameter for application of the curb extension:

- Avoid conflict with existing underground utilities.
- If overhead utility lines are present, use smaller trees or shrubs.
- Work within City setback requirements.
- Use native plants when possible.
- Do not impede necessary pedestrian movement.
- Incorporate existing drainage structures into the design as overflow inlets.
- The width of the curb extension must consider minimum lane requirements.
- In locations when an overflow can be directed or connected to an appropriate outlet

2.9. The practice of stormwater management in Addis Ababa.

Addis Ababa is located in the upper part of the Awash River basin and in the Akaki catchment. The Akaki catchment is divided into two sub-catchments: Little Akaki and Big Akaki river sub catchments. Kebena, Little Akaki, Big Akaki, Bantiyketu, Bulbula, Kechene, Jemo, Tafo, Hanqu are the major rivers that flow through the city. Addis Ababa has only few formal drainage systems installed. Most storm water runs off on the surface by gravity to low-lying areas and into streams and rivers. The main formal provider of urban drainage infrastructure in the city is the Addis Ababa City Roads Authority (AACRA). Urban drainage is a requirement in the design and construction of roads. Hence roadside ditches or underground concrete pipes are installed along main roads. However, the design of roadside drains does not consider the respective hydrologic catchment of each drain. The increasing surface sealing resulting from urban development is generating more surface runoff, resulting in flash flood in the different part of the city and river flooding in the downstream parts of the river catchment.51% mud and wood houses, 34% of villa and single story houses and 15% of condominium houses of Addis Ababa are located in flood prone areas (Jalayer et al. 2014).Current efforts to mitigate flooding include flood control structure, physical soil conservation measures and reforestation on Entoto Mountain and the provision of drainage ditches and embankment along rivers or streams. With a current built up area of approximately 290 km^2, the storm water volume is estimated to be in the range of 275 million m^3 per year. Removing this much amount of storm runoff is practically difficult using conventional drainage system. However, using the landscape for infiltration, harvesting, retention and evapotranspiration, this storm water could be potentially utilized as part of the city’s future water supply. So by developing a Landscape based storm water management for storm water management strategy helps to mitigate the impacts of increased runoff and storm water pollution by managing runoff as close to its source as possible. It comprises a set of site design strategies that minimize runoff by disconnecting storm water generating surfaces from drainage lines and managing the storm water through the processes of infiltration, evapotranspiration, harvesting, and detention WGA (2013).

2.9.1. Proposed LSM measures city level

Afforestation of steep slopes

The Addis Ababa city master plan proposes the development of multifunctional forest on mountains. Since the current agricultural land use of Jemo Mountain has aggravated stormwater runoff, one of the proposed LSM strategy is to afforestation of the mountain in such a way that both conservation forestry, agroforestry and plantation forestry could be practiced. Conservation forestry could be developed on steep slopes, agroforestry and plantation forestry on the mountain top. The incorporation of high value fruit trees are recommended in the agroforestry practice.

Stormwater interceptor swale-dyke systems

Stormwater interceptor swales and dykes are stormwater conveyance channels constructed to control the flow path of runoff for slope protection. Earth dyke typically consists of a horizontal ridge of soil placed perpendicular to the slope and angled slightly to provide drainage along the contour. The dike is used in conjunction with a swale to convey the diverted water. In the moderate slope cultivated crop area of the Jemo Mountain, stormwater interceptor swale-dyke system is recommended for collecting runoff from slope and directing it to a stabilized outlet thereby preventing erosion on slopes.

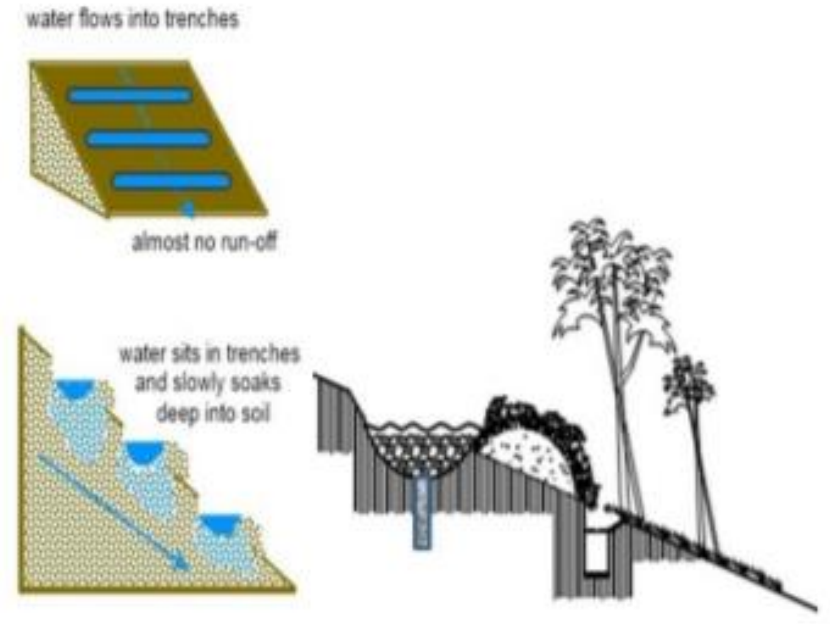


Figure 11: Stormwater Interceptor Swale and Dyke

Bench Terraces

In the high slope area of Jemo Mountain where agroforestry could be implemented, creating bench terrace and cropping along contour is proposed. Physical barriers (stone bunds, live hedges) should be created along the contours to retain rain water and make it infiltrate into the soil and to minimize soil erosion.

2.9.2. Block level LSM intervention

Green space development

The block level LSM interventions use communal open spaces. There are a number of small open spaces distributed between blocks. Most of these spaces have been developed in to green spaces. It is recommended to incorporate stormwater detention pond within or around the green spaces for detaining stormwater

Connect road bumps with infiltration tree pits

Most of the inner roads in the new single family residential areas are made from cobblestone. Bumpers to limit vehicular speed are constructed on some of the cobblestone roads. Road bumpers could be combined with infiltration tree pit. The trench is dug on the sides of the bumper, filled with gravel, and topped with soil and planted trees. Storm water runoff from the cobblestone surface flows through a storm drain along the bumper into the storm water tree pit. Planted trees absorb some of the storm water through their root system. The remaining storm water will be stored in the spaces of the gravel and then slowly infiltrate through the bottom.

Dry pond

Stormwater conveyed through gutter placed along cobblestone roads could be disconcerted from drainage channel and captured in dry pond established within community green spaces.

2.9.3. Proposed LSM measures for street

Vegetated Swale on right of way

Vegetated swales are shallow landscaped areas planted with grasses, shrubs and/or trees designed to capture, convey, and potentially infiltrate stormwater runoff as it moves downstream. Vegetated swale is proposed on road right of way for stormwater conveyance and infiltration. Curb cut is provided for runoff to enter the swale from the impervious asphalt surface.

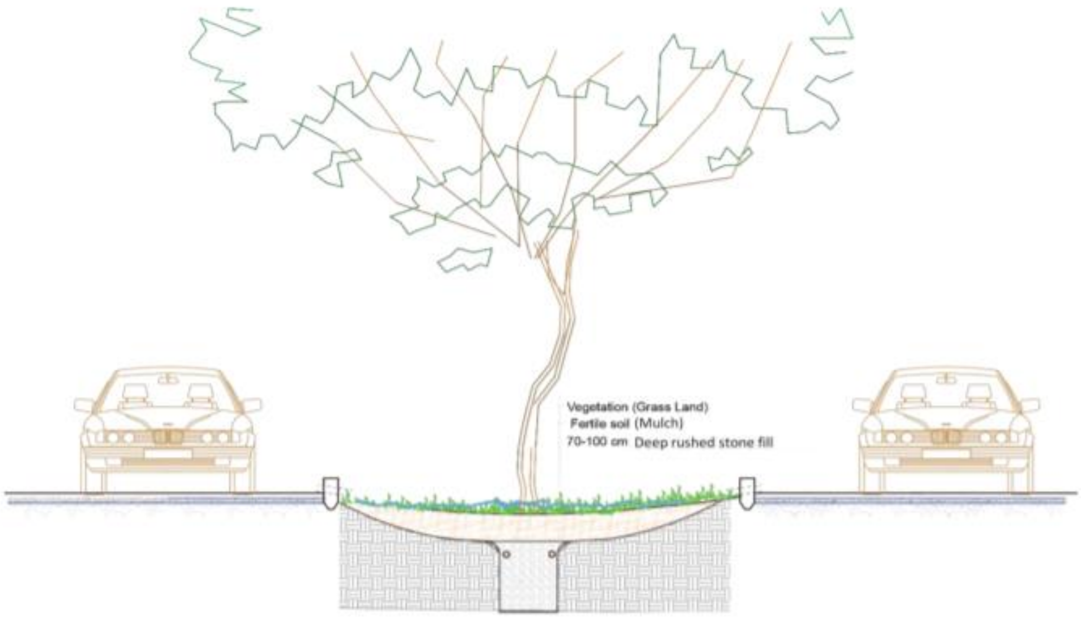


Figure 12: Vegetated swell on road median (Source Liu, 2013).

Rain garden on roundabouts

Rain garden could be developed on roundabouts of PAS to receive runoff from the impervious road. The existing curbs on round abouts can be used to direct runoff from the road along a gutter to a low point where it flows into the rain garden on the roundabout through curb cut.

Pervious pavers walkways

Pervious concrete paver blocks that provide void are recommended for walkways along the main street and ring road and on taxi terminal.

Green gutter and Street Planter

A green gutter is a type of bioretention facility located between vehicular lanes and walkway. Stormwater runoff enters the green gutter through a curb opening . Green gutter development and street planters are recommended between vehicular lanes and pedestrian walkway on primary arterial streets and ring roads.

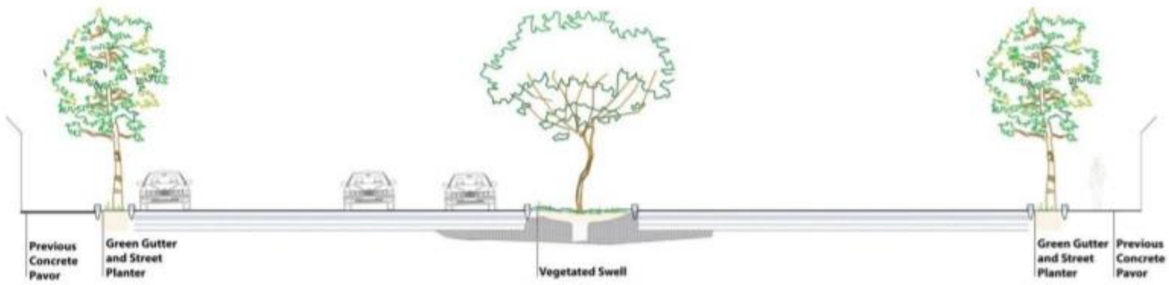


Figure 13: Green gutter and street planter (Source Liu, 2013).

2.9.4.LSM measures for cobblestone roads

Connect road bumps with infiltration trench and tree pits

In order to control vehicle speed on cobblestone roads, bumps are constructed at irregular intervals on cobblestone roads of residential areas. The bumpers are seen obstructing the flow of stormwater thereby accumulating stormwater on the cobblestone roads. In order to remove the accumulated water, road bumpers could be combined with infiltration trench and tree pit . Infiltration tree pits are contained landscape areas designed to capture and retain stormwater runoff.

Use more pervious base for cobblestone roads

From the point of view of storm water management potential of cobblestone roads, the permeability of sub-base material and the void left between cobblestones are crucial. To maximize permeability, the use of open graded base, which is a uniformly graded mixture of stone with the finer particles removed, is recommended.

Tree plantation along cobblestone roads

Spaces that area found on the sides of cobblestone roads could be used for tree plantation. Shade providing and fruit trees are the possible options. Trees intercept rainfall before reaching the ground thereby reducing the amount of runoff. In addition, trees absorb the infiltrated water and release to the atmosphere through evapotranspiration, contributing to the local water cycle (Liu, 2013).

Ethiopian National Urban Green Infrastructure standard respect to stormwater management

- Storm water management should be combined in an efficient way to minimize the run-off and maximize the production of urban agriculture / horticulture.
- Storm water infiltration ditches, bio swales and rain gardens as storm water measures installed, could be of mutual benefit for the competent authority as well as for people engaged in urban agriculture / horticulture.
- The use of cisterns, ponds, collecting facilities for roof-top run-off
- Orders the use of public parks for effective storm water management and restrict engineered structures to bigger parks (sub-city and city parks)
- For rain water infiltration, a minimum of 12 % of a private residential plot area should be unsealed and covered with vegetation
- A minimum of 30% of the total area of an administrative and commercial compound should be open space and allocated for green space
- A minimum of 15% of the total land area of a manufacturing site should be allocated for green space
- Big factory building roofs may be transformed into ‘green roofs’ for cooling the buildings and to reduce storm water runoff.
- Competent authorities should provide systems to reduce storm water runoff from rooftops, paved areas, and lawns that carry plant debris, soil particles, and dissolved chemicals into the city’s sewage drainage system.
- Industrial site development plans should employ storm water management and engineering practices before releasing water into the city’s storm drainage system.
- Storm water shall not be released directly from industrial compound into the public storm drainage system without first going through a natural, landscaped rain garden, grass bioswale or other natural feature to clean dirty water before it joins the natural waterway.
- The management of industries should make provisions to conserve water by utilizing alternative means such as water recycling or rainwater harvest.
- Competent authorities shall use natural and semi natural land for the city’s storm water management system and enhance infiltration and groundwater recharge on such sites.
- Steep slopes of more than 30% should be exclusively allocated for trees and shrub planting
- Disturbed areas shall be replanted with native plants and plant species
- Terracing of steep slopes shall be considered to implement storm water management practices
- Urban agriculture should incorporate storm water infiltration ditches, bio swales and rain gardens as storm water measures.

Chapter III: Material and Methods

The study area includes the major waterlogging lands in Addis Ababa city which can be analyzed by their hydrological and surface character to identify the major wet spot areas along the road. Catchment area character, wet spot volume was considered on the risk analysis of the process.

3.1. Study area and its Description

Addis Ababa, founded in 1987, is the capital and largest city of Ethiopia and is located coordinates of 9° 0' 19.4436" N and 38° 45' 48.9996" E. The total area of the city is 520 km2. Altitude in the city differs from 2100 m to a lit bit above 3000 m. The 2007 population census reports the population of Addis Ababa as 2.7 million, but various sources, including reports of the UN-Habitat, estimate the population of the city is more than 4 million. The waterlogging areas in Addis Ababa city are majorly based on the topographic character of the city along with the stream network. The northern boundary of Addis Ababa, has rugged topography characterized by steep slopes with less amount of water accommodation spots. Towards the south, the morphology changes to quite gentle slopes which contribute to the creation of wet spots along with the streamflow. Due to these Akaki Kality Sub city experience major waterlogging problems with selected case area to studied briefly.

Akaki –Kality is one of the ten sub cities of Addis Ababa and is the industrial zone of Addis Ababa as well as the country. It is located in the southern parts of the city. It is 20 km far from the city's center (Emmanuel Development Association, 2015). Akaki Kality, located at the GPS coordinates of 8° 53' 44.9916" N and 38° 47' 20.9832" E. And it is located 2,140 m above sea level (LatLong.net, 2012-2017).The topography of this sub city include both gentle and sloppy.

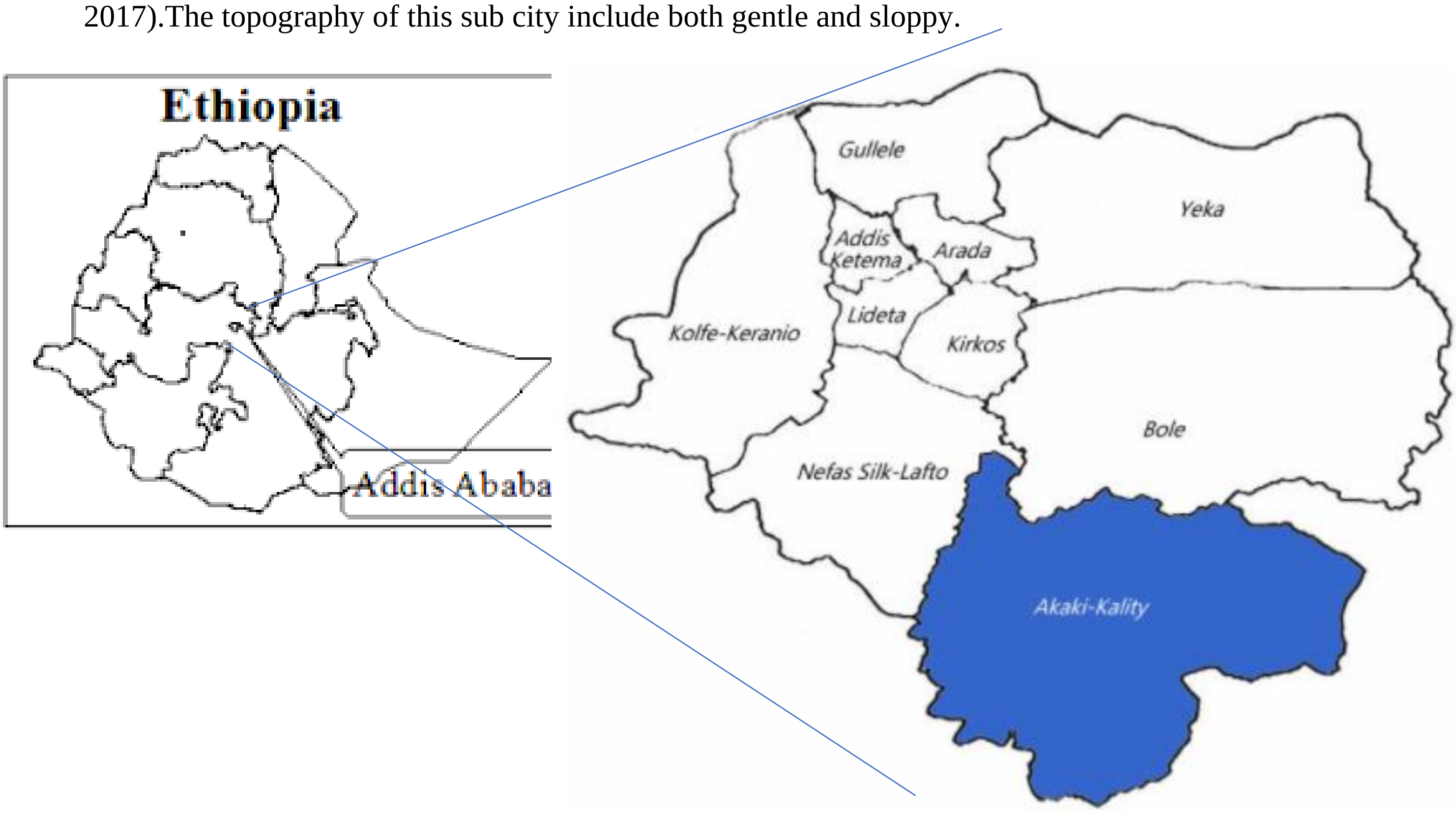


Figure 14: Location map of Ethiopia, Addis Ababa and Akaki Kality Sub city .

The city Addis Ababa is located at the center of the Akaki River catchment and this catchment geographically bounded between 8°46´–9°14´N and 38°34´–39°04´E with an area of about 1500 km2 (Ferezer, 2012). The main water bodies found in the Addis Ababa city are Akaki River and a four-water reservoir namely Legedadi, Geferssa, Dire, and Aba-Samuel. Akaki River has two main branches: The Great Akaki and Little Akaki. The north-south running river consists of two main Sub-Basin, Big Akaki river Sub-basin (Eastern catchments) and Little Akaki river Sub-basin (Western catchments). The convergence of which was the Aba-Samuel reservoir. (Tamru Alemayehu, 2001). The study areas involve places with high wet spot accommodation majorly found at low land areas of the Akaki kality Sub city especially where is a risk of high stormwater runoff and Waterlogged areas.

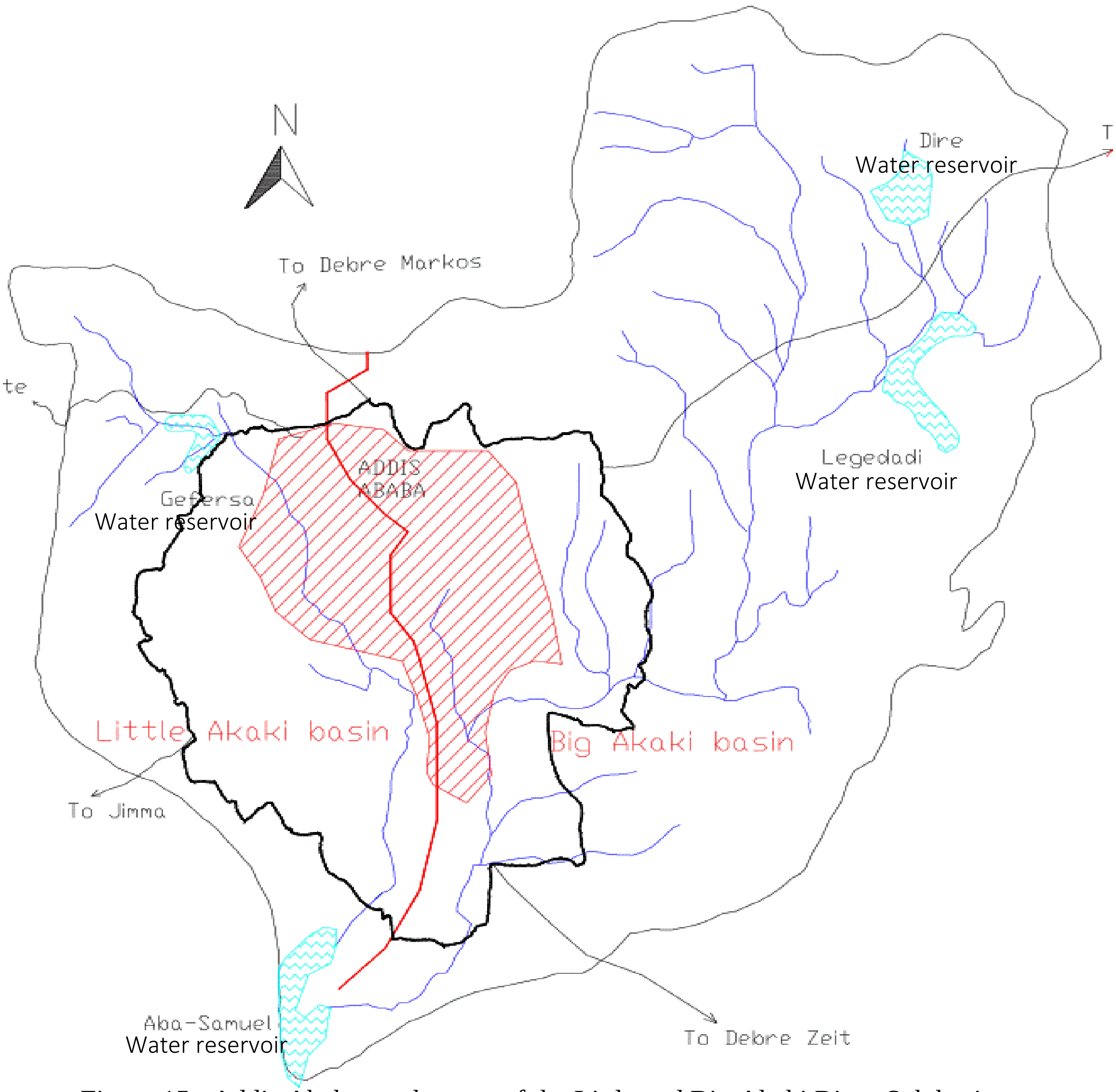


Figure 15 : Addis Ababa catchments of the Little and Big Akaki River Sub basins (Source: Mazhindu, et al ,2012).

In these Sub-basins in addition to natural factors, urbanization also affects the infiltration of water. Due to increase in the urbanization, the city river basin there is an increase of low infiltration capacity and to increasing the efficiency or speed of water transmission through channels. The increased number of impervious surface in urban parts of the river basin facilitates runoff and reduces infiltration of rainwater, which result of interrupted stream and drainage flow with wet spot accommodation Area.

3.2. Research and Data types

The study employed an Analytical research technique on sustainable stormwater management of waterlogged areas in the study area. Hence, to maintain triangulation in its findings, the design was conducted using qualitative and quantitative research approaches.

3.3. Data source

The research employed both primary and secondary data sources which it supported by GIS and QGIS topographic and hydrology analysis data. Primary data were collected using detailed site observation and verbal interview the dwellers. To manage the data collected from these sources it is supported by generating maps using GIS which identify the location and extent of the site waterlogging problem. The secondary data was collected from the respective offices which have an input on the site hydrological and physical scheme. Research reports, books, journals, and internet materials also used to attain and perform the overall concept.

3.4. Method of selecting the site

Due to the high precipitation rate, major problems are occurring mainly in the residential area local roads due to poor development of the infrastructure according to the site character. So, based on the intensity of waterlogging and road damage the street will be selected to create Bio drainage curb extension.

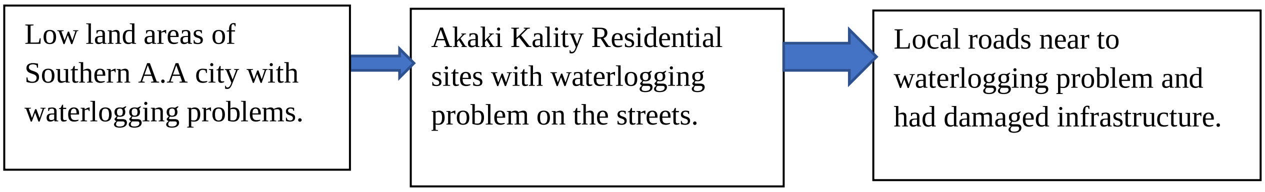


Figure 16: Local road stratification Methodology

3.4.1. Area selection mechanism.

Using GIS and QGIS analytical screening, all blue spot depression areas identified that are not connected to the stream network of the area to avoid the natural drainage system. Water accumulates in depression areas due to lack of capacity in the drainage system or perhaps total lack of drainage system. The contributing drainage areas can be upstream catchments. Then identify Blue spots' actual volume, areas with peak runoff volume, blue spots with lower volume and larger catchment areas, and blue spots close to roads to analyze the major waterlogging impacts on the infrastructure. Also these step helped to select a case area for analysis.

The second level is a calculation of rain sensitivity analysis for the individual depression to find the actual volume for each depression. It is done by assuming no drainage from depressions and assuming impermeability of the catchment at natural, semi-pervious, and impervious surface levels. In this way, a risk analysis of the blue spots can be known considering the amount of precipitation needed to fill low-lying areas.

3.5. Data collection Methods

To develop a well-functioning bio drainage curb extension with sufficient ability to avoid waterlogging on the surface of the road, both qualitative and quantitative data were collected through different mechanisms. The primary data collected through verbal question for the dwellers during field Survey by using a hydrological analysis maps as a checklist. The interview employed to collect data related to waterlogging and stormwater overflow hazards. The secondary data collected by analyzing different researches and written documents. Previous surface and hydrological researches on the study area collected from ministry of geological survey of Ethiopia and Akaki Kality Sub city office. The collected data helped to identify and clarify areas that are prone to waterlogging, flooding and on the major causes of these problems. To reenforce the previous researches and to identify waterlogged pointes (depression areas) different hydrological analysis of the surface taken place using Arch GIS and QGIS tools to collect data. The overall character of depression areas identified, Size, Actual volume and their significance on waterlogging and overflow problem.

The Data collection method takes process for identification and map waterlogged areas in Addis Ababa city first by analyzing different research documents that are worked on Addis Ababa hydrological character. These helped to know other researchers' perspective, to know which areas area expected to have these problems and why these areas had these problem, thus to study the cause and effect of the possible hydrological scheme. Then using different hydrological tools /ArcGIS and QGIS / the exact waterlogged pointes identified. These helps to create a quantifiable data on the waterlogged points/areas/. The GIS tools used to find the waterlogged pointes with their stream direction, measurable size of waterlogged areas, the catchment character, watershed property and catchment area for each waterlogged point. From these field surveys was performed as a dominant method of the data collection using the generated maps as a check list. As a primary data the dwellers on the area interviewed, different places with waterlogged problem surveyed to collect data related to overflowing, flooding, waterlogging hazards and the problem outcome surveyed seeing the infrastructure damage by these risks mostly on the local cobblestone streets.

To design curb extension as a sustainable, waterlog management and peak runoff solution for the local street, the secondary data collected from different research and written documents on curb extension system with respect to Addis Ababa drainage and stormwater management method. The data collected to design the curb extension incorporate both local and international standards which included both applicability standard and surface and hydrological character of the study area. On the Application Standard the size of the curb respect to the size of the road, the slop of the area with respect to the type of the curb extension needed to be installed taken into consideration. On the surface and hydrological character of the study area surface material/runoff coefficient/, infiltration capacity of the soil, overflow direction, peak runoff rate on the site and peak runoff volume occurred on the site taken into consideration.

Based on the design of the curb to estimate the efficiency on how much it reduced the waterlogging intensity and stormwater runoff problem, data collected related to standard given from local and international metaphor on managing stormwater and waterlogging problem to identify the required performance level of the newly designed curb and the amount of runoff volume need to be reduced.

Tools of data collection

Table 4: Data collection methods and tools

No	Specific objectives	Type of data	Source of data	Collection methods	Instrument used	Analysis
1	Identify and map waterlogging lands found in low lands of Addis Ababa city.	Water shade, waterlogged areas, waterlogging intensity, Peak runoff rate and volume	Addis Ababa city hydrological maps.	Generation of maps, observation, measuring	PC/GIS software tools/ and camera	Considering water shade, soil character and groundwater table of the site find the most waterlogging area.
2	Design sustainable curb extension as a sustainable waterlogging and peak runoff solution for the local street.	The different character of the site: surface runoff coefficient, infiltration capacity, rainfall intensity, runoff volume, peak runoff rate, and plant typology which is capable of bio drain the logging capacity.	The selected site existing features and literature review.	Photographing observation, measuring and studying the volume rate.	Camera, GIS Software	Finding a sustainable curb extension that responds to the character of the site that can be applied for a certain area with measurable bio drainage intensity.
3	Estimate the efficiency of the curb extension that reduces stormwater runoff and waterlogging intensity.	Quantity of peak overflow and runoff rate after applying the sustainable curb extension for the intended area.	Performance of newly developed curb extension.	Calculating the performance of the curb and the intensity of the waterlogged area	PC (different soft wares)	Considering standards compare the peak runoff volume that causes waterlogging to its reduced volume to distinguish the efficiency of the design curb extension.

3.6. Material on rainfall intensity and Volume calculation Method

Analyzing Rainfall intensity Rate.

The rainfall intensity rate in 1 hr., throughout 33 years of data (1985-2017) E.c, from Ethiopian metrological agency obtaining the daily average intensity rainfall at 9 o clock in these years with one hour time of concentration which equals to the storm duration taken place. The total storm duration is not taken, rather a period of rain that produces the peak rainfall in 1 hr. To compute the peak runoff rate to a period of rain that produces the highest precipitation, seasonal factors of Ethiopia are taken into consideration. Choosing the driest (November), the mid wet (April), and the wet season (August).

Table 5: Rainfall intensity Data of Addis Ababa

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total sum mm for all years/Hr	11.86	31.54	59.58	92.89	79.03	118.99	233.84	256.51	142.50	31.761	4.53	6.53
Daily Average mm/Hr	0.370	1.017	1.862	3.096	2.469	3.718	7.307	8.016	4.453	1.024	0.146	0.225

Peak runoff rate and volume calculation method

By preparing the intensity rainfall data of the area, the Rational method of hydrologic calculation is used to find the peak stormwater runoff rate in catchment areas which leads to filling the depression areas. The peak runoff rate calculated in a certain catchment character with different runoff coefficient to acquire the runoff intensity with different surface character and in different housing settlement considering the case of urbanized areas. Natural state area with 0.2 runoff coefficient, semi urbanized area with 0.55 runoff coefficient and city business area with 0.85 runoff coefficient taken in the calculation all with 2-10% slop consideration .

Area of the watershed that drains to the point for which the peak runoff rate is obtained from the individual sub-basins area on ArcGIS which are included in Akaki Kality. Little Akaki and Big Akaki basins cover most of Akaki kality area and also there are small basins that are only included in Akaki sub-city border. Having the variables of running coefficient of different surface areas, the intensity of rainfall in different seasons, and area of the catchment, the peak runoff rate calculated with Q=0.0028CIA witch 0.0028 helps to convert to SI_unit Q=m3/sec. And the peak runoff volume calculated by considering the durational factor to the peak runoff volume.

3.7. Method of analysis

The collection of data considering the existing site and methodologies to perform bio drainage curb extension were analyzed to identify the peak runoff rate of the area, infiltration capacity and amount of runoff. The waterlogged areas on the surface of the road asserted by the amount of water it holds within a certain depth and the rate of excessive stormwater that was discharge from the studied site. Finally, based on the intensity of the water on the site and the capability of the bio-retention to withdrawal water from the surface, the design was tested quantitatively comparing the existing waterlogging concentration on the site.

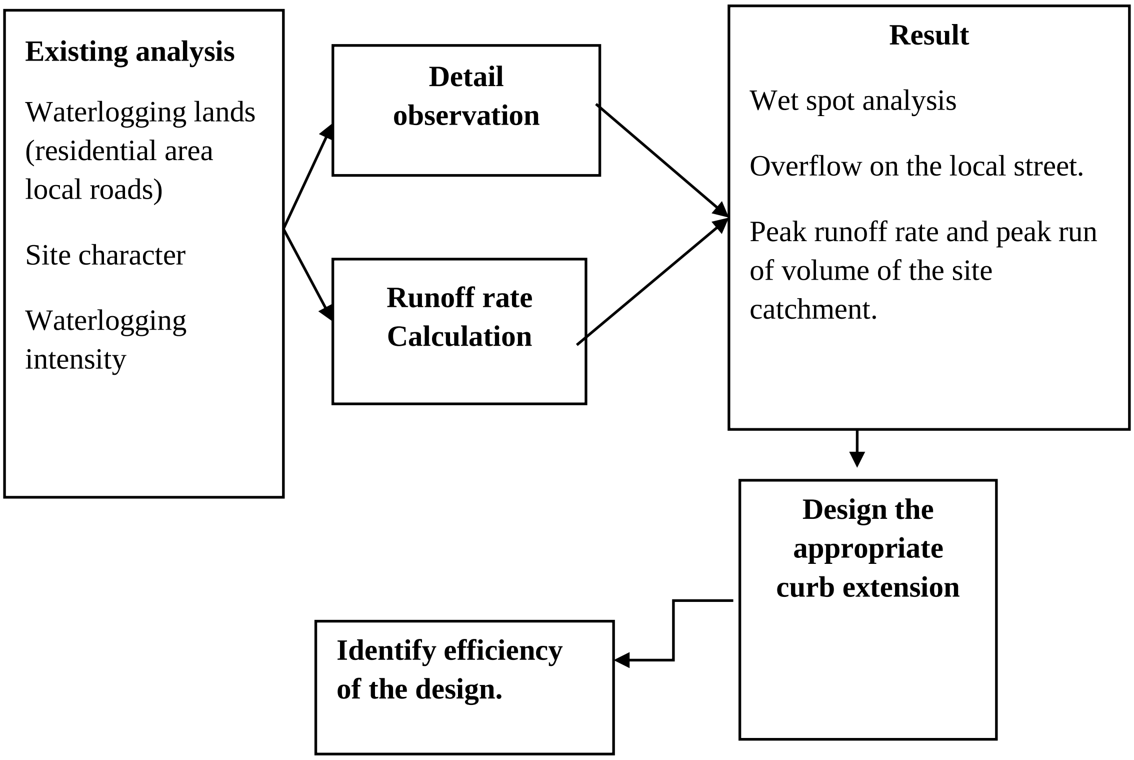


Figure 17: Method of analysis

3.7. Data Presentation

The data was presented using different maps, graphs, and tables that show the hydrological analysis of the selected site, and its final result.

Chapter IV: Result

4.1. Mapping and analyzing the existing hydrological character of Addis Ababa

The city's hydrological flow depends on the topographic surface character of the city. The stream flows from the north of the site as Big and Little Akaki catchments and leads to the flat laying areas of the south. Wet areas can be created following the flow direction of the stream and their adjacent surroundings considering overflow and stormwater runoff.

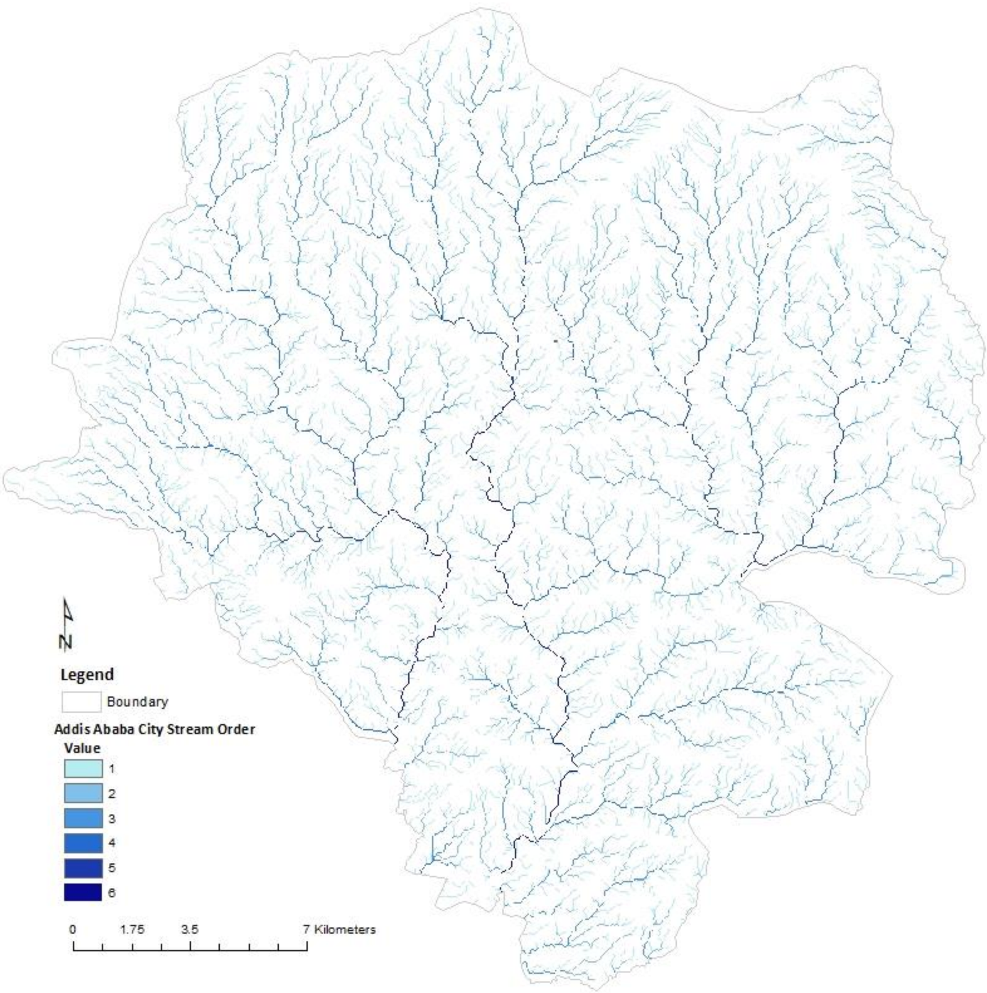


Figure 18 : Addis Ababa city stream order showing the highest and the lowest stream accumulation areas and there flow direction prospect.

The wet Areas (blue spots) occur due to the amount of rain to the land surface which is not allowed for infiltration into the ground or evaporation to the atmosphere. Hence, every drop of rain flow along on the land surface until it reaches a volume of free water collected in a depression. If these volumes are larger than $10m^3$ and the accumulation is close to a road, they are considered as threats and are included in the risk analysis procedure. That incorporates the blue spot actual volume, catchment character (coverage area and infiltration capacity), and rainfall intensity of the area.

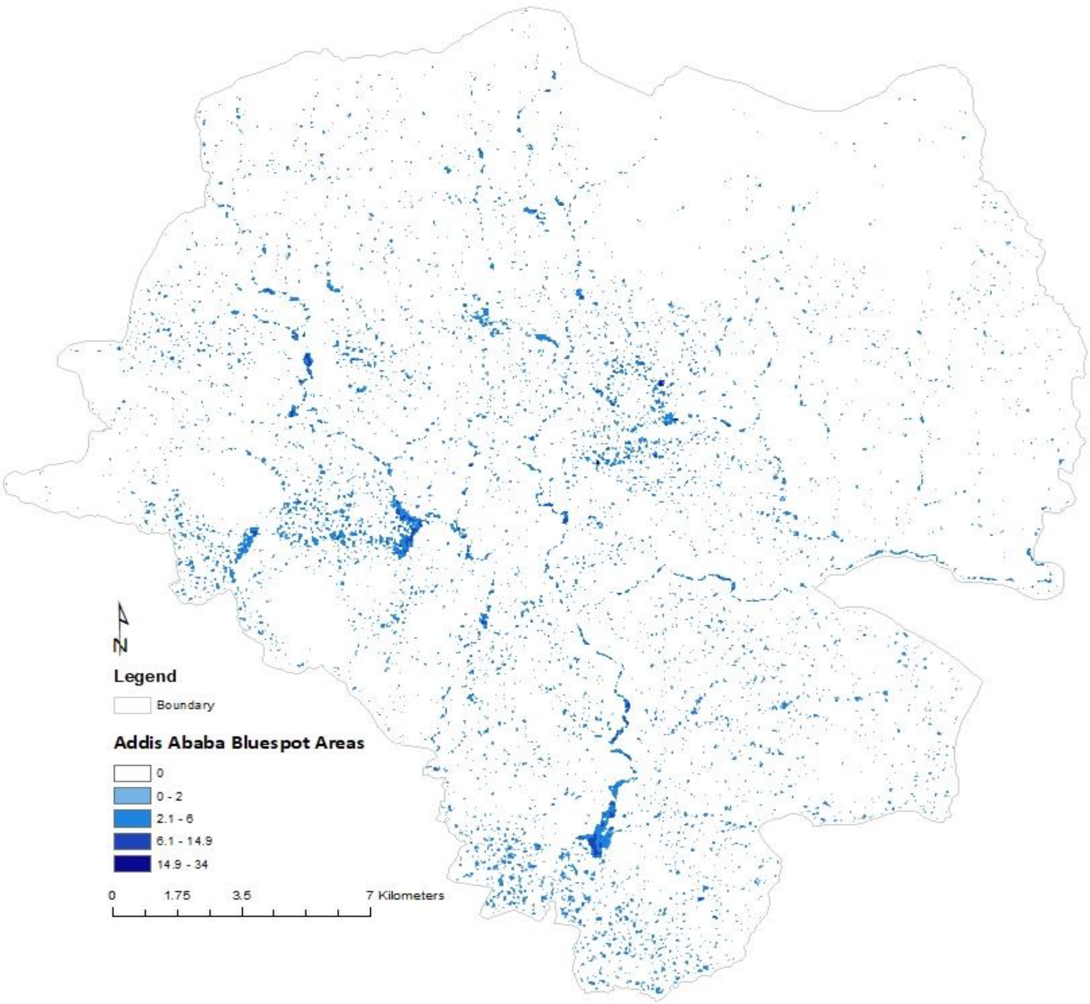


Figure 19 : Addis Ababa city blue spot depression areas found at the lowest and at the highest topographic level of the city.

Based on the bloodspot model (Fig 19) in Addis Ababa the major wet spot areas were found in central, western and southern parts of the city. These areas experience saturated land conditions and waterlogging problems. Most of the problems occur along local roads, construction sites and on bare land areas.

Areas found in the central part of Addis Ababa City. Waterlogging effects along and side to the local roads which are in Felwoha and Lideta (Fig 20) Areas.

Figure 20: Central part of Addis Ababa city with a waterlogging problem. (left side) Felwoha area and (right side) Lideta area. (Source: photograph taken by the author on August 2019)

Located Areas found in the southwestern part of the city with the amount of groundwater level rise at the same time the level of saturation causing waterlogging will increase. Some of the site case areas were found at Jemo, Lafto, and Kolfe Keraniyo(Fig 21).

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Figure 21: South western part of Addis Ababa with waterlogging problem Jemo(top two),Lafto(low to the left), and (lower right)Kolfe Keraniyo. (Source: photograph taken by the author on August 2019)

Since the topography of the city become lower and flat to the southern part of the city the hydrological flow and also the groundwater level unconfined aquifer becomes close by to the surface level and its effect showed in most of the site ground surface. Roads with no drainage facility, vegetated sites, open flat areas, and also housing construction areas experience the waterlogging problem. Some of the viewed sites were found in kality, Akaki and Tulu dimtu(Fig 22)areas.

Figure 22: Southern part of Addis Ababa with waterlogging problem Akaki Area(top 2 on the left) kality area(top on the right) and (Bottom 3)Tulu Dimtu area. (Source: photograph taken by the author on August 2019)

Akaki Kality Sub city Wet spot areas.

The Hydrological stream flow of Addis Ababa city is towards the south to Akaki Kality sub city (Fig 23). Most of the wet spots concentrated along Akaki river and others dispersed throughout the area. The wet spots that were not connected to the stream network considered as a treat. Over flow from these depression areas occur during high precipitation time which caused waterlogging problem.

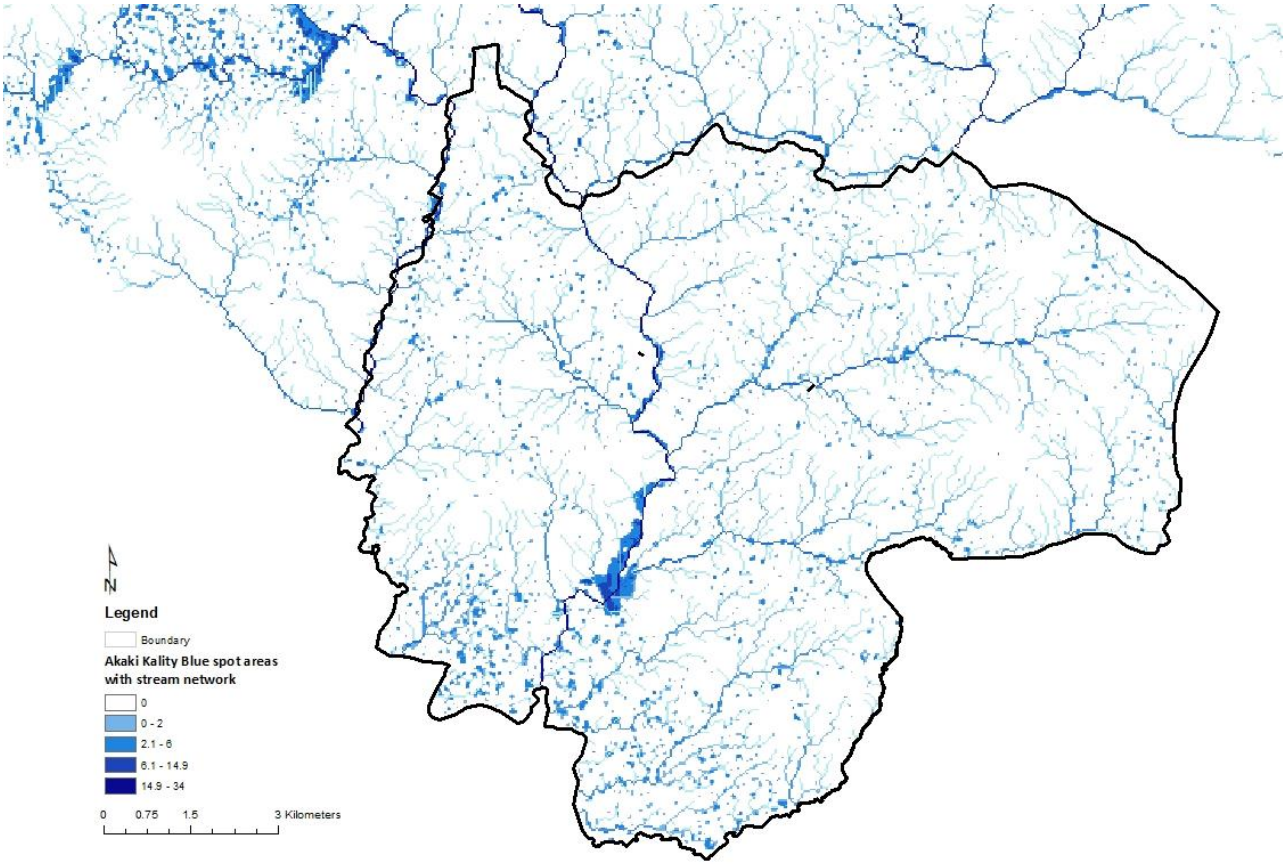

Figure 23: Akaki Kality Sub city blue spot depression areas related to the stream network.

Actual volume of wet spot depression Areas

After wet spot areas that are prolong to waterlogging and flooding problem identified, Vectorized form of the depression area create(Fig 24). From these vectorized polygons size of the bloodspot, elevation of the depression, and actual volume of the depression found (Annex-1).

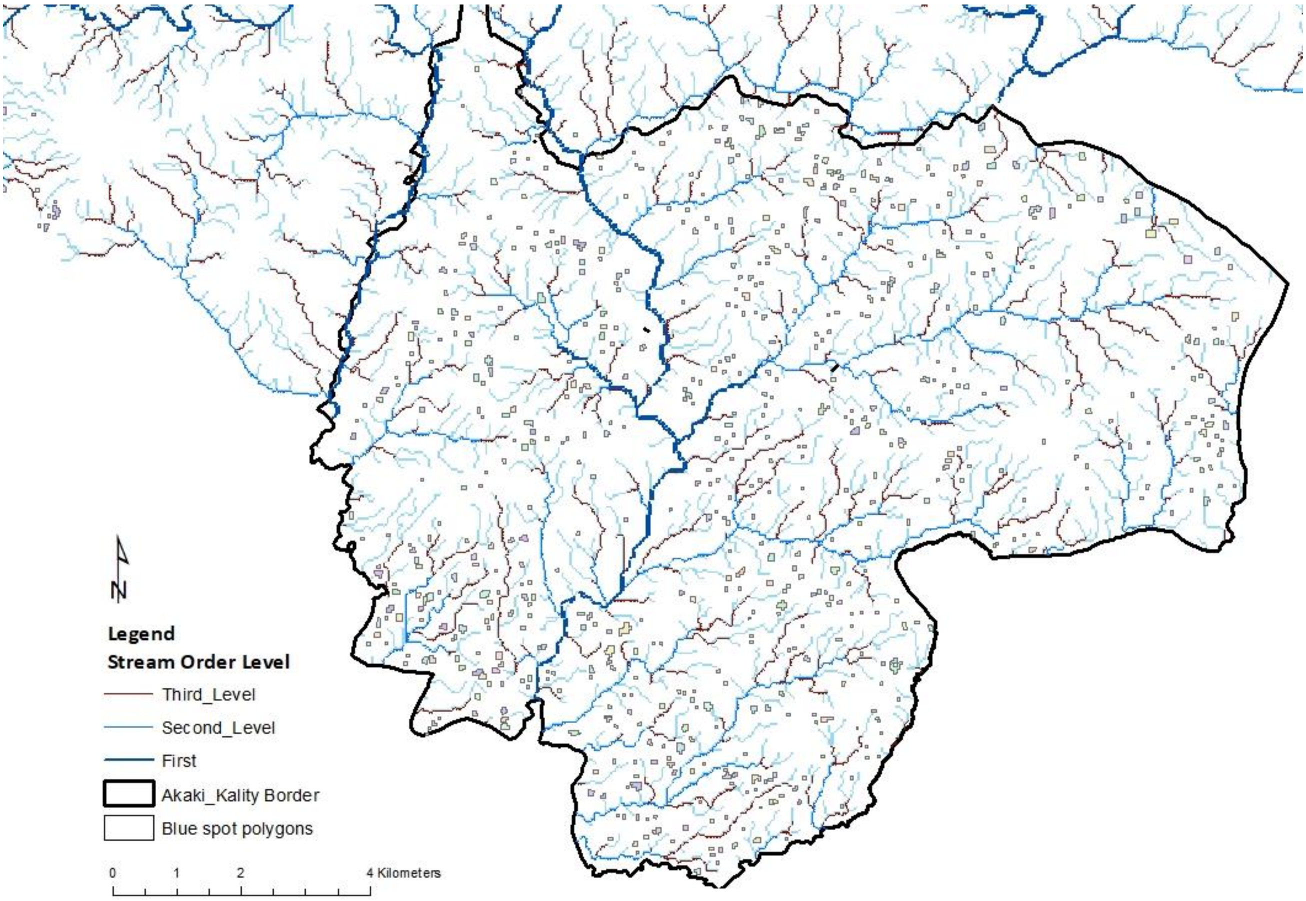

Figure 24: Akaki Kality Sub city Depression areas

The zero-groundwater level (the original terrain) helps to identify the surface volume below the given elevation which counts as the actual volume of the depression (Annex-1). The larger volume of the Blue spots occurs around the major stream of Akaki river.

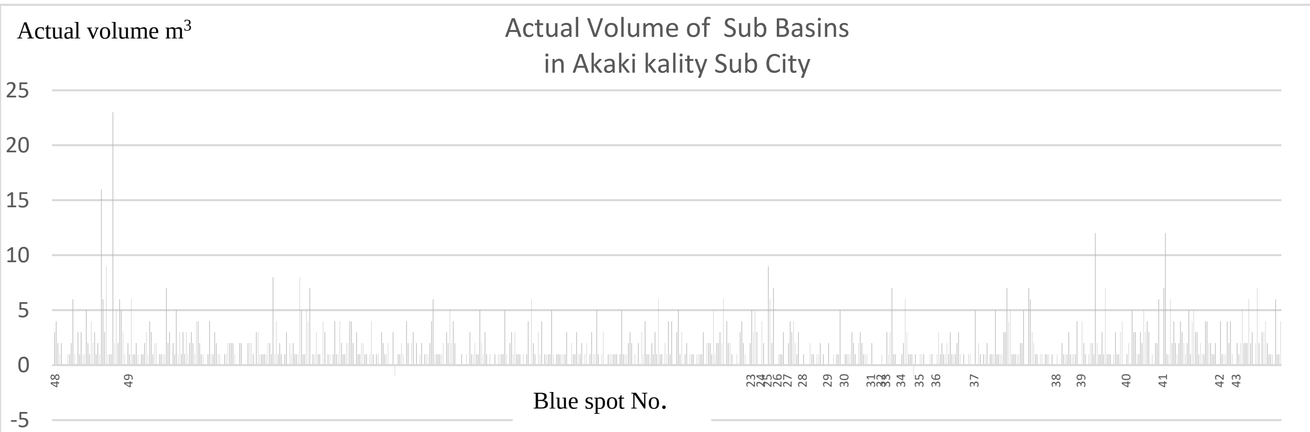

Figure 25: Actual volume of the depression areas in subbasin of Akaki Kality Subcity.

The actual volume of the depression areas in Akaki Kality mostly lies in between 1m^3 to 7m^3 and in some catchment areas it goes beyond 8 m^3 to 23 m^3. (Fig 25). These depression volumes hold the peak runoff volume of their individual catchment flow..

Based on the calculation (Annex-2) the runoff rate in the dry season is much smaller than the wet season. At the same time, the catchment area development of the city has an impact on the peak runoff rate. The more the surface is at the natural state the less peak runoff rate and vice versa.

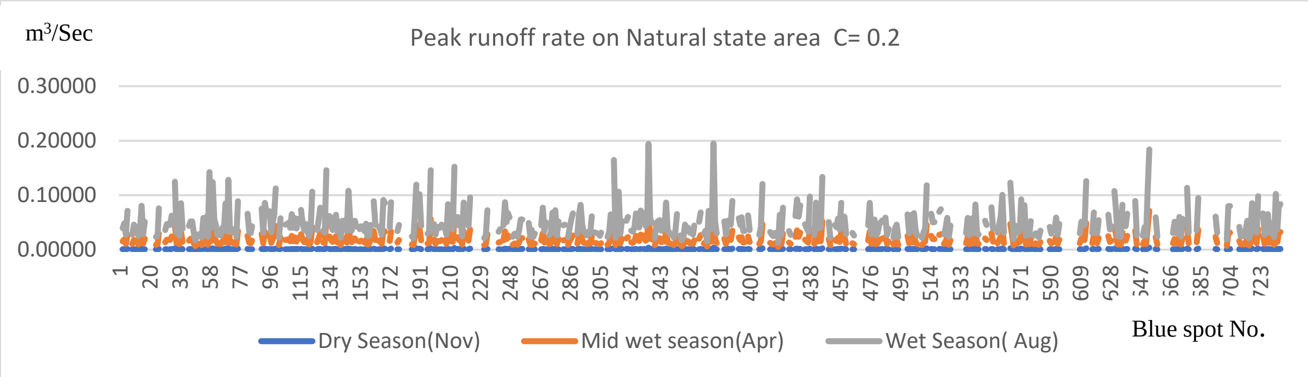

Figure 26: The peak runoff rate on natural surface Catchment considering the seasonal factors.

The peak runoff rate in the natural surface area (Fig 26) has the smallest peak runoff rate from the other surface catchment characters. In the dry season, the maximum runoff is below 0.004m^3/sec, in the mid-wet season it's below 0.08m^3/sec and in the wet season its below 0.200m^3/sec. Naturally kept areas have low runoff rate due to the high permeability of the surface area.

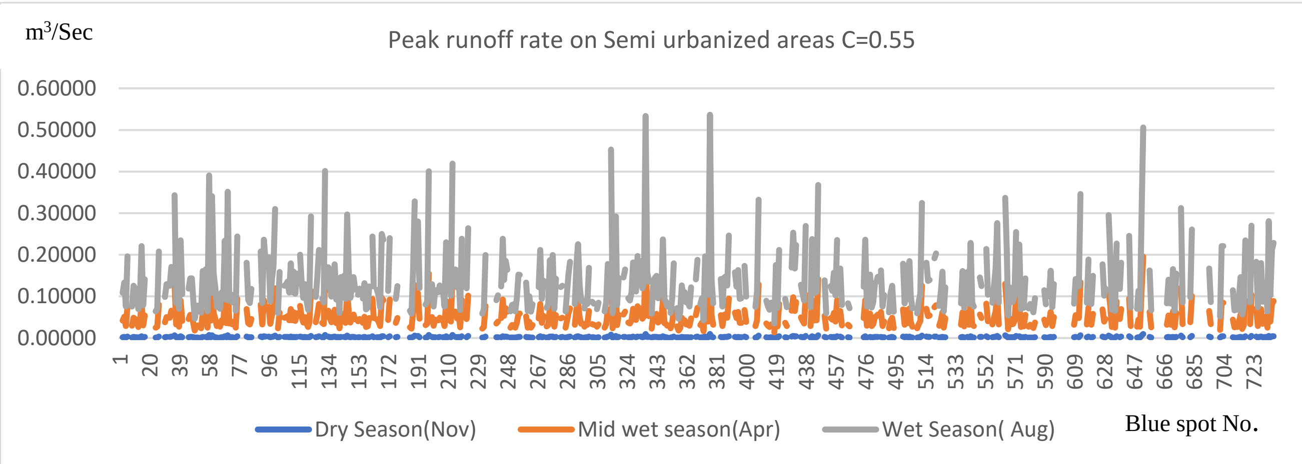

Figure 27: The peak runoff rate on Semi urbanized surface area catchment considering the seasonal factors.

In semi urbanized surface area (Fig 27) there is a slight peak of runoff. The lowest runoff goes up to 0.01m3/se in dry season. In mid wet season 0.200m3/se and in wet season it reaches to 0.500 m3/se. having a part of some development and incorporation non infiltrating surface areas of the catchment surface, the peak runoff rate increases.

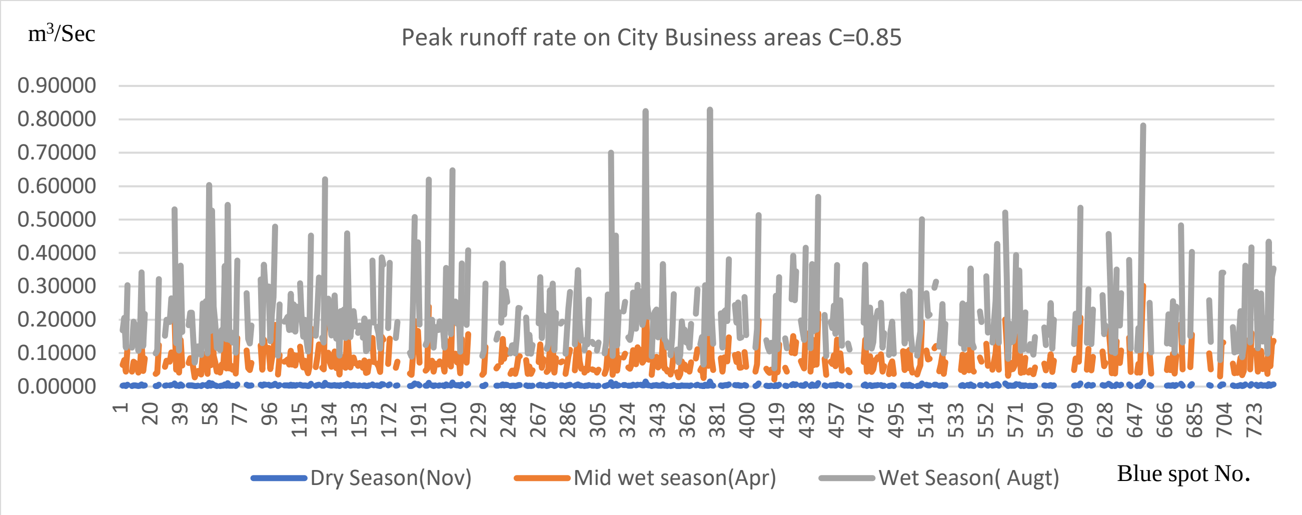

Figure 28: The peak runoff rate on urbanized city business areas catchment considering the seasonal factors.

The peak runoff rate in fully developed areas with the lowest permeability of surface has the highest runoff value (Fig 28). In the dry season, the peak runoff goes up to 0.015 m3/se. In mid wet season 0.300 m3/sec and in the wet season above 0.800 m3/sec having the catchment area's highest runoff rate. The impermeability of the surface has major significance to get the highest peak runoff rate considering the other surface characters of the catchment areas.

The value of peak runoff rate calculated by rational method (Annex-2) varies through the intensity of rainfall considering seasonal factors and runoff coefficient of the surface area. The land use of the site has a major impact on the peak runoff intensity in these hydraulic assessments.

Result on Peak runoff volume

After finding the runoff rate of the site on different catchment characters, the total runoff volume is acquired by multiplying the pick runoff rate with the 1 hr. Time rainfall storm duration (Annex-3). The elapsed time in the rainfall duration differs throughout the year and as the storm duration increases the peak runoff volume also increases.

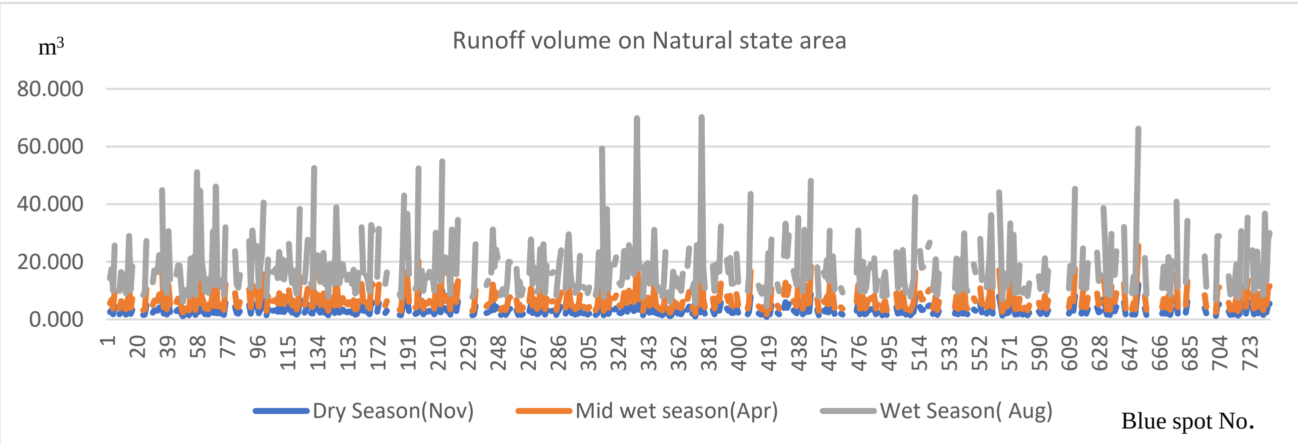

Figure 29: The peak runoff volume rate on natural surface catchment considering the seasonal factors and the site peak runoff rate.

The peak runoff volume on the natural state value (Fig 29) is the smallest because at the natural state of the land permeability character and infiltration capacity of the surface area is at the highest rate. During the dry and mid wet season, the surface area experiences a small amount of runoff volume which is less than 15 m^3.

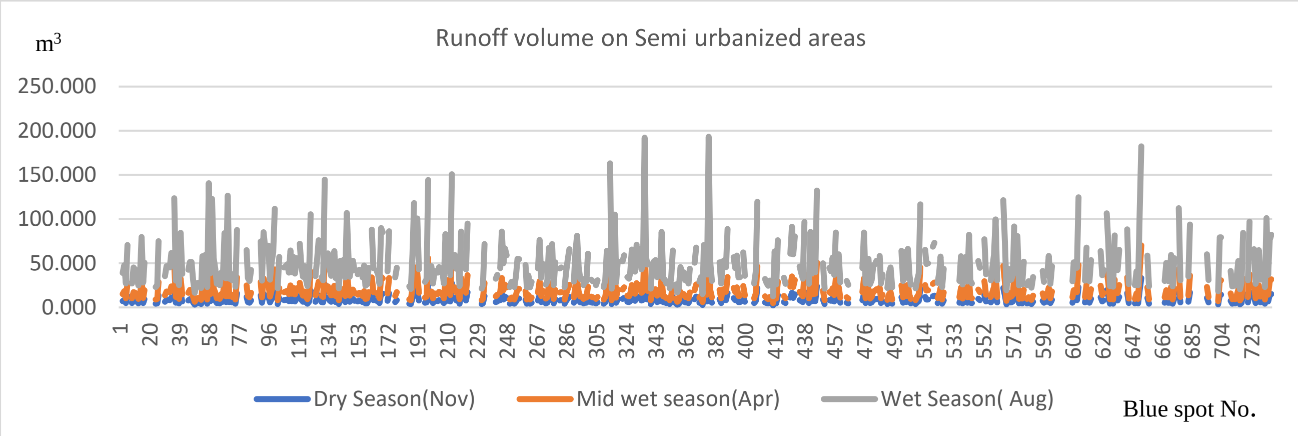

Figure 30: The peak runoff volume rate on Sumi urbanized surface area catchment considering the seasonal factors and the site peak runoff rate.

With the increasing of impermeable surface, the stormwater runoff intensity rises. With that, the runoff volume also increases due to the small amount of infiltration of water to the ground. During the dry season, the runoff volume on semi-urbanized areas has the smallest impact due to less precipitation (Fig 30). But in the mid wet and wet season along with the increase of rainfall intensity, the runoff volume also increases up to 180 m^3 per given catchment.

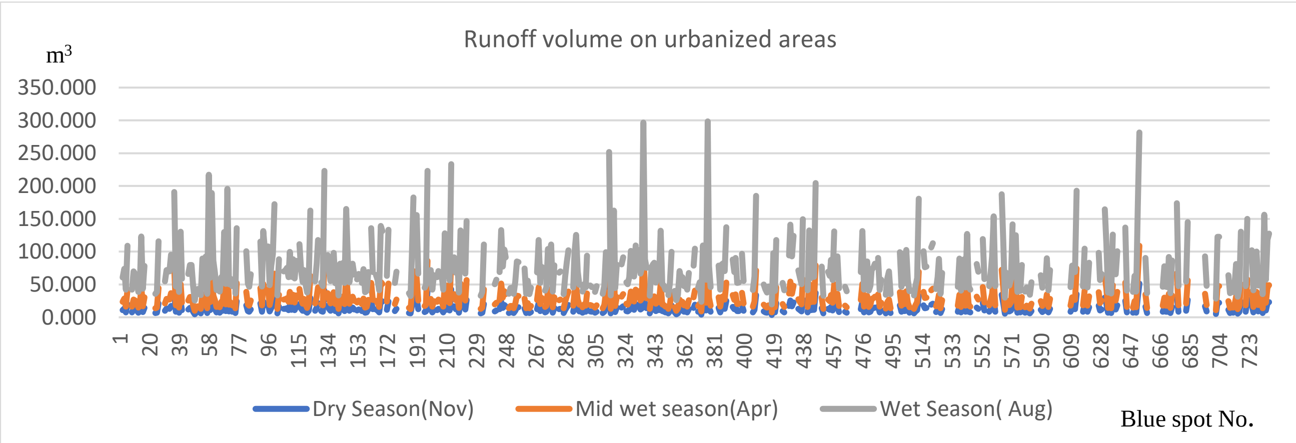

Figure 31: The peak runoff volume rate on urbanized city business areas catchment considering the seasonal factors and the site peak runoff rate

In the case of fully urbanized areas, the runoff volume goes to the highest rate (Fig 31). Because the runoff coefficient of the surface is the highest, it leads to having the highest runoff rate and run of volume. The surface also has the lowest infiltration capacity with a low permeability rate, which also has a major impact on the runoff volume. As a total result, the runoff volume is direct reciprocal to the peak runoff rate. As the peak runoff rate increases during a certain storm duration, the volume also peaks to the highest accommodation. The site catchment character has an impact considering infiltration capacity and permeability of the surface.

The Actual wet spot depression volume Vs The peak runoff volume in different state of catchment character.

<u>The peak runoff volume at natural catchment areas.</u>

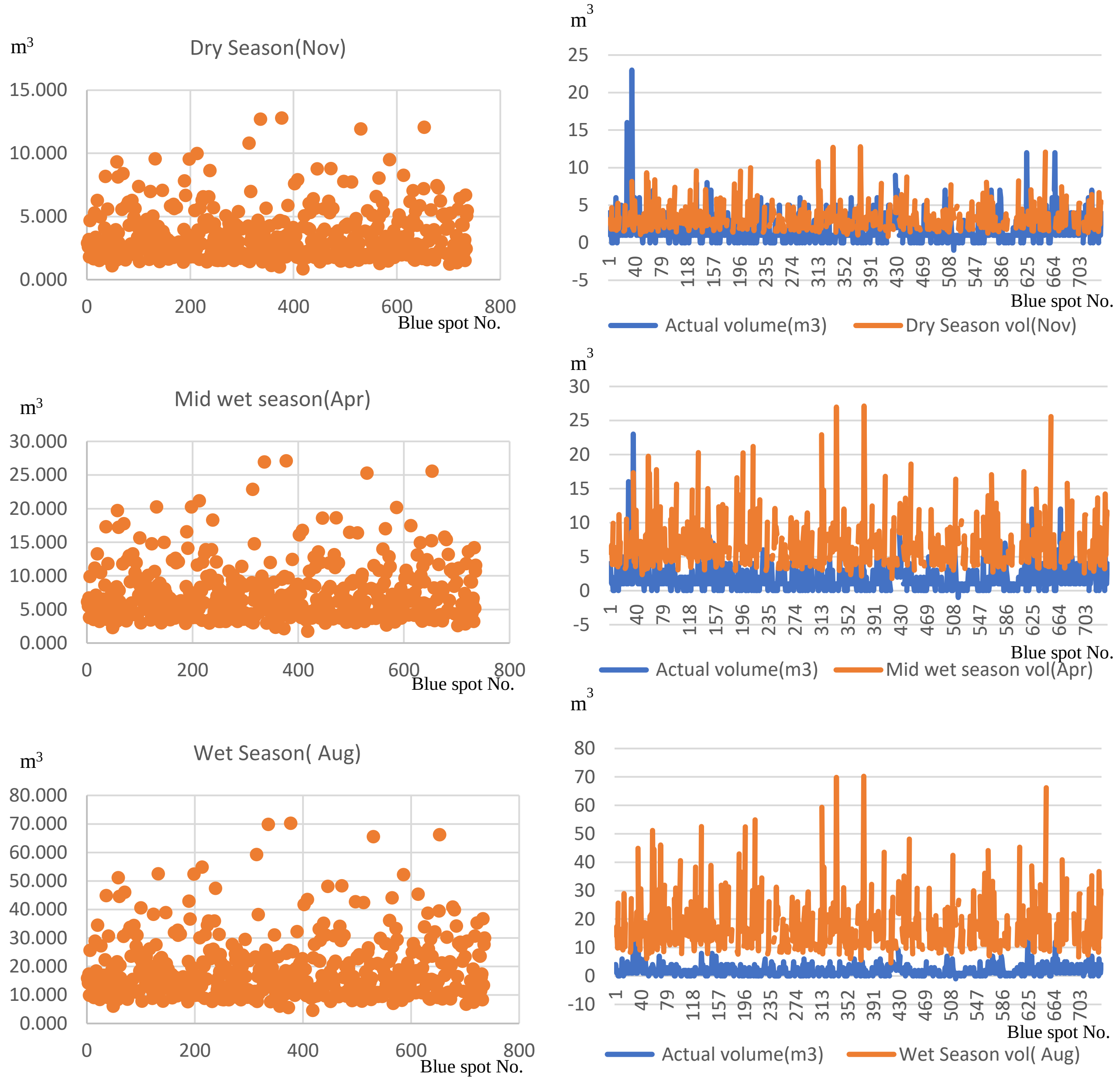

Figure 32: The peak runoff volume ratio on the natural surface catchment area during different seasons (left blocks). And actual volume of the site depression value in comparison with the peak runoff volume on the natural surface catchment (right blocks).

The natural catchment area of runoff maximum volume goes from 14m3 up to 70 m3 (Fig 32 left blocks) throughout rainfall intensity of the year. Comparing to the actual depression volume the runoff(Fig 32 right blocks) exceeds the capacity mainly during wet season with the value up to 70 m3 and the actual volume lies in between 1m3 to 23 m3 capacity.

The peak runoff volume at Semi urbanized catchment areas.

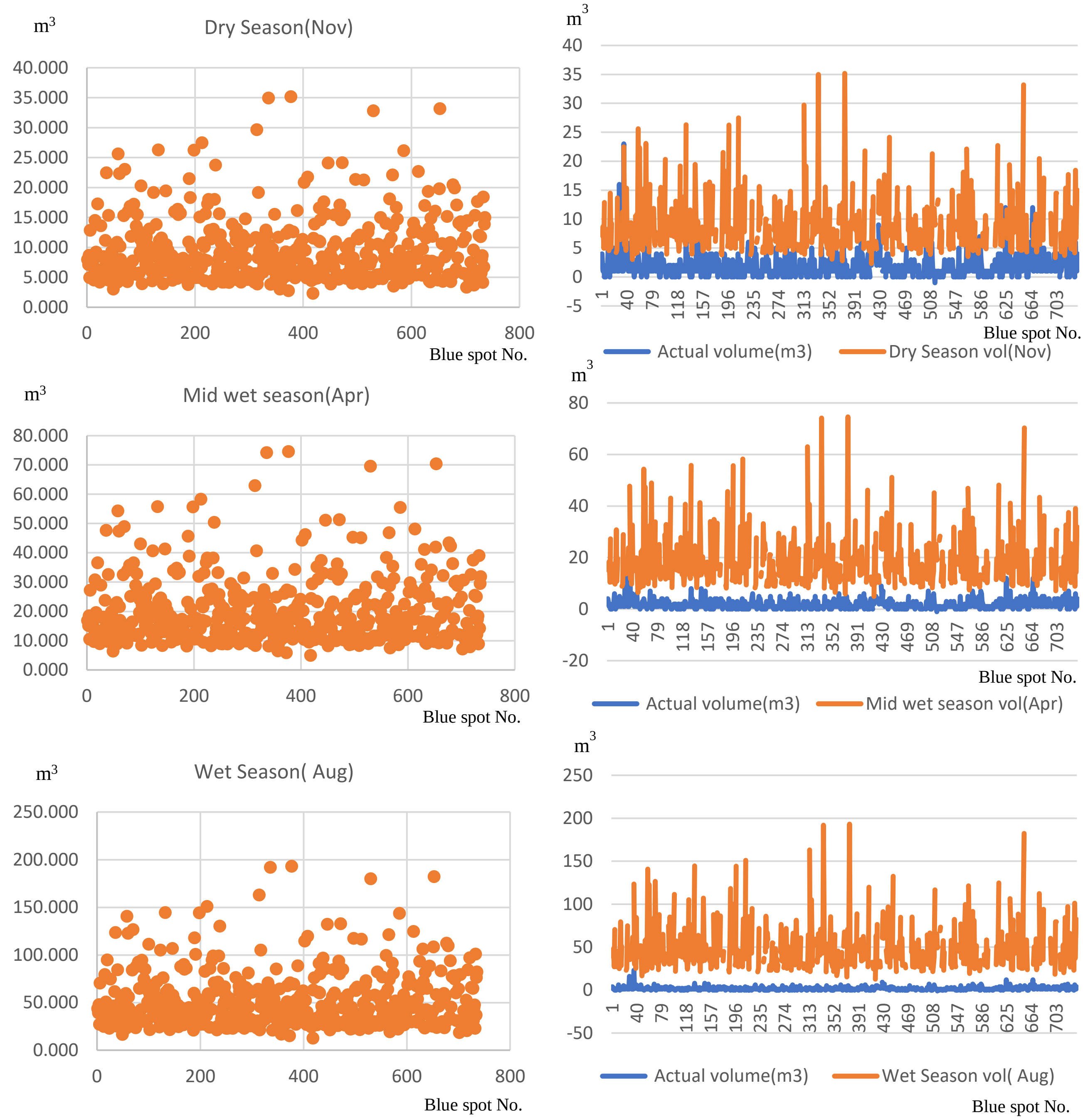

Figure 33: The peak runoff volume ratio on Sumi urbanized surface catchment area during different seasons(left blocks).And actual volume of the site depression value in comparison with the peak runoff volume Sumi urbanized surface catchment(right blocks).

On Semi Urban area catchment character, the maximum volume goes from 35m3 up to 180 m3 (Fig 33 left blocks) throughout rainfall intensity of the year. Comparing to the actual depression volume the runoff exceeds slightly in dry season while during wet season the runoff volume value goes up to 180 m3 hence the actual volume lies in between 1m3 to 23 m3 capacity(fig 33 right blocks).

The peak runoff volume at Urbanized catchment areas.

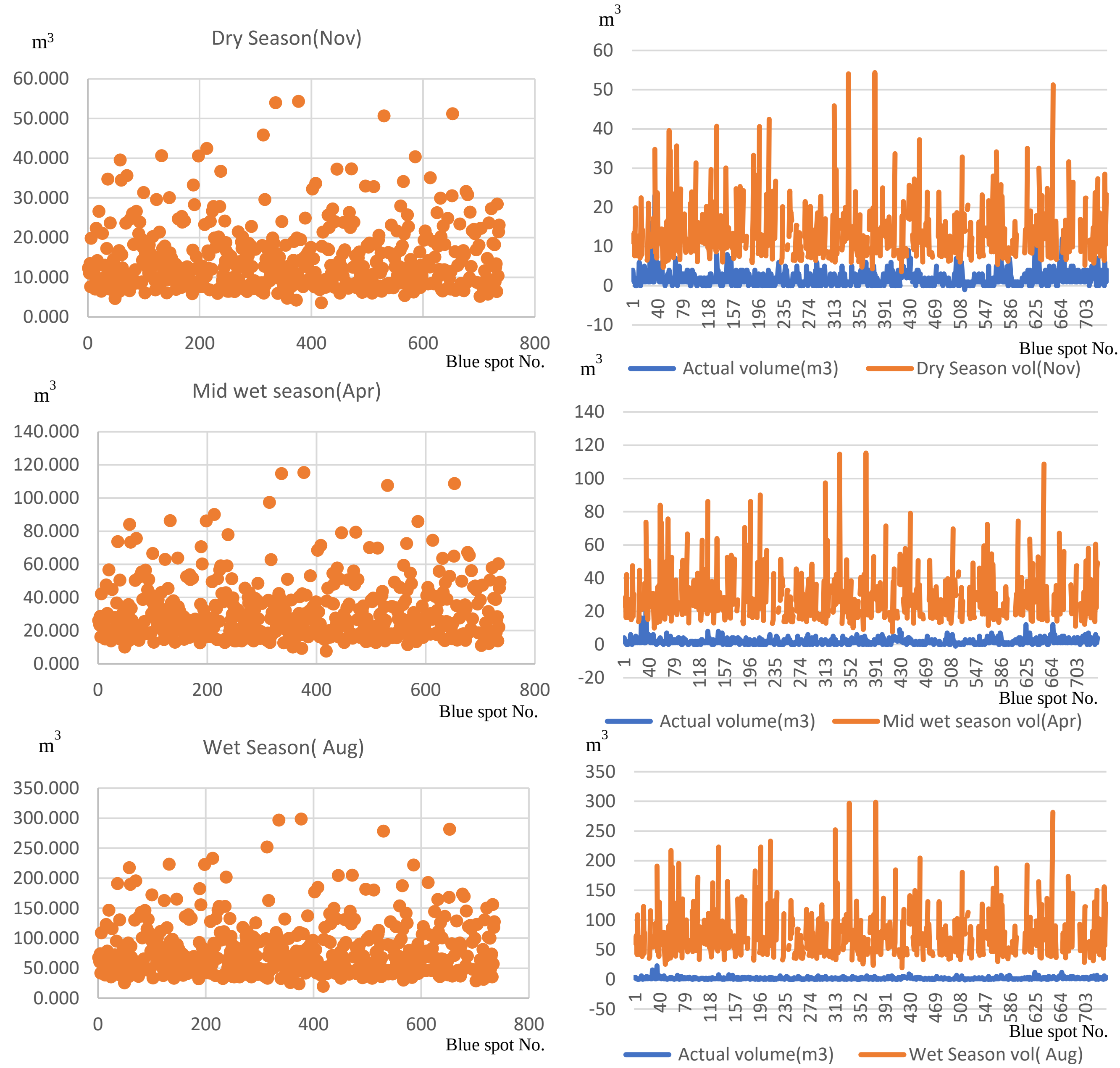

Figure 34: The peak runoff volume ratio on Urbanized surface catchment area during different seasons (left blocks). And the Actual volume of the site depression Value in comparison with the peak runoff volume of urbanized surface catchment (right blocks).

Developed urban areas have the maximum runoff volume than other catchments. The runoff volume of these catchment areas goes from 51m3 up to 296 m3 (Fig 34 left block) throughout the rainfall intensity of the year. All runoffs exceed the volume of the actual depression in all seasons and have a possibility of overflow and flooding. The maximum wet season falls in the range of 296 m3 and the actual volume lies in between 1m3 to 23 m3 capacity (Fig 34 right blocks).

Risk Assessment on overflow and waterlogged areas based on runoff volume.

Increasing runoff volume on different catchment areas in different seasonal orientations lead to risk assessment based on the amount of precipitation need to fill the low-lying areas with smaller depression volume. Depression areas that are filled by the lowest precipitation considering their permeability and seasonal factors tend to have a high risk of overflow.

Precipitation level that causes a risk of flooding and overflow within the lowest runoff rate coefficient can exert a major impact when it is implied on the highest surface runoff. Since the natural catchment area has the highest permeability and the lowest runoff rate than the other catchment areas, it can be used to attain the risk assessment. Depression areas in natural catchment character that are overflooded by the minimum precipitation even if having the highest infiltration rate can be indicated as high-risk areas. In the natural catchment areas, the dry season has less peak runoff rate and runoff volume. Actual depression volumes that are overflow by the minimum intensity of rainfall (Fig 35) 0.146mm/hr at dry season, 3.096 mm/hr at a mid-wet season, and 8.016 mm/hr at wet season have a larger risk with the increase of the runoff coefficient.

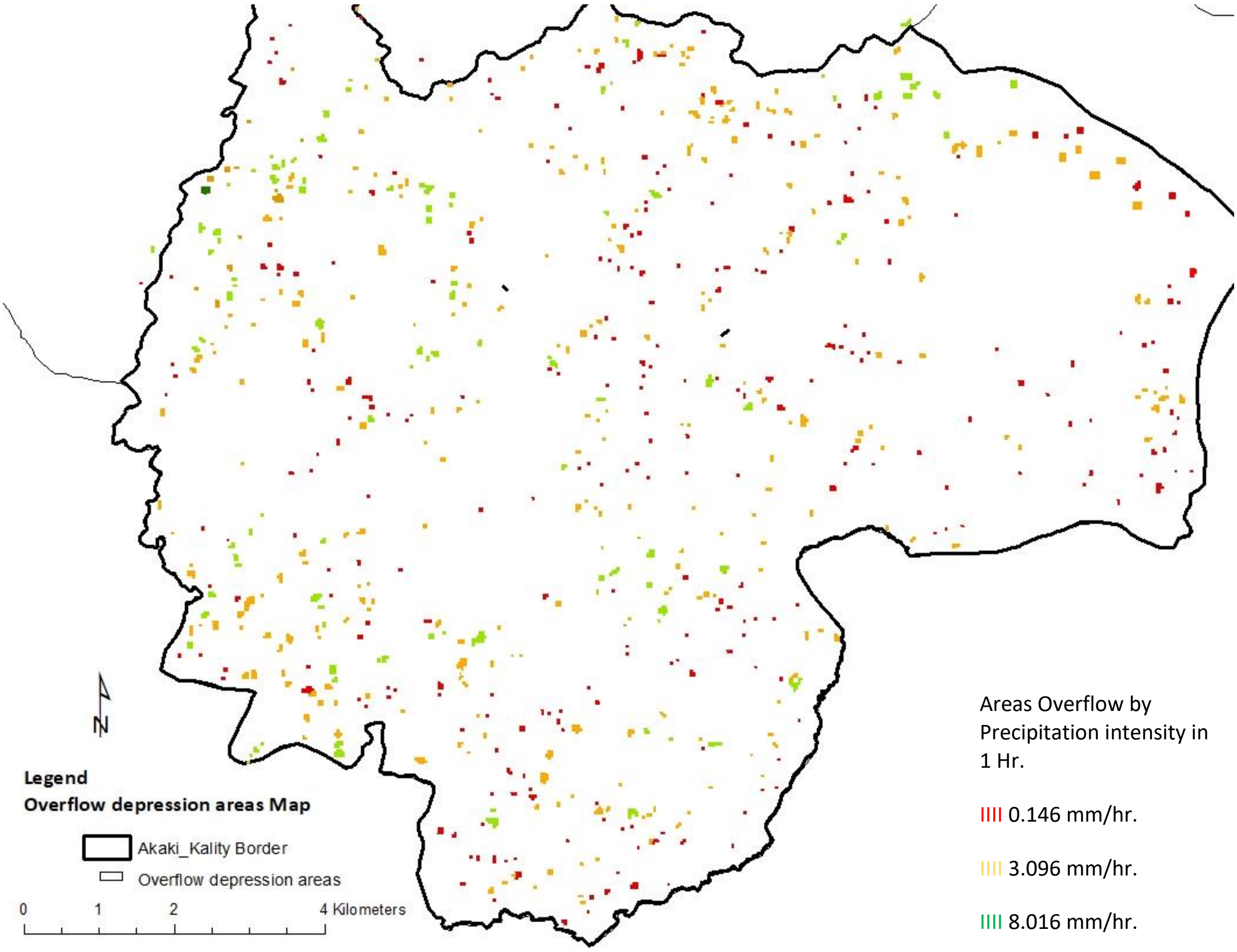

Figure 35: Risk analysis on the depression areas of Akaki Kality Sub city

Depressions that overflow by 0.146 mm/hr have the smallest actual volume rate to hold the runoff volume of their catchment area. With minimum precipitation they overflow on the 0.2 runoff coefficient.

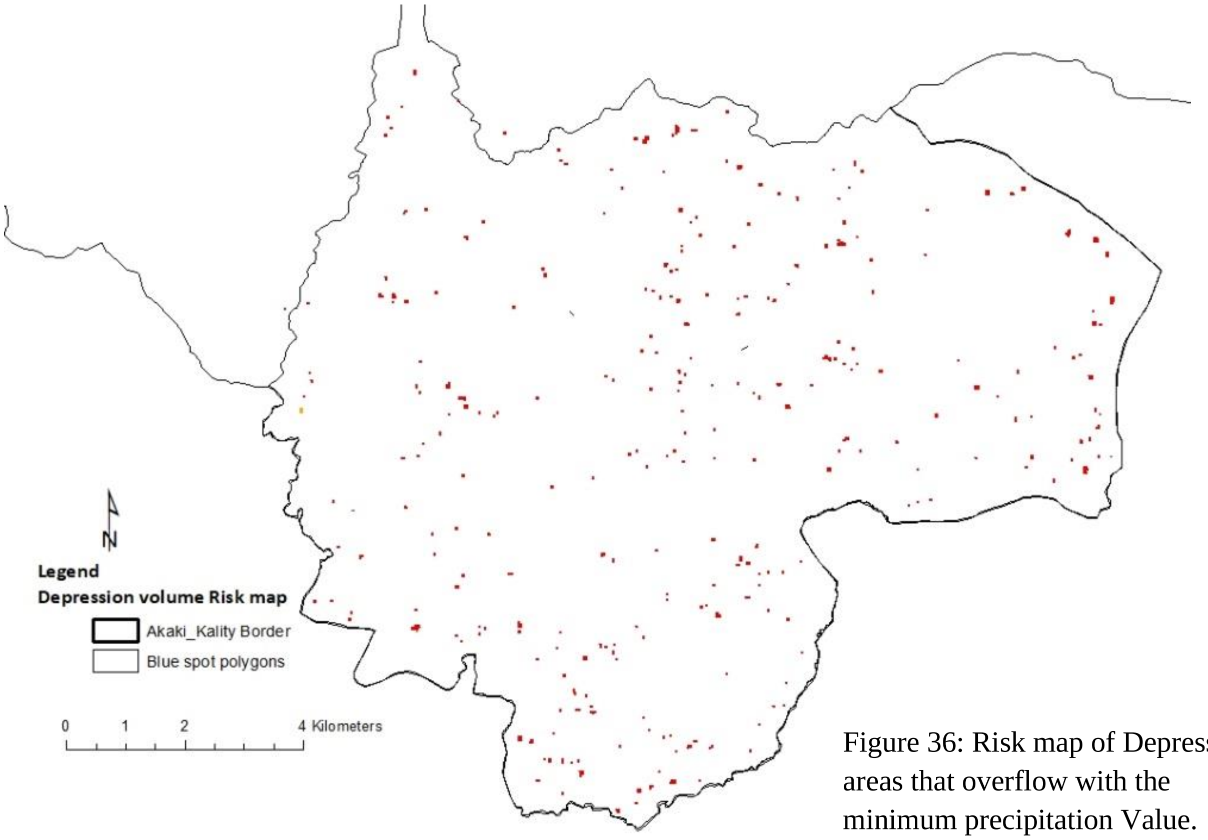

Figure 36: Risk map of Depression areas that overflow with the minimum precipitation Value.

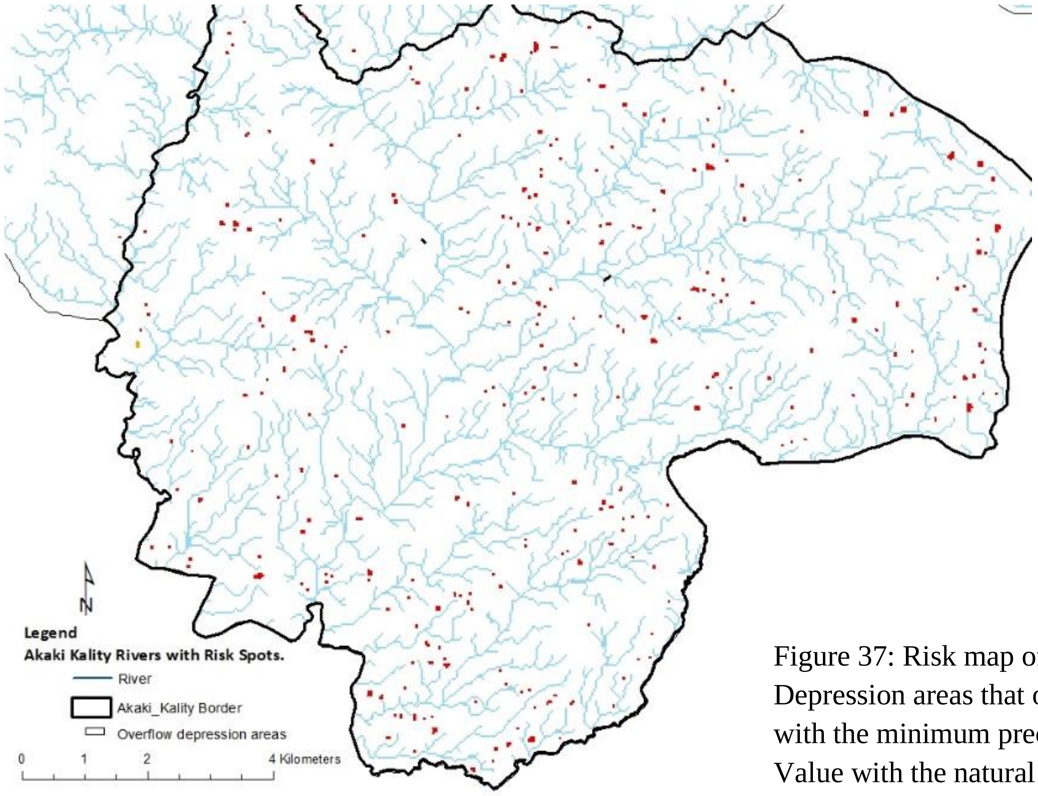

Figure 37: Risk map of Depression areas that overflow with the minimum precipitation Value with the natural stream order.

The overflow from the depression areas does not have natural drainage mechanism which surpasses the stream network of the site (Fig 37). The areas with overflow volume with the lowest precipitation considering the catchment character and seasonal factors it has an impact on the road infrastructure (Fig 38).

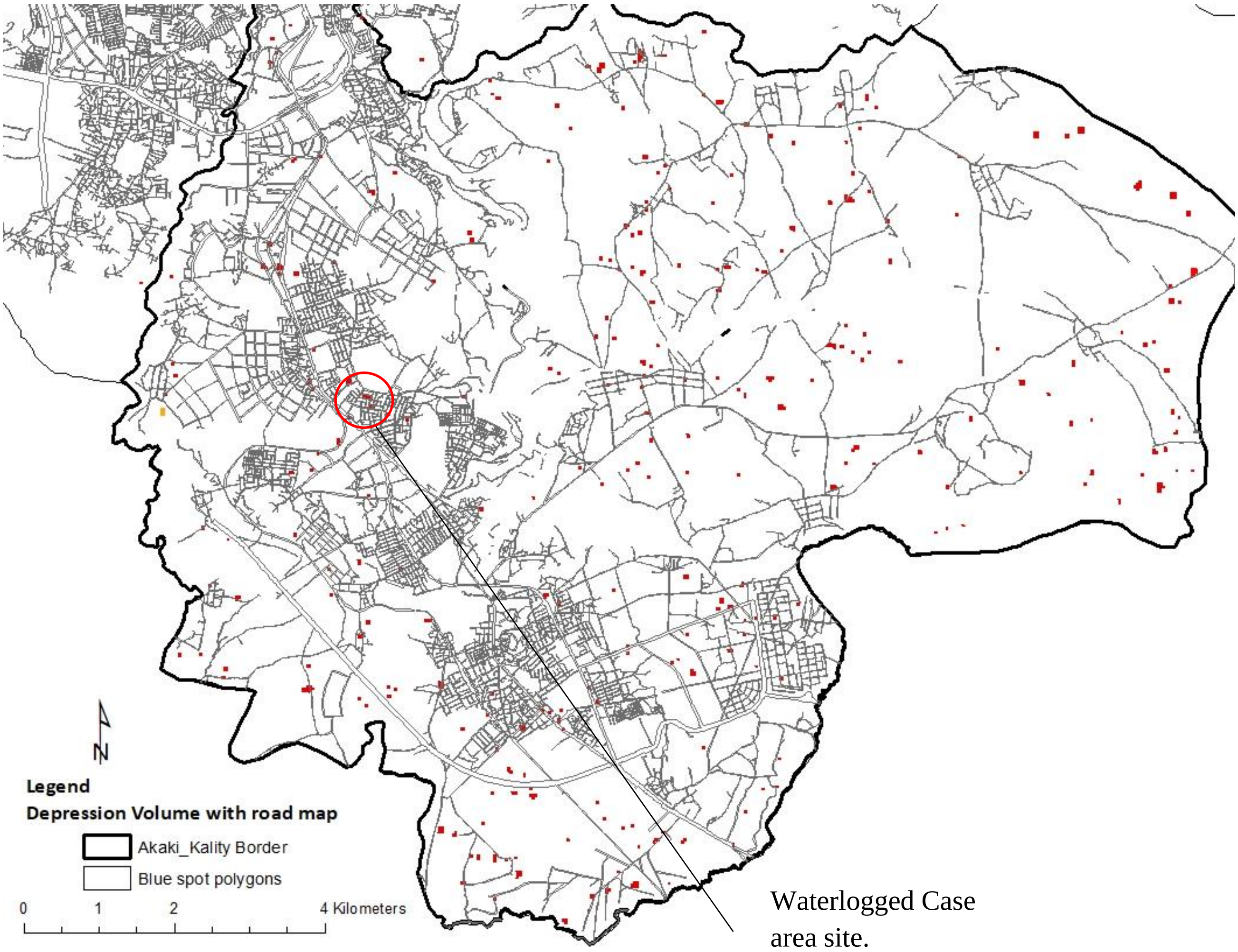

Figure 38: observing overflow depression areas with the road map of Akaki Kality Sub-city and case area site location

The case area site has a road covered with local coble stone material with a width of 8 meters excluding local developed drainages ditches along each side having 1-meter width. Peak runoff occurs from the northern part of the site to the south attending the slope and also the side adjacent roads (Fig 39 right side top picture) have major significance on adding a runoff volume to the catchment area.

Due to un attendance of Surface runoff from these side roads there create an impact on the main road surface area (right side to the bottom) . Runoff occurs with the minimum precipitation on the site.

Figure 39: The Study site in Akaki Kality Sub-city with cobblestone road features, damaged surface areas (bottom right), and (Top right)adjacent road surface to the site. (Source: photograph taken by the author on August 2019)

On the sides of the road, there are small vegetations that grow in the wet season. Due to the existence of waterlogging and flooding problem on the site, these plantations didn't have that much significance on infiltrating the water accumulation and overflow on the road. Total study area road length 101.4m with a total catchment area of 811.2 sq. m. The site peak runoff rate (Table 6) is calculated by a rational equation which gives 2.321×10^{-5} m^3/sec to 1.274×10^{-3} m^3/sec during the dry season and wet season respectively. The total runoff volume (Table 7) during the highest precipitation interval goes up to 4.588 m^3 within that catchment area.

Table 6: Peak runoff rate of the selected site considering the surface area runoff coefficient

Site Area	Intensity of rainfall/Hr			Coble Stone Paved Area	Peak runoff rate		
ha	Dry Season (Nov)	Mid wet season (Apr)	Wet Season (Aug)	Runoff coefficient 2%-10% slop	Dry Season (Nov)	Mid wet season (Apr)	Wet Season (Aug)
0.08112	0.146	3.096	8.016	0.7	2.321×10^{-5}	4.922×10^{-4}	1.274×10^{-3}

Table 7: The peak runoff volume on the study site during different seasons considering their Peak runoff rate

Site Area	Peak runoff rate				Runoff volume(m3)		
ha	Dry Season (Nov)	Mid wet season (Apr)	Wet Season (Aug)	Storm Duration(hr)	Dry Season (Nov)	Mid wet season (Apr)	Wet Season (Aug)
0.08112	2.321×10^{-5}	4.922×10^{-4}	1.274×10^{-3}	1	0.0835	1.772	4.588

Based on the risk analysis map (Fig 38) the site is found in Basin 49 Sub-basin Id of 2014 within a depression Blue spot name of 293 (Annex-3), actual depression volume of 3 m^3. But the overall catchment has a minimum runoff volume of 4.75 m3 during the smallest precipitation on high infiltration surface that overflows the actual depression volume. Assuming the road placement and the overall catchment area of the depression lies at semi-urban development the maximum runoff volume will be 71.819 m3 covering 16.16 ha of the total catchment runoff. With these rates, considering 0.08112 ha of the road area the minimum runoff volume will be 0.023 m^3 and the maximum runoff on the road will be 3.604 m3 assuming the road site is categorized in the mid urbanized area.

Based on the Intensity duration frequency curve(IDF Data)of Addis Ababa (Fig 5) taking the storm duration recurrence interval of 2,5,and10 years of Monthly rainfall Intensity the peak runoff rate and the runoff volume within 1hr, 1.50hr, and 2 hr storm duration (Table 8) Addis Ababa experience the highest 40mm/hr rainfall intensity within 10 years recurrence interval, which the runoff will be 22.895 m^3 on the site.

Table 8: Monthly rainfall intensity of Addis Ababa city based on Addis Ababa Bole observatory center from IDF curve data.

Storm Duration Recurrence interval	Area	Monthly Rainfall intensity(mm/hr)			Coble Stone Paved Area Runoff coefficient 2%-10% slop	Peak runoff rate (m3/Sec)			Runoff volume (with a given rainfall duration)		
	ha	In 1hr	In 1.5hr	In 2hr		In 1hr	In 1.5hr	In 2hr	In 1hr	In 1.5hr	In 2hr
2 years	0.0811	30	24	18	0.7	0.00477	0.00382	0.00286	17.171	20.605	20.605
5 years	0.0811	36	28	24	0.7	0.00572	0.00445	0.00382	20.605	24.040	27.474
10 years	0.0811	40	32	27	0.7	0.00636	0.00509	0.00429	22.895	27.474	30.908

So, by having the site highest daily runoff volume 4.588 m3, considering the overall catchment area runoff volume rate with respect to the site area having 3.604 m3, and taking Addis Ababa storm duration recurrence interval with 1 hr intensity of rainfall 17.17 m^3 of 2 years,20.60 $m^3$of 5 years and also considering the highest interval of 10 years with the runoff volume of 22.89 m3, the Sustainable curb extension designed to avoid the overflow from the depression area. The designed curb extension has the capacity to comprehend the runoff volume and waterlogging effect on the surface of a given road within these runoff volume rates in different circumstances.

4.2. Designing curb extension as a solution

The design of sustainable curb extension helps to minimize the rate of runoff during high intensity of precipitation. These help to control overflow of runoff volume from the site high-risk depression area, provides clear drainage lain, avoid waterlogging problem due to the near groundwater table and it have an ability to retain a certain amount of water to manage the waterlogging intensity of the area that occurs by the over-saturation of groundwater table and the maximum runoff volume. The design also serves as a bump-out to control the vehicular flow on the site Since the design includes green element, it improves the aesthetic value and boosts the livability of the neighborhood.

Figure 40: Existing case area (left side map) and study area plan with curb extension,(right side) drainage facility, individual and total catchment area of the curb infiltration capacity.

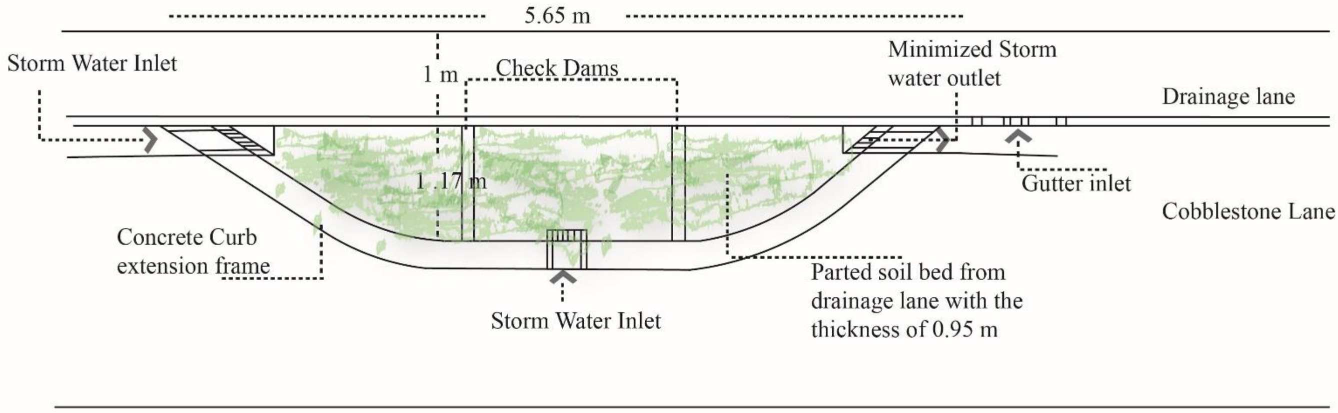

Figure 41: Detailed plan layout of the designed curb extension

The general design of curb extension lies on the existing total surface area of the road as a bump-out with an outward distance of 1.17m from the corner of the road with a length of 5.65 m. And it also has a drainage gutter lain along the road length in which the treated and minimize stormwater flows into the catchment basin. Drainage lain with 1 m width also serve as a sidewalk area by covering the top surface.

The curb extension has 2 inlet pads, one at the corner of the curb and the other one at the front that collects the total catchment runoff volume for a single curb intake. To release the outflow water from the curb extension there is an outlet pan that is connected to the drainage of the road. To stabilize the slope difference in curb extension there are check dams with a width of 1.17m. For accepting the functionality of the curb extension, it needs to facilitate the highest intensity of runoff volumes that the site gain. In this case, 4.588m^3 runoff volume from the site (Table 7),17.17 m^3,20.605 m^{3,} and 22.89m^3 volumes from IDF data (Table 8) of 2,5 and10 years respectively taken as the highest intensity runoff volume of Addis Ababa as inflow volume to the site.

To control the overflow and waterlogging intensity it takes 5 curb extension installations by the area of 4.56 m^2 into 811.2 m^2 of the total catchment area of the road. The total curb area coved by the designed curb extension is 22.8m^2 which is 3% of the total road area. The volume outflow taking 1×10^{-6} m/s infiltration capacity of the soil in 1hr storm duration, which gives 0.08208 m3 for both daily and the maximum10 years' durational intensity runoffs. The size of magazine length(depth) for the five-curb extension is calculated based on water balance from inflow and outflow stormwater. The runoff volume that one curb needs to uptake to avoid runoff on the site is 0.8938 m^3 during the wettest season and 4.562m^3 during 10 years storm duration (Table 9). Since the curb extension developed to avoid and control the highest runoff rate on the site, it considers the relapse interval of 2 ,5 and 10-year IDF data as a design input. Taking the highest runoff volume that need to be handled by individual curb capacity and considering the area of the curb 4.56 m^2, the depth is 1.01 m below the ground to retain the runoff volume covering 157.68 m^2 catchment area to drain individually.

Table 9: The final Design runoff outcome comparison with the Peak runoff rates of the site.

	Volume in flow per hr.	Volume outflow	Total curb area runoff intake	Individual curb runoff intake	Depth needed to accumulate inflow volume	Overflow from the mezzanine considering the highest depth(1.01 m)
Runoff volume on the site	4.58 m^3	0.082 m^3	4.469 m^3	0.8938 m3	0.19 m	-
Overflow from risk analyzed depression area	3.604 m^3	0.082m^3	3.52 m^3	0.704 m3	0.15 m	-
2-year recurrence runoff volume	17.17 m^3	0.082m^3	17.088 m^3	3.417 m^3	0.74 m	-
5-year recurrence runoff volume	20.60 m^3	0.082m^3	20.523 m^3	4.104 m^3	0.90 m	-
10-year recurrence runoff volume	22.895m3	0.082 m^3	22.813m^3	4.562 m3	1.01 m	0.082 m3

The designed curb extension on the street has an intake capacity of 22.813 m^3 runoff volume from the highest peak runoff rate of the site 22.895 m^3, giving the area of 811.2 m^2 and leaving 0.082 m^3 overflow to the surface. So, considering the depth and the overall area the curb takes, the volumetric capacity of the design element can handle the maximum rate of runoff during 10-year event precipitation that occurs on the site.

4.3. Identify the efficiency of the curb to avoid waterlogging and runoff using retention

Since the groundwater level of the city maximized along north to south direction and based on the risk analysis taken from the depression areas of the site catchment, the designed curb has to retain the stormwater intake to avoid waterlogging that subdue in the ground level and minimize the amount of storm drainage that outflow from the study area.

For retaining purposes, the design curb includes ponding area (30 cm depth), Mulch area (5 cm depth), Sand (50 cm depth), gravel (16 cm), and vegetation cover. Considering the infiltration rate and the void ratio of the elements the designed curb has the ability to hold a significant amount of water that will drain to the ground with a certain period of time. These processes will minimize the highest waterlogging and overflow effect occur during the maximum precipitation intensity.

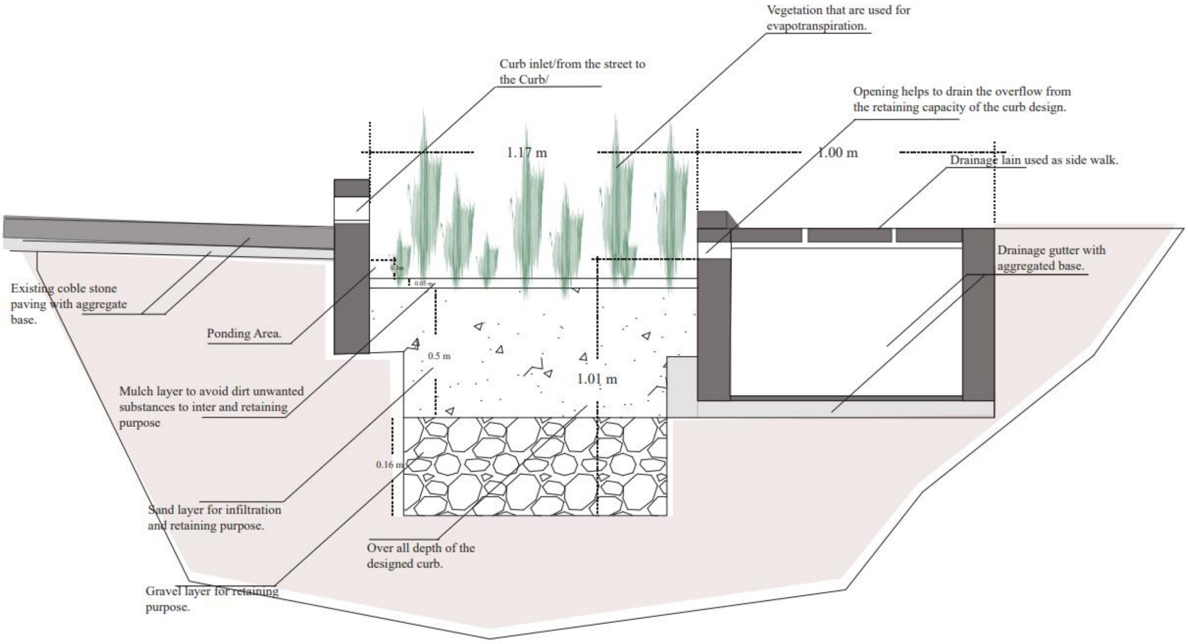

Figure 42: Sectional layout of the design curb element

Considering the highest precipitation interval 22.895 m^3 with the curb intake value of 22.813 m^3 the curb has 1.01 m depth. These depths include the elevation of the ponding area that has the ability to retain 6.84 m^3 of water, the mulch that helps to avoid dirt and segregate unwanted substances to enter and have the ability to retain 0.19 m3 of water, and considering the hydraulic property of sand and gravel they have the holding capacity of 2.28 m3 and 1.276 m3 of stormwater respectively. Also adding grass as a plantation 0.27 in/day (0.00285 m/hr.) transpiration rate, it has the ability to intake 3.75 m^3 of stormwater. The designed curb extension retains a total of 14.336m^3 volume of water with the intake of 5 curbs and 2.79m^3 volume of water retention by a single curb extension.

Table 10: Total curb retention volume intake

		Elements in the curb design hydraulic performance with their dept total of 1.01 m					
	Total Area	Ponding (0.3m)	Mulch (0.05 m)	Sand (0.5 m)	Gravel (0.16 m)	Vegetation cover	Total retaining capacity
five curb extensions	22.8 m2	6.84 m3	0.19 m3	2.28 m3	1.276 m3	3.75 m3	14.336 m^3
For individual curb	4.56 m2	1.3 m3	0.038 m3	0.456 m3	0.25 m3	0.75 m3	2.79 m^3

Having the retaining capacity of the design curb elements, the system responds in different ways throughout the different intensities of rainfall. As stated before, taking the maximum runoff volume of the site during the wet season and taking the highest precipitation intensity with 2,5- and 10-years recurrence rate, the stormwater that will channel from the curb towards the drainage facilities vary.

Curb extension efficiency rate given 4.58 m3 the highest runoff volume during the wet season (Aug) considering the Intake capacity of the designed curb extension and its final retaining capacity.

Table 11: Curb extension efficiency rate during the wet season.

Max runoff volume on the site	Volume outflow from the total curb area	Volume inflow into the curb.	Retaining capacity of the curb	Stormwater that will drain from the curb towards the drainage facilities
4.58 m3	0 – considering 1.01-meter depth	4.469 m^3(5 curb elements)	14.336 m3	Non (stormwater will retain and infiltrate to the ground.)
		0.893 m^3 (individual)	2.79 m3	

Curb extension efficiency rate given 17.17 m^3 runoff volume occur at 2 years recurrence time. Within these relapse time taking with 30 mm/hr monthly rainfall intensity.

Table 12: Curb extension efficiency rate in 2 years recurrence time.

Max runoff volume on the site	Volume outflow from the total curb area	Volume inflow into the curb.	Retaining capacity of the curb	Efficiency with %	Stormwater that will drain from the curb towards the drainage facilities
17.17 m3	0 – considering 1.01-meter depth	17.08 m3(5 curb elements)	14.336 m3	83.9 %	2.752 m3
		3.417 m3 (individual)	2.79 m3		0.62 m3

Curb extension efficiency rate given 20.60 m^3 runoff volume occur at 5 years recurrence time. Within these relapse time taking with 36 mm/hr. monthly rainfall intensity.

Table 13: Curb extension efficiency rate in 5 years recurrence time.

Max runoff volume on the site	Volume outflow from the total curb area	Volume inflow into the curb.	Retaining capacity of the curb	Efficiency with %	Stormwater that will drain from the curb towards the drainage facilities
20.60 m3	0 – considering 1.01-meter depth	20.52 m3(5 curb elements)	14.336 m3	69.86%	6.187 m3
		4.104 m3 (individual)	2.79 m3		1.314 m3

Curb extension efficiency rate taking the maximum runoff volume that occurs on 10 years recurrence time interval given 22.895 m^3. Within these relapse times, the area has the maximum precipitation of 40 mm/hr monthly rainfall intensity.

Table 14: Curb extension efficiency rate in 10 years recurrence time.

Max runoff volume on the site	Volume outflow from the total curb area	total Volume inflow into the curb and the max intake capacity of the curb.	Retaining capacity of the curb	Efficiency with %	Stormwater that will drain from the curb towards the drainage facilities
22.895 m3	0.082 m3	22.81 m3(5 curb elements)	14.336 m3	62.8 %	8.477 m3
		4.562 m3 (individual)	2.79 m3		1.772 m3

Generally, the curb design decreases the maximum water saturation and runoff volume by retaining 14.336 m3 of water from the given site of 811.2 m^2. The design considers all the possible runoff volumes that can occur on the site during the wet season within different time intervals. Considering all the highest rainfall intensity recurrence times, only the 10 years relapse time of volume intake has an excess runoff volume of 0.082 m^3 from the designed curb element. But by taking the maximum runoff volume at the wet season on the site and by taking the storm duration recurrence interval of 2 and 5 years, the design curb element successfully retains the intake volume avoiding overflow. Considering inflow volumes and retaining capacity of the curb, the design releases a certain amount of stormwater to the side drainage facilities that will feed to the downstream catchments. At 2 years, 5 years, and 10 years storm duration recurrence intensity 2.752 m^3, 6.187 m^3, 8.477m^3 volume of stormwater respectively will be drained to the drainage facility to the side of the curb.

Chapter V: Discussion

Nowadays sustainable stormwater management system is commonly applied in areas where there are high precipitation and stormwater runoff. Urbanized areas have a major problem of stormwater runoff due to the impermeability of the surface area caused by urbanization. The effects of urbanization in the urban hydrological processes are visible through the change of the surfaces that cover the city area (Yamashita et al, 2016) and the accelerating runoff flow velocity thus leads to increasing the urban flood risks and waterlogging (Weng, 2001; Li & Wang, 2009). Change in underlying surface condition, urban development, and construction led to the growth of impervious areas, reduced surface infiltration, reduced groundwater recharged, increased runoff, and increased peak flow (Ning et al,2017). Unlike higher topographical areas urban development in low-lying areas often affected by waterlogging after rainfall, since the rainwater cannot be discharged in time due to the slop character. Addis Ababa has a different topographical character that manages the hydrological flow of the city. Most urban areas have problems such as inadequate drainage facilities, lack of pipeline clogging, and rainwater collection facilities. More than half of the waterlogging points are caused by this problem. During a rain event, these facilities cannot play their role as drainage mechanism (Ning, et al, 2017). The fundamental causes of waterlogging in the city are series of problems, such as little attention to drainage projects, weak awareness of waterlogging prevention, lack of active prevention measures, and outdated planning and construction ideas (Wang, 2018).In Addis Ababa, the streets are the most affected areas caused by this stormwater runoff. Besides the amount (the ratio) of the stormwater on the site, the groundwater table has a great impact on creating waterlogging and saturation of stormwater to the site causing degradation on the infrastructure. Recent years have seen a growing number of rainstorms under the global climate change which severely impedes social management, urban operation, and people's lives. The negative effect is worsened by the backward drainage infrastructure and the lack of flood control and emergency measures. As an essential way to prevent and mitigate disasters and build sponge cities, the risk assessment of urban rainstorm waterlogging provides details on disaster risk valuation, explains the influencing factors, and gives a clear view and direction to the improvement of urban drainage system (He et al,2017).

In order to analyze the influence degree of waterlogging in urban areas, the waterlogging impact needs to be quantified and mapped. Based on the actual data acquired from the site, the spatial data related to waterlogging influence degree will be comprehensively analyzed. As the living density, urban infrastructure elements, and facilities around the waterlogging point are closely related to the influence degree analyzed. The statistical analysis function of ArcGIS software can be used to calculate the application of data within a certain buffer range. After the statistical data is normalized, a data series related to the influence degree of each waterlogging point will be obtained (Pan et al,2017). Considering these in the area of waterlogging intensity, the blue spot analysis will be taken place to map and identify all the depression areas assuming 100% catchment runoff and no drainage from the depression (Nielsen et al,2011). By analyzing the study area of Addis Ababa City hydrological character, the blue spot areas with a high risk of overflow majorly found in the south and west region of the city. Based on the topographical character of the city the lowest region with the minimum slop level is impacted by stormwater runoff overflow and waterlogging. where all depressions in the map material are identified, acquiring their actual volume allowing rain to fall on the model land surface while not allowing for infiltration into the ground or evaporation to the atmosphere is necessary. If these volumes are larger than $10m^3$ and close to a road, they are considered as threats (Hansson et al,2010). But in the analysis, some of the depression areas are less than $10m^3$. However, they have the incapability of holding the run-off volume that exerts by their catchment, which caused them to overflow. Depression areas which area overflow by the smallest precipitation rate have a higher risk of creating flooding, stormwater runoff, and water saturation (Nielsen et al, 2011). In Akaki Kality there are depression areas that area overflow by the lowest precipitation intensity of 0.146mm/hr. These areas have an actual volume capacity that is very low to hold the runoff volume exerted by their catchment or the volume that is gained by the precipitation intensity on the site. The second level is a calculation of rain sensitivity for each individual depression. It is done by assuming no drainage from depressions and assuming impermeability of the catchment of 20, 40, 50, 60, 80 & 100%. In this way, a risk map can be drawn showing the amount of precipitation needed to fill low-lying areas (Hansson et al,2010). By using the rational method of finding the peak runoff rate and the runoff volume of the catchment areas, runoff volume towards the depression spots, high-risk areas were identified. By taking the most infiltrated coefficient these depressions that have a higher risk to overflow with 0.146 mm/hr, 3.096 mm/hr, and 8.016 mm/hr during different seasonal factors. While selecting a case study area the catchment character, the overall peak runoff volume, and the infrastructure damage it exerts on that area takes into consideration. In the case area of Akaki Kality sub-city, the total catchment stormwater runoff volume is much higher than the depression area actual volume found in that catchment. This leads to the overflow of the stormwater runoff direct to the local coble stone street causing degradation.

The design of curb extension has a major significance in controlling the stormwater runoff that occurs on the site. When designing curb extension, the site surface character (infiltration rate), the total area of the site, rainfall intensity of the site, and the slop of the site taken into consideration (Wise, 2008). The designed curb is proposed on the local street of Akaki kality area. It has a coble stone layer having a 0.7 runoff coefficient within 811.2m2 as a total area of the case site. The designed curb extension in the case area has the tendency of controlling the stormwater runoff that occurs during the highest precipitation rate of monthly rainfall, which takes into consideration of the intensity duration frequency curve (IDF data) of Addis Ababa at a maximum of 10 years of recurrence interval. Considering the principles on designing the curb extension, the “Code for Design of Urban Outdoor Drainage”, implemented in China, requires: “The design of drainage pipe network must meet the standard of 3 - 5 years rain event”. The urban outdoor drainage design specification standard can only withstand rain of 27 - 33 mm/h or 100 mm/24 hours. Faced with sudden heavy rains, such a huge amount of rainfall exceeds the design standard for drainage pipelines, so it is too late to discharge, easily making waterlogging in the city (Wang, 2018). In the design based on the calculated runoff volume that occurred on the site and the monthly rainfall intensity of Addis Ababa city based on Addis Ababa Bole observatory center from IDF curve data the design considers 2, 5, and 10 years of storm duration recurrence interval, the design taking the site rainfall intensity of 8.016 mm/hr of the wet season and 30 mm/hr and 36 mm/hr of 2 and 5 years respectively. Even if the 5 years recurrence interval precipitation rate exceeds the above standard the design can manage it through infiltration, retention, and evapotranspiration techniques with the help of the sizing of the curb element. But considering the maximum 10 years recurrence interval the design has a small amount of overflow but the excess stormwater runoff is managed to be subdued to the side drainage facility.

In the design process, site analysis needed for mapping, measuring street dimensions in order to estimate the room available for retrofit treatment areas and sections of street right-of-way dimensions should be measured that helps to know the fitted size of the curb to amend right-of-way width, vehicular travel way and lane widths, curb and gutter width and utility structures widths like manholes, waterline access points, underground power and gas lines, and cable vaults (Fox, 2015).

Considering this design of curb extension facility sizing first step is the coble stone area removal from the total area of 811.2m2 subtracting the total curb area 22.8 m2 it leaves 788.4m2 of untouched coble stone area while using 3% of the total area for infiltration purpose. According to the City of Portland's 2004 Stormwater Management Manual (SWMM) specifies 6% or less for surface infiltration using the "Simplified Approach" (Gallagher,2009). The size of the designed curb extension has to experience the maximum rainfall rate it has a depth of 1.01 m with 4.56 m2 area. And the curb design has a 1-meter side drainage facility which helps to amend the excess water Curb extensions are excellent to use in steep slope conditions because they can act as a "backstop" for capturing runoff from the upstream flow. For use in green street applications, curb extensions should have check dams installed for street slopes over 2%. For street slopes over 5%, the interior of the curb extensions should be adjoined with check dams and act more as a series of planters (Fabry et al, 2010). On the design Slop of the area is also considered the minimum slop taken is 2%. In these site cases, it has a degrading character from the north of the site to the south. So, to avoid inlet water runoff in the curb check dams are needed which are equal to the bump-out width of the curb from the road to slow down the speed of the runoff into the curb itself. Also, there are outlet pads that can feed the outflow volume to the gutter. And the drainage inlets are covered by metallic mesh to avoid derbies and other blocking materials not to inter the drainage facility. But through time these curb extensions need to be maintained. According to Ethiopian road Authority the roads drainage blocked by derbies trashes and sediments witch cause flooding on the surface of the road. Those roads lack maintenance to remove these constraints. So, in the application of curb extension the problem can occur, besides it has its Owen vegetation that creates plant derbies inside the curb, blocking the outflow or blocking the drainage in late. Maintenance to remove plant derbies, trash, sediments at inlets and at the edge of the curb is needed. Inspecting for structural damage also must, whether it is on its 100% level of performance, or the storm runoff causes certain degradation.

To know the performance and efficiency of curb extension design, it is critical to quantify the benefit of the facilities incorporated and considered in the curb design (Gallagher, 2009). Vegetated curb extensions show potential and constant assessment is recommended. Performance is summarized below in regards to the specific objectives., which include peak flow reduction and flow volume reduction. Peak flows were essentially eliminated for both design storms, with outflows within the range of dry weather flows seen at the monitoring location on days without rain. a minimum 60% reduction in peak flow, and would provide protection for a majority of local basements regardless of the infiltration rate is needed (Gallagher, 2009). Considering the design of the curb extension, choosing the maximum intensity of rainfall the peak runoff reduced from 22.895 m3 to 0.082 m^3. Taking 22.81 m^3 which is 95% of the peak runoff volume is managed by the designed curb extension. And for flow volume reduction: The combination of facility volume and infiltration was able to capture a vast majority of each design storm. Volume reduction for the 24-hour storm is more closely tied to infiltration rate, with higher rates providing greater reductions. However, even with very low infiltration rates the facility would retain 20% of the total runoff volume and provide a measurable benefit to CSO control (Gallagher, 2009). The use of these facilities could greatly reduce the amount of stormwater volume reaching the future CSO tunnel system. Infiltration rates at this facility were excellent, even during saturated conditions. This ensures that the facility will be ready for subsequent storms and eliminates the need for vector control (because extended periods of standing water are unlikely (Gallagher, 2009). In the design by incorporating a certain layer of elements in the depth of the curb Infiltration, retention and evapotranspiration techniques used as a hydrological performing element to decrease not only the flow volume of the peak runoff better to attain the waterlogging problem. By considering the void ratio of the layer elements in the curb (sand and gravel), by considering the evapotranspiration of a plantation (in my design case simple grass), and by having a slight area of ponding the inflow stormwater gradually distributed to the ground and its amount reduced. The curb design retains at the maximum intensity of rainfall by 62% of its inflow volume.

Generally, the idea of a combination of “discharge and storage” is one of the important guiding ideologies for urban waterlogging management. Especially in some cities where urban drainage systems have been established and large-scale renovation is not available, the construction of urban discharge and storage system is one of the most important measures to deal with excessive rainfall (Wang, 2018). So, the design with the retention ability that will minimize the waterlogging problem by maintaining these requirements of the curb either at the design level or on the application level of the ground, the curb will effectively reduce the calculated runoff volume to the minimum and decrease the waterlogging problem on the site.

Chapter VI: Conclusion and Recommendation

6.1. Conclusion

With the development of cities from time to time and the increasing urbanization rate globally, experiencing a high rate of storm runoff volume going to be common. Roads and their drainage facilities are the major impacted areas due to these runoff volumes and the water accumulation on the surface. The study has tried to solve the problems of waterlogging and storm runoff on the site considering the catchment character of the area. To point out the major problematic areas in Addis Ababa, Wet spot analysis with respect to flooding and overflow areas taken place. These studies were done using hydrological analysis of computer tools and field inspection. During these analyses, blue spot areas of Addis Ababa identified more of to the south and western region of the city. considering the vast area coverage and the hydrological aquifer character of the city, Akaki Kality area has a higher risk of stormwater runoff and waterlogging problems. Within the basins (Annex-1) that are in Akaki kality sub-city, wet spot areas were found. These areas are analyzed based on the actual volume and based on the peak runoff rate that the catchment they are in. As the smaller volume depressions they have, wet areas experience a higher risk of overflow. Depending on the severity of possible conflicts between the blue spot and the street, the level of investigation can be expanded to analyze the rain sensitivity of individual blue spots' peak runoff rate and peak runoff volume. The blue spot(depression) area has the risk of overflow and has a high waterlog effect with the minimum precipitation selected as a case area. The site catchment area where the depression was found has an actual volume of 3 m^3 of the depression area and a total runoff volume of 71.819 m^3 of the total catchment.

To avoid overflow of stormwater runoff and waterlogging effect, a sustainable stormwater management system is designed. The sustainable design (curb extension) helps to minimize the overflow that occurs in the site and it has a tendency of minimizing the level of saturation caused by the overflow through retention, infiltrations, and evapotranspiration. The curb extension was designed in consideration of the maximum runoff volume on the site during the wet season and the storm duration recurrence interval of monthly rainfall intensity of Addis Ababa city. So, given the area of the site 811.2 m^2 to control the runoff volume 5 curb elements were proposed with an area of 4.56m^2 and depth of 1.01 m for each element. Since the design is proposed based on the risk analysis of the area peak runoff rate and peak runoff volume on different catchment states, choosing the highest runoff volume on the area and the highest intensity of precipitation, it can serve to control the maximum rate of volume intake in the site which is 22.895 m^3. In this case, the design is not affected by seasonal rainfall intensity changes and flood occurrence that affect the road infrastructure.

The designed curb extension manages the amount of inflow volume not only to avoid stormwater runoff but also to decrease water saturation caused by the overflow. By using the hydrological character (infiltration and porosity level) of the elements that are incorporated into the design, it solves the problem of waterlogging in the area. The design curb has a total retaining capacity of 14.336 m3 having a maximum of 8.477 m3 of water released to the side drainage facility. Considering this retention capacity, the design curb has the ability to retain 62 % of the maximum runoff volume that entered in the curb element. And since the intensity of the precipitation rate decreases within different storm duration recurrence interval timing of 2 and 5 years, the curb has an efficiency of managing the maximum runoff volume on the site effectively.

Generally, the designed curb extension has a higher impact to minimize and control the damage that occurred on the infrastructure caused by an uncontrolled runoff volume and overflow majorly caused by the effect of urbanization. Since the design incorporates a green element to minimize the outflow, the vegetation can provide a green street providing better environmental performance while creating an attractive and safer environment. So the proposed design controls the overall catchment volume-boosting the appearance and livability of the neighborhood include upgraded drainage systems by improved monitoring of water level to address the lower streams.

6.2. Recommendations

The applicability of Green infrastructure helps to manage stormwater and to create healthier urban environments. At the scale of a city county or neighborhood these sustainable stormwater management techniques is more effective and can be applied throughout the time by creating sustainable management of stormwater using a natural performance design. Application of this sustainable stormwater management system on a wider scale with further studies is recommended.

At the city scale:

- In the hydrological Analysis of Addis Ababa city, many local depressions need to be considered and analyzed deeply considering their minimum actual volume and their higher possibility to be overflooded by their catchment runoff volume. Which leads to infrastructure damage.
- These blue spot areas need to be measured in deeper level for future road and other infrastructure construction purposes.
- The design of sustainable curb extension should have to be given as a guideline on the road constructions considering its provision of flood protection, cleaner air, and cleaner water.
- Considering the slope of Addis Ababa there are many low land areas with the same problem of storm management and waterlogging. These types of studies will be a good opportunity to look into the waterlogging problem deeply by fellow researchers.
- Other research can be made not only on the retention and the infiltration capacity of the sustainable curb extension but for further research its cooling effect, aesthetic performance, traffic calming performance, can be considered as apart of planning and practice.

For the case study area scale

- The curb performance can be tested with an experimental application on the ground to acquire the best results of its efficiency by obtaining a certain budget for the work process.
- Considering the further research of the design it can give economic value to the community and enhancement the surrounding neighborhood wellbeing.
- By increasing the scale of sustainable storm management, it has a possibility of managing the hydrological balance of the basins which may include quality of water, habitat expansion, and other facilities in the area.

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.

Annex

Annex_1

Table A-1:Actual Volume Value of depression areas in Akaki Sub City respect to their Basin

Basin	FID	Sub Basin Id	gridcode	Area(sq m)	Area in Ha	perimeter(m)	Longitude	Latitude	water_leve	Actual Vol m3	Surfac Area of dep. in sq m	B.Spot No
Basin 48	1158	1502	291	98440.36	9.844	1380.21	38.8	9.0	2246	3	2.05	133
									2246	4	3.118	134
	1242	1594	281	88144.08	8.814	1364.81	38.8	8.9	2228	2	1.398	131
	1262	1615	273	107671.35	10.767	1865.04	38.8	8.9	2210	1	1.024	66b
	1267	1620	279	61080.36	6.108	1251.43	38.8	8.9	2220	2	1.533	130
	1354	1729	196	158838.74	15.884	2405.45	38.8	8.9	2130	0	0	62a
									2130	0	0	64
									2130	0	0	65
	1359	1735	179	61170.57	6.117	1231.23	38.8	8.9	2196	1	2.241	62b
	1360	1736	180	101703.96	10.170	1938.70	38.8	8.9	2198	1	0.746	63
	1378	1762	191	96183.92	9.618	1752.14	38.8	8.9	2170	2	1.369	61
	1408	1803	189	84928.47	8.493	1535.13	38.8	8.9	2184	6	12.758	60
	1411	1807	185	56294.73	5.629	1191.49	38.8	8.9	2180	1	1.447	59
	1428	1832	186	79036.66	7.904	1232.55	38.8	8.9	2181	0	0.868	58b
	1431	1836	161	179124.20	17.912	1978.80	38.8	8.9	2167	3	3.841	45
	1432	1837	173	63502.04	6.350	1197.12	38.8	8.9	2169	1	0.8	47
	1438	1844	182	114121.63	11.412	1794.08	38.8	8.9	2184	3	4.844	55
									2186	1	0.808	56
									2184	1	0.849	58a
	1444	1852	176	213251.27	21.325	2200.51	38.8	8.9	2185	5	4.227	50
									2174	2	2.906	52
									2182	1	0.797	53
									2185	4	3.971	54
	1452	1863	145	51942.98	5.194	990.50	38.8	8.9	2161	2	1.092	42a
	1458	1870	143	56720.75	5.672	1360.85	38.8	8.9	2165	3	1.575	44
	1469	1887	152	168442.12	16.844	2249.35	38.8	8.9	2185	1	7.954	48
									2185	2	1.085	49
	1483	1903	142	104295.46	10.430	1715.39	38.8	8.9	2164	1	1.806	42b
									2160	16	9.833	43
	1499	1924	125	79732.01	7.973	1242.44	38.8	8.9	2166	6	5.8	19
	1501	1926	146	104875.75	10.488	1639.98	38.8	8.9	2177	3	2.751	17
									2177	9	8.362	18
	1504	1929	148	101496.28	10.150	1813.18	38.8	8.9	2181	1	2.732	16
	1511	1939	111	138388.22	13.839	2170.16	38.7	8.9	2155	1	0.625	9
									2155	1	0.452	10
	1513	1941	115	277841.21	27.784	2766.00	38.7	8.9	2198	23	54.7	20
	1514	1942	100	68217.83	6.822	1422.92	38.8	8.9	2175	2	1.17	14
	1519	1948	113	96528.43	9.653	2246.21	38.8	8.9	2173	5	5.357	15
	1523	1954	114	56628.26	5.663	1270.35	38.8	8.9	2157	2	1.806	8
	1543	1989	97	189887.81	18.989	2283.81	38.8	8.9	2162	6	2.72	7
	1546	1993	98	85553.37	8.555	1423.61	38.8	8.9	2139	5	4.367	5
									2139	3	2.555	6
	1557	2005	3	96982.55	9.698	1507.19	38.7	8.9	2130	1	0.432	1
Basin 49	922	1271	1006	96353.39	9.635	1592.04	38.8	8.9	2200	2	1.612	239
	939	1303	1002	115945.66	11.595	1783.51	38.8	8.9	2196	1	0.54	240
	945	1310	880	115774.54	11.577	1700.43	38.8	8.9	2214	6	6.471	611
	951	1319	908	69282.21	6.928	1388.99	38.8	8.9	2215	1	1.45	601
	954	1323	991	37506.49	3.751	1042.90	38.8	8.9	2166	1	1.334	242
	960	1332	882	55397.00	5.540	1074.05	38.8	8.9	2218	2	2.661	612
	964	1338	883	63042.93	6.304	1219.40	38.8	8.9	2217	1	2.106	613
									2209	0	0.491	614a
	968	1344	905	49366.14	4.937	1116.22	38.8	8.9	2221	1	1.546	604
	972	1349	904	130268.84	13.027	1736.88	38.8	8.9	2222	1	1.431	603
									2222	2	2.309	607
	978	1356	827	134137.55	13.414	1968.72	38.8	8.9	2216	3	3.696	615
	979	1357	906	52213.14	5.221	1186.26	38.8	8.9	2219	1	1.277	602
	986	1366	995	316454.11	31.645	3594.69	38.8	8.9	2225	4	2.95	238
	987	1369	815	87430.48	8.743	1217.22	38.8	8.9	2202	3	2.177	625
	990	1373	998	276086.17	27.609	3058.23	38.8	8.9	2212	1	0.541	241
	994	1377	823	126021.46	12.602	1978.28	38.8	8.9	2213	2	1.273	616
	997	1381	810	98987.89	9.899	1847.93	38.8	8.9	2196	2	3.253	626

	998	1382	751	60430.70	6.043	1033.79	38.8	8.9	2222	0	0.95	605
									2222	1	2.046	606
	999	1383	938	57177.15	5.718	1287.59	38.8	8.9	2216	1	1.705	535
	1000	1384	798	88788.19	8.879	1561.73	38.8	8.9	2187	1	1.165	627
	1002	1387	748	78407.20	7.841	1304.45	38.8	8.9	2219	1	1.384	608
	1013	1402	785	189236.84	18.924	2335.84	38.8	8.9	2174	7	6.922	632
	1015	1404	745	74313.33	7.431	1458.73	38.8	8.9	2226	2	3.702	548
	1019	1408	784	284928.92	28.493	2468.69	38.8	8.9	2173	3	2.151	225
	1023	1412	927	73306.07	7.331	1636.21	38.8	8.9	2222	0	0.77	547
	1024	1413	928	85207.53	8.521	1704.36	38.8	8.9	2223	2	4.55	545
	1025	1414	779	69184.98	6.918	1050.76	38.8	8.9	2186	1	1.821	243
									2186	5	9.691	244
	1026	1415	778	53081.99	5.308	1035.53	38.8	8.9	2179	1	1.974	245
	1029	1419	945	197601.68	19.760	2978.25	38.8	8.9	2242	3	3.125	519
									2242	1	0.701	520a
									2227	3	1.936	523
									2234	1	1.107	524
	1030	1420	735	208551.11	20.855	2402.09	38.8	8.9	2221	3	4.827	609
									2221	1	1.402	610
	1035	1426	929	146271.63	14.627	2275.69	38.8	8.9	2224	2	4.123	544
	1038	1429	783	74585.91	7.459	1410.77	38.8	8.9	2169	3	2.804	631
	1040	1432	775	67821.28	6.782	1096.09	38.8	8.9	2170	2	2.519	246
	1041	1433	731	95657.52	9.566	1516.99	38.8	8.9	2213	1	1.682	621
									2208	4	4.89	633
	1043	1435	931	212997.03	21.300	2713.27	38.8	8.9	2226	4	2.557	536
									2226	2	1.831	541
									2226	1	1.015	542
									2226	1	1.072	543
	1044	1436	937	168037.07	16.804	2667.46	38.8	8.9	2231	0	0.388	525
	1047	1441	730	68101.94	6.810	1400.00	38.8	8.9	2197	0	0.676	622
	1049	1443	765	191383.98	19.138	2862.22	38.8	8.9	2190	1	0.59	628
	1051	1445	739	151067.37	15.107	2007.70	38.8	8.9	2224	4	6.043	549
									2211	1	2.46	552
	1055	1450	725	157041.09	15.704	2283.82	38.8	8.9	2216	1	2.483	619
	1058	1454	781	70998.69	7.100	1321.93	38.8	8.9	2185	3	7.607	247
	1060	1456	769	114268.89	11.427	2086.84	38.8	8.9	2187	2	1.97	251
	1064	1461	716	140273.68	14.027	2077.96	38.8	8.9	2195	1	0.871	624
	1065	1462	718	250766.39	25.077	3067.83	38.8	8.9	2214	1	1.569	617
									2214	0	0.647	618
	1068	1467	721	48837.57	4.884	921.36	38.8	8.9	2183	0	0.471	623
	1070	1469	332	128757.49	12.876	1851.01	38.8	8.9	2217	1	1.089	532
									2217	1	1.096	533
									2218	2	3.05	534
	1072	1471	354	101592.40	10.159	1529.35	38.8	8.9	2241	2	3.084	517
	1074	1475	708	104255.78	10.426	1817.94	38.8	8.9	2184	2	3.661	629
	1076	1477	330	109573.04	10.957	1849.57	38.8	8.9	2220	2	2.782	538
	1078	1481	331	88768.59	8.877	1403.14	38.8	8.9	2209	1	0.896	537
	1079	1482	333	145342.59	14.534	1884.63	38.8	8.9	2216	0	0.629	531
	1084	1488	350	89494.83	8.949	1865.00	38.8	8.9	2239	0	1.199	518
	1085	1489	773	129035.50	12.904	1844.83	38.8	8.9	2180	2	2.46	248
	1089	1496	758	86076.64	8.608	1790.90	38.8	8.9	2172	2	1.537	630
	1092	1499	346	125559.87	12.556	1915.81	38.8	8.9	2239	0	0.643	520b
									2231	0	0.308	526
	1097	1505	343	161899.10	16.190	1648.55	38.8	8.9	2221	0	0.466	527
	1098	1507	709	106041.78	10.604	1606.19	38.8	8.9	2166	2	2.517	600
	1102	1512	319	78177.38	7.818	1628.70	38.8	8.9	2218	2	3.259	539
	1103	1514	339	104858.72	10.486	1796.91	38.8	8.9	2223	2	2.566	529
	1109	1520	715	73425.43	7.343	1455.28	38.8	8.9	2180	1	2.05	597
	1110	1521	720	54876.94	5.488	1187.61	38.8	8.9	2189	0	0.695	596
	1112	1524	335	78615.99	7.862	1414.24	38.8	8.9	2217	3	4.425	530
	1117	1530	320	236961.39	23.696	2831.00	38.8	8.9	2226	3	4.541	540
									2226	1	1.167	550
									2226	1	1.565	551
	1124	1538	695	79650.45	7.965	1359.91	38.8	8.9	2209	1	3.373	592
	1127	1542	770	120315.19	12.032	1680.07	38.8	8.9	2181	1	1.835	252
	1129	1544	696	171146.00	17.115	2001.75	38.8	8.9	2215	1	1.08	557
									2215	2	2.256	558
	1132	1548	303	76825.29	7.683	1347.70	38.8	8.9	2219	2	3.326	554
	1133	1549	348	69413.46	6.941	1150.14	38.8	8.9	2232	1	0.252	487
	1134	1550	352	325085.98	32.509	3372.39	38.8	8.9	2261	8	5.887	484

									2239	1	0.489	486
	1137	1553	304	138030.23	13.803	1668.24	38.8	8.9	2221	4	4.948	553
	1140	1557	340	98505.80	9.851	1982.59	38.8	8.9	2224	1	2.111	493
	1141	1560	325	80478.33	8.048	1369.24	38.8	8.9	2211	2	2.19	501
	1143	1563	469	117477.89	11.748	1701.80	38.8	8.9	2257	1	1.072	483
	1144	1564	639	143242.62	14.324	1728.80	38.8	8.9	2187	0	1.217	249
	1145	1565	640	75261.49	7.526	1284.27	38.8	8.9	2188	1	1.022	250
	1146	1566	761	114464.69	11.446	1989.04	38.8	8.9	2177	3	5.723	259a
	1148	1569	688	48606.22	4.861	1612.65	38.8	8.9	2197	0	0.551	593
	1150	1572	689	118583.79	11.858	1661.49	38.8	8.9	2199	2	2.899	594
									2197	1	1.478	595
	1151	1573	698	121138.66	12.114	1993.37	38.8	8.9	2187	2	1.204	599
	1152	1575	316	76204.39	7.620	1352.15	38.8	8.9	2208	1	1.536	555
	1153	1576	345	240488.57	24.049	3155.53	38.8	8.9	2231	1	0.808	492
	1157	1581	341	129644.08	12.964	1806.06	38.8	8.9	2229	1	0.93	494
	1159	1583	756	77784.90	7.778	1648.65	38.8	8.9	2177	8	8.958	259b
	1160	1585	693	102603.47	10.260	1549.01	38.8	8.9	2211	5	3.691	560
	1168	1595	301	118566.93	11.857	1558.77	38.8	8.9	2210	1	1.336	559
	1170	1598	638	94542.04	9.454	1557.22	38.8	8.9	2182	1	2.089	309
									2184	5	5.498	310
	1172	1600	612	84400.01	8.440	1335.95	38.8	8.9	2181	4	5.032	255
	1178	1608	754	95970.60	9.597	1620.01	38.8	8.9	2177	7	5.508	260
									2177	0	0.44	261
	1183	1613	691	76571.40	7.657	1686.58	38.8	8.9	2205	1	1.422	563
	1185	1615	322	106807.67	10.681	1634.34	38.8	8.9	2220	1	0.162	500
	1191	1621	687	55629.65	5.563	1077.59	38.8	8.9	2198	3	4.307	569
	1193	1627	635	58775.54	5.878	1444.78	38.8	8.9	2181	1	1.088	256
	1196	1631	644	100639.71	10.064	1782.91	38.8	8.9	2183	1	2.148	307
									2183	0	0.769	308
	1197	1632	682	197768.42	19.777	2195.54	38.8	8.9	2195	4	2.578	598
	1200	1636	643	100418.07	10.042	1543.50	38.8	8.9	2180	3	4.125	305
									2178	0	0.761	306
	1204	1640	307	93794.09	9.379	1417.21	38.8	8.9	2200	1	0.764	556
	1207	1643	692	83415.74	8.342	1381.35	38.8	8.9	2203	1	2.303	567
	1209	1645	462	59890.05	5.989	1015.09	38.8	8.9	2235	0	0.556	482
	1211	1648	315	202517.19	20.252	2538.67	38.8	8.9	2215	1	1.346	502
	1217	1658	610	191380.65	19.138	3374.06	38.8	8.9	2180	4	3.827	253
									2175	1	0.264	257
									2171	1	0.242	258
	1222	1663	460	91725.89	9.173	1811.08	38.8	8.9	2239	4	6.433	485
	1226	1668	683	194208.43	19.421	2398.36	38.8	8.9	2202	2	1.683	568
									2202	1	0.511	570
	1229	1673	676	86555.10	8.656	1802.07	38.8	8.9	2171	1	0.858	265
									2167	2	1.898	266
	1234	1678	604	76221.40	7.622	1926.53	38.8	8.9	2132	2	1.416	264b
	1235	1679	609	101145.18	10.115	1700.07	38.8	8.9	2179	4	5.497	262
									2174	4	7.424	263
	1236	1680	311	79223.87	7.922	1301.90	38.8	8.9	2215	2	4.616	503
									2213	0	0.69	504
	1239	1683	421	66072.56	6.607	1046.88	38.8	8.9	2218	3	4.693	497
									2216	1	3.312	498
	1247	1692	458	93544.13	9.354	1640.15	38.8	8.9	2232	1	0.544	488
									2226	2	3.486	489
	1252	1699	618	53361.93	5.336	1273.53	38.8	8.9	2130	2	2.4	264a
	1259	1707	312	47316.37	4.732	943.81	38.8	8.9	2208	1	2.816	506
	1264	1712	645	134921.49	13.492	2406.13	38.8	8.9	2178	1	1.29	304
	1267	1715	296	265826.21	26.583	2591.96	38.8	8.9	2209	0	0.761	561
									2209	1	1.24	562
	1273	1722	617	226507.52	22.651	3167.70	38.8	8.9	2184	4	5.095	254
	1274	1723	674	97183.37	9.718	1897.07	38.8	8.9	2167	1	1.358	267
									2167	0	0.01	268
	1275	1724	292	122248.74	12.225	1800.65	38.8	8.9	2202	1	1.756	565
									2199	1	1.248	566
	1280	1731	619	65309.06	6.531	1259.37	38.8	8.9	2153	0	1.584	301
	1283	1735	291	71436.58	7.144	1534.08	38.8	8.9	2199	3	3.881	571
	1285	1737	454	324567.72	32.457	2879.43	38.8	8.9	2227	2	1.52	490
									2207	1	1.671	491
	1296	1752	299	104742.30	10.474	1654.31	38.8	8.9	2196	1	1.254	509
	1299	1755	672	61328.48	6.133	1372.92	38.8	8.9	2165	2	1.534	578
	1303	1760	646	93044.93	9.304	1472.60	38.8	8.9	2178	0	1.634	302

									2178	0	1.35	303
	1304	1761	602	88989.47	8.899	1338.39	38.8	8.9	2140	3	3.436	269
	1305	1763	293	102394.86	10.239	2010.09	38.8	8.9	2187	-1	-1	510
									2176	0	0.11	564
	1309	1769	624	94649.74	9.465	2003.70	38.8	8.9	2178	1	0.902	300
	1315	1776	430	61063.85	6.106	1184.25	38.8	8.9	2207	1	1.334	496
	1321	1784	599	186305.28	18.631	2074.79	38.8	8.9	2133	2	1.164	270
	1322	1785	287	91720.14	9.172	1924.05	38.8	8.9	2193	1	0.888	575
									2187	0	0.492	576
	1324	1789	455	82137.93	8.214	1620.14	38.8	8.9	2221	4	4.905	456
	1326	1793	414	339504.25	33.950	4242.09	38.8	8.9	2228	2	2.855	495
									2228	0	0.05	499
	1344	1812	626	133386.42	13.339	1548.04	38.8	8.9	2174	2	3.13	299
	1356	1825	616	98904.36	9.890	2000.49	38.8	8.9	2171	3	1.46	297
	1358	1827	409	125064.78	12.506	2281.08	38.8	8.9	2216	0	0.447	505
	1368	1838	569	54604.05	5.460	1118.40	38.8	8.9	2135	2	1.662	276
	1369	1840	369	192977.59	19.298	2374.55	38.8	8.9	2208	0	0.431	507b
									2208	1	1.535	508
									2187	2	1.888	511
	1375	1846	407	96568.03	9.657	2033.19	38.8	8.9	2206	0	0.295	507a
	1379	1850	658	213562.76	21.356	3047.09	38.8	8.9	2197	1	2.052	572
									2197	1	1.044	573
	1387	1859	281	222677.73	22.268	2741.81	38.8	8.9	2194	1	1.349	574
									2174	2	1.586	577
	1390	1862	589	159198.80	15.920	1849.76	38.8	8.9	2137	4	3.228	271
									2129	6	6.279	273
	1397	1869	363	140731.50	14.073	1745.79	38.8	8.9	2184	1	0.959	512
									2182	1	1.271	513
									2178	1	2.669	514
	1413	1887	591	47874.28	4.787	978.13	38.8	8.9	2111	1	1.085	298
	1414	1888	572	56058.91	5.606	1209.30	38.8	8.9	2116	1	2.15	275
	1426	1904	585	161455.57	16.146	2159.69	38.8	8.9	2181	2	1.59	295
									2181	0	0.459	296
	1428	1907	568	222764.09	22.276	2707.30	38.8	8.9	2140	3	3.092	272
									2125	2	1.99	274
	1429	1908	659	293453.83	29.345	3379.75	38.8	8.9	2181	5	3.079	580
									2181	2	1.972	581
									2174	4	3.323	582
	1431	1910	277	73617.37	7.362	1218.88	38.8	8.9	2170	2	3.685	432
	1436	1916	271	83316.16	8.332	1571.04	38.8	8.9	2172	0	0.146	579
									2165	0	1.516	584
	1437	1917	424	100171.11	10.017	1533.71	38.8	8.9	2212	0	0.552	452
	1438	1919	428	193322.74	19.332	2326.62	38.8	8.9	2217	1	1.147	451
	1439	1920	581	112657.87	11.266	2108.46	38.8	8.9	2163	0	0.392	289a
	1447	1934	377	149982.45	14.998	2211.79	38.8	8.9	2213	0	0.185	448
	1448	1935	415	132723.39	13.272	2210.15	38.8	8.9	2216	1	1.923	449
									2216	0	0.126	450
	1451	1939	556	52077.36	5.208	1093.84	38.8	8.9	2114	3	4.581	277
	1452	1940	655	64688.83	6.469	1344.22	38.8	8.9	2162	1	2.606	587
	1456	1944	439	65338.08	6.534	1360.33	38.8	8.9	2232	1	1.976	442
	1461	1951	269	51894.89	5.189	1213.36	38.8	8.9	2163	2	2.177	586
	1464	1954	367	78855.98	7.886	1587.59	38.8	8.9	2177	1	1.299	404
	1470	1960	488	123596.51	12.360	2305.03	38.8	8.9	2253	1	1.275	455
	1473	1963	567	122748.55	12.275	2456.05	38.8	8.9	2116	5	6.919	278
									2119	2	4.19	290
	1476	1968	653	54996.00	5.500	1382.69	38.8	8.9	2162	1	2.042	588
									2162	3	2.993	589
	1477	1970	359	108245.81	10.825	1444.33	38.8	8.9	2172	1	1.629	430
	1479	1972	263	52244.11	5.224	1117.80	38.8	8.9	2158	0	0.49	591
	1480	1973	270	81025.11	8.103	1507.73	38.8	8.9	2166	1	1.315	585
	1481	1974	397	51559.67	5.156	1131.65	38.8	8.9	2215	0	0.721	447
	1482	1975	398	65403.59	6.540	1235.24	38.8	8.9	2219	0	0.12	445
									2218	1	1.492	446
	1483	1976	273	78053.10	7.805	1608.85	38.8	8.9	2175	0	0.528	431
									2172	1	2.09	433
	1484	1979	651	99342.58	9.934	1583.51	38.8	8.9	2158	1	1.308	590
	1488	1983	587	171707.24	17.171	2159.52	38.8	8.9	2176	1	1.248	294
	1491	1987	403	76030.46	7.603	1272.59	38.8	8.9	2224	1	2.064	443
	1493	1989	576	111825.77	11.183	1827.88	38.8	8.9	2124	5	6.226	291
									2128	1	1.796	292

	1495	1992	381	58941.44	5.894	1137.75	38.8	8.9	2196	0	0.11	401b
	1496	1993	400	65932.23	6.593	1590.33	38.8	8.9	2223	2	3.035	444
	1507	2005	492	151219.72	15.122	1656.76	38.9	8.9	2269	3	3.633	454
	1509	2007	266	138359.22	13.836	1579.46	38.8	8.9	2156	1	2.53	437
	1512	2014	583	161607.45	16.161	2306.31	38.8	8.9	2163	3	9.32	293
	1516	2019	256	57142.66	5.714	1084.32	38.8	8.9	2166	1	1.321	436
	1518	2021	365	115205.03	11.521	1825.63	38.8	8.9	2202	1	1.827	400
									2200	1	1.24	403
									2190	0	0.485	405
	1519	2022	561	98977.41	9.898	1738.50	38.8	8.9	2160	1	0.857	280
	1522	2026	578	101871.58	10.187	1424.16	38.8	8.9	2163	0	0.858	288b
									2163	1	1.549	289b
	1525	2029	267	51717.41	5.172	1089.65	38.8	8.9	2153	4	4.92	438
	1527	2031	121	91099.88	9.110	1368.01	38.8	8.9	2186	0	0.945	407
	1528	2032	123	122837.51	12.284	1712.06	38.8	8.9	2192	6	9.618	406
	1529	2033	364	148641.69	14.864	2251.58	38.8	8.9	2203	2	2.568	397
									2201	1	1.648	398
									2198	0	0.452	402
	1532	2036	552	66082.91	6.608	1042.70	38.8	8.9	2162	3	4.876	279
	1535	2039	255	143389.82	14.339	2226.63	38.8	8.9	2170	1	1.446	434
	1537	2041	222	182857.92	18.286	2445.79	38.8	8.9	2236	4	1.617	377
	1539	2045	387	102043.47	10.204	1731.88	38.8	8.9	2197	0	0.51	453
	1543	2049	203	72048.21	7.205	1423.35	38.8	8.9	2213	1	1.677	380
									2213	1	1.538	381
	1544	2050	564	57285.12	5.729	1270.51	38.8	8.9	2164	1	1.008	282
	1547	2053	386	73437.66	7.344	1446.07	38.8	8.9	2205	1	1.481	390
	1551	2057	153	66049.61	6.605	1325.52	38.8	8.9	2203	5	5.752	399
	1552	2058	383	136718.04	13.672	1740.04	38.8	8.9	2203	1	2.118	396
									2192	0	0.389	401a
	1554	2060	565	70394.22	7.039	1325.38	38.8	8.9	2159	1	2.892	281
	1557	2064	253	66884.60	6.688	1107.95	38.8	8.9	2149	1	1.178	439
									2140	1	1.306	441
	1559	2066	251	56564.25	5.656	1452.08	38.8	8.9	2144	1	1.426	440
	1561	2070	124	68988.68	6.899	1216.65	38.8	8.9	2173	1	1.269	415
									2175	1	1.778	416
	1562	2071	60	62277.62	6.228	1304.57	38.8	8.9	2163	3	4.965	286
									2163	0	1.57	288a
	1563	2072	59	52187.14	5.219	981.80	38.8	8.9	2164	0	0.54	285
	1564	2073	58	69521.65	6.952	1373.76	38.8	8.9	2162	2	3.817	287
	1575	2092	56	144314.78	14.431	1843.66	38.8	8.9	2169	1	1.166	283
									2166	1	0.781	284
	1577	2094	120	366843.44	36.684	3880.51	38.8	8.9	2168	3	1.869	418
	1580	2097	249	48268.68	4.827	1233.75	38.8	8.9	2134	1	0.782	420
	1581	2098	200	102560.68	10.256	1702.69	38.8	8.9	2203	1	1.152	384
	1585	2103	125	236799.71	23.680	3203.53	38.8	8.9	2177	2	1.733	417
	1586	2105	202	64643.35	6.464	1244.33	38.8	8.9	2208	0	0.766	383b
	1589	2108	201	116952.45	11.695	1876.43	38.8	8.9	2212	1	1.696	378
									2212	2	2.787	382
									2207	0	0.991	383a
	1590	2109	224	117679.69	11.768	1856.15	38.8	8.9	2329	1	1.604	375
	1592	2113	174	133167.99	13.317	2057.53	38.8	8.9	2206	3	3.97	391
									2206	1	1.313	392
	1595	2116	78	77436.69	7.744	1557.41	38.8	8.9	2160	1	1.064	311
	1597	2120	245	73110.06	7.311	1575.86	38.8	8.9	2135	5	2.872	424
	1605	2129	118	88874.58	8.887	1679.07	38.8	8.9	2140	1	1.117	419
	1610	2134	117	147389.39	14.739	2036.78	38.8	8.9	2145	0	0.556	413
									2158	1	1.201	414
	1615	2140	164	90796.53	9.080	1586.18	38.8	8.9	2188	3	3.061	393
	1623	2149	115	159505.82	15.951	2719.12	38.8	8.9	2150	0	0.432	411
									2145	0	0.154	412a
	1624	2150	137	149497.43	14.950	2617.80	38.8	8.9	2168	1	1.05	408
	1625	2151	146	96708.90	9.671	1960.98	38.8	8.9	2170	1	1.648	395
	1628	2156	199	108187.00	10.819	1750.69	38.8	8.9	2202	1	1.354	379
	1629	2157	232	432083.76	43.208	3432.07	38.8	8.9	2105	1	0.432	315
	1633	2163	172	128519.84	12.852	2277.69	38.8	8.9	2199	1	1.717	385
	1635	2165	96	109548.17	10.955	1671.84	38.8	8.9	2134	1	0.77	421
									2129	0	1.413	422
	1637	2167	165	47671.46	4.767	1232.38	38.8	8.9	2173	1	1.531	394
	1638	2168	77	110315.17	11.032	2454.43	38.8	8.9	2158	5	3.042	312
	1645	2177	214	117242.62	11.724	1706.58	38.8	8.9	2218	1	0.708	376

	1651	2185	112	120859.49	12.086	1821.26	38.8	8.9	2123	1	2.345	423
	1653	2188	45	77263.86	7.726	1744.11	38.8	8.9	2134	1	0.546	313
	1656	2191	26	89478.14	8.948	1566.11	38.8	8.9	2108	2	2.902	318
	1665	2204	126	86773.25	8.677	1331.59	38.8	8.9	2129	3	3.676	410
	1670	2210	28	192179.61	19.218	2458.21	38.8	8.9	2172	2	1.522	314
	1674	2218	90	74049.74	7.405	1325.75	38.8	8.9	2112	0	0.745	425
	1676	2224	145	70738.74	7.074	1240.13	38.8	8.9	2151	1	1.635	409
	1678	2226	108	61276.96	6.128	1048.58	38.8	8.9	2115	0	1.414	427
									2113	2	3.368	428
	1680	2229	158	48977.79	4.898	1182.71	38.8	8.9	2150	0	0.899	388
	1684	2233	195	76633.46	7.663	1553.42	38.8	8.9	2184	3	2.735	386
	1685	2234	94	144998.09	14.500	1895.23	38.8	8.9	2122	1	1.324	426
									2118	4	4.007	429
	1686	2235	206	58200.74	5.820	1010.15	38.8	8.9	2194	1	1.409	373
	1694	2245	129	37801.79	3.780	916.77	38.8	8.9	2122	1	1.701	359
	1695	2246	155	49844.74	4.984	1305.65	38.8	8.9	2138	1	1.117	389
	1697	2249	74	102329.96	10.233	1852.71	38.8	8.9	2114	2	1.598	316
	1700	2253	211	84922.87	8.492	1610.06	38.8	8.9	2192	1	2.83	374
	1701	2254	27	89288.37	8.929	1491.42	38.8	8.9	2112	3	4.301	317
	1704	2258	189	69108.19	6.911	1325.16	38.8	8.9	2151	1	1.463	387
	1716	2271	134	72101.72	7.210	1180.40	38.8	8.9	2143	6	16.04	360
	1726	2285	186	61358.36	6.136	1617.13	38.8	8.9	2148	1	1.24	372
	1728	2288	142	98528.37	9.853	1473.44	38.8	8.9	2148	1	2.299	361
									2152	0	1.122	362a
									2145	2	1.848	363
	1729	2289	156	114455.80	11.446	1621.71	38.8	8.9	2154	1	1.114	362b
	1732	2292	106	152397.51	15.240	2090.53	38.8	8.9	2130	4	5.586	357
									2113	1	3.692	358
	1734	2294	180	65931.88	6.593	1211.41	38.8	8.9	2149	4	6.961	364
	1736	2296	228	77662.74	7.766	1509.12	38.8	8.9	2158	0	0.768	368
	1740	2301	227	34449.93	3.445	975.53	38.8	8.9	2153	0	0.545	365b
	1741	2305	25	159158.18	15.916	2098.21	38.8	8.9	2099	3	3.545	320
	1742	2306	101	86411.90	8.641	1735.64	38.8	8.9	2129	5	5.999	356
	1745	2309	98	83650.52	8.365	1525.34	38.8	8.9	2102	1	1.035	354
	1746	2310	43	434595.02	43.460	3087.04	38.8	8.9	2097	3	2.537	319
	1748	2312	100	113746.12	11.375	1448.87	38.8	8.9	2104	0	0.9	355
	1750	2314	44	67218.22	6.722	1248.01	38.8	8.9	2087	1	0.901	321
									2081	2	3.13	324
	1755	2319	183	155921.50	15.592	2061.35	38.8	8.9	2154	0	0.449	365a
									2157	1	0.821	366
									2159	1	1.887	367
	1756	2320	230	114874.33	11.487	1556.54	38.8	8.9	2168	1	1.547	371
	1761	2325	229	61048.93	6.105	1225.56	38.8	8.9	2159	0	0.667	369
	1766	2331	231	117427.96	11.743	1344.20	38.8	8.9	2160	1	1.219	370
	1768	2333	22	119737.20	11.974	1746.45	38.8	8.9	2078	1	1.408	323
	1770	2335	37	102588.91	10.259	1364.12	38.8	8.9	2071	1	0.255	350
	1771	2336	23	199670.95	19.967	2116.64	38.8	8.9	2084	1	1.073	322
									2081	3	3.542	325
									2079	0	0.823	326
									2078	2	2.238	328
	1772	2337	66	127930.65	12.793	1917.90	38.8	8.9	2085	2	1.168	353
	1773	2338	64	100105.39	10.011	1800.19	38.8	8.9	2072	2	3.434	351
	1774	2339	42	131980.51	13.198	1659.62	38.8	8.9	2078	1	1.368	327
	1775	2340	67	76333.16	7.633	1190.85	38.8	8.9	2073	5	7.571	352
	1777	2342	34	77157.25	7.716	1439.58	38.8	8.9	2071	1	1.153	348
									2071	2	2.951	349
	1781	2346	14	140557.00	14.056	1669.08	38.8	8.9	2078	2	2.36	329
	1782	2347	13	80502.94	8.050	1122.71	38.8	8.9	2063	3	2.772	330
									2064	2	2.527	331
	1784	2349	35	258110.61	25.811	2291.26	38.8	8.9	2073	6	6.746	346
									2073	0	0.532	347
	1787	2352	16	117798.06	11.780	1350.25	38.8	8.9	2073	4	7.783	332
									2071	2	2.729	333
	1790	2355	18	60898.42	6.090	1156.14	38.8	8.9	2071	2	3.988	334
	1792	2357	15	90137.13	9.014	1592.96	38.8	8.9	2059	1	1.47	336
	1793	2358	7	269074.85	26.907	2692.74	38.8	8.9	2061	0	1.81	339
									2061	0	0.661	340
									2061	1	1.537	341
									2065	0	1.198	343
									2068	3	3.076	344

	1794	2359	4	72673.77	7.267	1387.09	38.8	8.9	2066	4	3.141	337
	1795	2360	19	61771.20	6.177	1066.25	38.8	8.9	2071	2	3.799	335
	1799	2364	6	55125.05	5.513	1047.17	38.8	8.9	2058	1	1.352	342
	1800	2365	1	68746.95	6.875	1617.09	38.8	8.9	2058	0	0.79	338
Basin 23	1	2	1	28669.72	2.867	745.30	38.8	8.9	2193	2	2.299	23E
	5	7	5	142322.79	14.232	2313.19	38.8	8.9	2235	5	3.568	23A
	6	8	7	58547.42	5.855	1193.41	38.8	8.9	2240	3	6.493	23B
	7	9	6	171496.20	17.150	2632.45	38.8	8.9	2245	5	4.694	23C
									2241	3	4.714	23D
Basin 24	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes				
	4	5	4	75902.20	7.590	1383.89	38.8	8.9	2243	4	4.975	24A
	7	12	9	60171.06	6.017	1238.48	38.8	8.9	2253	2	3.508	24B
Basin 25	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes				
	3	6	6	137078.40	13.708	1471.94	38.9	8.9	2245	9	10.96	25D
	4	8	7	205227.62	20.523	2898.87	38.9	8.9	2258	6	4.763	25A
	5	9	4	135340.32	13.534	2349.32	38.8	8.9	2278	2	1.572	25B
	6	10	5	180726.45	18.073	2741.50	38.8	8.9	2274	7	3.937	25C
Basin 26	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes				
	5	7	7	103890.37	10.389	1680.21	38.9	8.9	2264	1	2.047	26B
	6	8	4	88048.71	8.805	1683.40	38.9	8.9	2272	1	1.188	26A
	7	9	8	73362.82	7.336	1480.90	38.9	8.9	2260	1	1.382	26C
	9	11	9	217814.12	21.781	2757.27	38.9	8.9	2282	3	3.346	26D
Basin 27	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	1	60165.85	6.017	1469.52	38.9	8.9	2266	2	1.84	27B
	7	8	6	192445.37	19.245	2354.84	38.9	8.9	2269	4	4.987	27A
	8	9	11	86960.47	8.696	1624.01	38.9	8.9	2268	3	4.165	27E
	9	10	7	91062.19	9.106	1296.31	38.9	8.9	2265	4	7.831	27C
	11	13	12	89427.99	8.943	1700.92	38.9	8.9	2274	2	2.933	27D
	12	14	13	297884.46	29.788	4279.58	38.9	8.9	2286	1	0.978	27F
									2276	3	2.54	27G
Basin 28	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes				
	3	4	17	112204.33	11.220	1595.98	38.9	8.9	2287	1	2.712	28A
	6	7	16	48168.56	4.817	1190.14	38.9	8.9	2281	0	0.498	28B
									2277	0	2.1	28C
									2279	0	0.329	28D1
	7	8	8	101180.02	10.118	1708.76	38.9	8.9	2279	2	2.19	28E
	8	9	11	91941.36	9.194	1805.53	38.9	8.9	2277	1	1.851	28F
	11	14	9	127168.99	12.717	1666.11	38.9	8.9	2282	1	0.329	28D2
	12	16	10	82900.28	8.290	1361.00	38.9	8.9	2276	0	0.744	28G
	15	20	7	190663.89	19.066	2224.43	38.9	8.9	2270	1	0.822	28H
									2265	1	1.35	28I
	18	24	2	135378.16	13.538	1613.55	38.9	8.9	2258	2	3.13	28J
	20	26	3	64158.69	6.416	1043.83	38.9	8.9	2257	0	0.605	28K
									2261	1	2.74	28M
Basin 29	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	1	67594.41	6.759	1163.01	38.9	8.9	2256	2	2.82	29A
	1	2	2	57996.23	5.800	1207.39	38.9	8.9	2256	0	0.935	29B
									2255	0	0.904	29C
	2	3	3	211025.97	21.103	2574.39	38.9	8.9	2256	1	0.833	29F
									2242	0	1.73	29H
	3	4	4	180431.08	18.043	2437.20	38.9	8.9	2253	1	0.662	29G
									2248	1	0.758	29J
	4	5	5	298643.82	29.864	3082.59	38.9	8.9	2245	5	5.81	29I
Basin 30	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes				
	5	7	27	100095.79	10.010	1459.59	38.9	8.9	2270	1	2.486	30H
	12	15	51	191066.32	19.107	1952.75	38.9	8.9	2259	1	1.409	30I
	13	16	22	61252.52	6.125	1339.67	38.9	8.9	2263	1	1.618	30F
									2259	1	1.246	30G
	23	29	15	123718.09	12.372	1626.87	38.9	8.9	2260	3	3.501	30D
	24	30	16	59567.68	5.957	1254.48	38.9	8.9	2251	2	3.787	30E
	25	31	45	69685.09	6.969	1286.92	38.9	8.9	2248	1	1.135	30K
	26	32	46	106195.13	10.620	1785.87	38.9	8.9	2252	0	0.37	30J

	34	41	14	109738.34	10.974	1638.15	38.9	8.9	2252	2	2.133	30C
	42	49	37	119128.53	11.913	2380.77	38.9	8.9	2280	3	1.79	30N
									2288	2	1.448	30O
	44	52	9	131338.73	13.134	1752.85	38.9	8.9	2245	1	0.769	30B
	45	55	7	60960.51	6.096	1203.83	38.9	8.9	2228	1	1.831	30A
	47	57	34	83523.63	8.352	1396.99	38.9	8.9	2232	1	1.711	30M
Basin 31	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	5	49845.78	4.985	1424.41	38.8	8.9	2198	2	4.54	31D
	3	4	6	86975.56	8.698	1213.14	38.8	8.9	2203	0	0.853	31B
	4	5	2	101764.00	10.176	1600.40	38.8	8.9	2210	0	0.232	31A
	5	6	3	51384.32	5.138	1213.36	38.8	8.9	2196	0	0.242	31C
Basin 32	FID	Sub Basin Id	gridcode	Area		Perimeter	Longitudes	Latitudes				
	7	9	6	264092.02	26.409	3359.62	38.9	8.9	2249	1	1.228	32A
Basin 33	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	3	144441.84	14.444	2249.92	38.8	8.9	2174	3	2.841	33B
	1	2	4	67440.59	6.744	1284.54	38.8	8.9	2159	1	1.191	33C
	2	3	2	140993.86	14.099	2069.59	38.8	8.9	2166	3	3.625	33A
	3	4	5	75469.23	7.547	1304.61	38.8	8.9	2161	7	5.802	33D
	7	11	8	149325.96	14.933	2206.13	38.8	8.9	2158	1	0.929	33E
	8	12	10	81837.53	8.184	1448.76	38.8	8.9	2150	1	0.546	33F
	10	15	11	57552.57	5.755	976.75	38.8	8.8	2118	0	0.485	33G
Basin 34	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	1	2	15	48462.93	4.846	1121.98	38.8	8.9	2154	1	1.458	34B
	2	3	20	70348.56	7.035	1569.40	38.8	8.9	2118	2	7.65	34F
	4	5	17	86657.04	8.666	1434.35	38.8	8.9	2141	6	10.11	34H
	8	10	12	262670.05	26.267	3721.71	38.8	8.9	2169	3	1.625	34A
									2144	1	0.576	34C
									2144	1	1.231	34I
	10	13	7	146728.60	14.673	1993.70	38.8	8.8	2110	1	1.782	34E
	11	14	8	110764.99	11.076	2030.79	38.8	8.8	2128	-1	-1	34D
	18	21	4	112734.95	11.273	1670.46	38.8	8.8	2092	1	0.61	34J
Basin 35	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	8	155176.31	15.518	1977.97	38.8	8.8	2092	1	1.928	35B
	1	2	6	164633.80	16.463	2228.81	38.8	8.8	2087	1	1.378	35C
									2087	1	1.173	35D
	3	4	4	62484.29	6.248	1199.38	38.8	8.8	2076	0	0.865	35F
	4	5	5	89309.40	8.931	1562.54	38.8	8.8	2084	0	0.705	35E
	5	6	9	129268.27	12.927	1875.89	38.8	8.8	2084	0	0.302	35A
	6	7	2	52040.46	5.204	1266.93	38.8	8.8	2076	1	3.545	35H
	9	10	10	98412.71	9.841	1401.51	38.8	8.8	2074	1	1.505	35G
Basin 36	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	1	3	20	405386.62	40.539	4832.38	38.8	8.8	2095	1	0.74	36C
									2095	3	2.596	36D
									2095	1	0.597	36E
									2095	2	1.017	36F
									2081	1	0.791	36G
	2	4	23	66148.09	6.615	1202.50	38.8	8.8	2098	1	1.409	36A
									2094	2	1.932	36B
	3	5	21	67478.00	6.748	1073.46	38.8	8.8	2074	1	1.224	36H
	4	7	18	130256.39	13.026	1675.04	38.8	8.8	2071	3	3.26	36I
	5	8	8	58928.77	5.893	1047.19	38.8	8.8	2070	1	1.508	36L
									2068	1	1.604	36M
	6	9	9	128640.75	12.864	1740.13	38.8	8.8	2069	1	1.142	36K
	8	11	5	66296.41	6.630	1231.34	38.8	8.8	2066	2	3.24	36N
	9	12	2	185180.21	18.518	1881.33	38.8	8.8	2066	3	2.53	36P
	11	14	11	68199.77	6.820	1200.57	38.8	8.8	2068	1	1.41	36J
	12	15	14	61033.58	6.103	1105.07	38.8	8.8	2073	0	0.669	36S
									2073	1	1.448	36T
	16	21	16	58972.06	5.897	1356.75	38.8	8.8	2071	0	1.438	36R
									2074	0	0.809	36U
	17	22	4	117941.13	11.794	1715.17	38.8	8.8	2063	1	0.991	36O
	20	25	12	101283.26	10.128	1505.52	38.8	8.8	2071	1	1.434	36Q
Basin 37	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	

	0	1	84	173369.57	17.337	3582.98	38.8	8.9	2173	5	2.743	37A
	1	2	60	84588.40	8.459	1303.00	38.8	8.9	2155	0	1.132	37E
									2155	2	2.567	37F
									2155	1	1.233	37G
	2	3	61	69042.63	6.904	1291.59	38.8	8.9	2156	0	0.677	37D
	8	13	79	101651.40	10.165	1425.41	38.8	8.9	2148	1	1.14	37B
	11	16	77	134456.61	13.446	2279.07	38.8	8.9	2159	1	1.32	37C
	12	17	58	223949.36	22.395	2999.47	38.8	8.9	2149	2	1.033	37H
	13	18	59	68901.51	6.890	1126.11	38.8	8.9	2131	0	0.517	37I
									2128	1	1.348	37J
	23	30	82	143398.55	14.340	1857.34	38.8	8.9	2163	1	0.895	37V
									2149	1	0.628	37W
	25	32	64	273115.77	27.312	2995.84	38.8	8.9	2136	5	3.782	37K
	27	34	50	167442.74	16.744	2203.81	38.8	8.9	2104	1	1.307	37L
	29	36	63	43532.75	4.353	1675.27	38.8	8.9	2114	1	1.051	37Q
	32	41	83	98703.08	9.870	1827.70	38.8	8.9	2171	1	0.851	37U
	37	46	46	69833.35	6.983	1113.15	38.8	8.9	2092	1	2.567	37M1b
	39	48	69	70753.22	7.075	1329.75	38.8	8.9	2160	3	1.336	37R
	40	49	47	84442.13	8.444	1640.85	38.8	8.9	2091	3	4.62	37M1
	41	50	52	206071.87	20.607	2408.32	38.8	8.9	2126	7	2.22	37O
									2149	4	2.001	37P
	43	52	44	182041.01	18.204	2427.80	38.8	8.9	2101	5	4.283	37N
	52	63	33	56158.66	5.616	1187.88	38.8	8.9	2088	1	1.463	37I2
	56	68	30	97260.71	9.726	1575.44	38.8	8.8	2079	1	1.192	37G2
	59	71	17	58602.50	5.860	1022.24	38.8	8.8	2075	1	2.601	37B2
	60	72	15	116296.70	11.630	2088.16	38.8	8.8	2073	1	1.264	37A2
									2073	1	1.589	37C2
	61	74	31	57250.27	5.725	1055.98	38.8	8.8	2078	2	4.105	37P2
	62	75	27	66552.68	6.655	1039.37	38.8	8.8	2081	2	3.12	37H2
	64	77	28	59483.10	5.948	1297.72	38.8	8.8	2088	5	6.42	37K2
	65	78	7	50229.57	5.023	1078.98	38.8	8.8	2069	0	0.834	37S2
	66	79	11	77506.07	7.751	1583.35	38.8	8.8	2072	0	0.723	37Q2
									2072	7	9.06	37R2
	68	81	21	323173.67	32.317	2965.47	38.8	8.8	2079	6	8.06	37Z
									2075	3	5.24	37D2
									2077	2	2.06	E2
									2077	1	1.88	37F2
	69	83	8	93005.55	9.301	1855.19	38.8	8.8	2070	1	1.11	37T2
	71	85	29	65402.53	6.540	1212.17	38.8	8.8	2086	0	0.733	37L2
									2081	1	1.41	37M2
	74	89	23	81118.97	8.112	1290.46	38.8	8.8	2074	1	0.733	37O2
	75	90	25	131167.40	13.117	1845.95	38.8	8.8	2077	0	0.372	37N2
	76	91	5	59886.54	5.989	1222.83	38.8	8.8	2062	1	2.69	37Y2
	81	97	4	104701.93	10.470	1434.24	38.8	8.8	2063	1	3.55	37W2
									2062	1	0.998	37X2
	86	103	9	84062.73	8.406	1268.05	38.8	8.8	2068	0	0.727	37U2
									2063	1	1.58	37V2
Basin 38	FID	Sub BasinId	gridcode	Area		perimeter	Longitudes	Latitudes				
	1	2	11	154925.60	15.493	2795.59	38.8	8.9	2083	1	0.717	38B
									2081	0	0.249	38E
	3	4	12	173674.85	17.367	2219.59	38.8	8.9	2090	0	0.596	38A
									2088	2	2.05	38C
									2088	1	0.94	38D
	5	6	8	161854.35	16.185	1818.40	38.8	8.9	2076	1	1.22	38G
									2076	1	8.69	38H
	6	7	13	66908.96	6.691	1400.81	38.8	8.9	2080	3	4.69	38F
	7	8	5	114489.11	11.449	1474.26	38.8	8.9	2069	1	1.476	38J
									2069	1	1.335	38K
	9	11	6	100738.17	10.074	1885.56	38.8	8.9	2076	1	2.099	38I
	12	14	1	280497.07	28.050	3139.26	38.8	8.8	2074	1	1.363	38N
									2064	4	6.75	38O
Basin 39	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	48	68533.87	6.853	1172.14	38.8	8.9	2146	4	5.87	39C
	1	2	49	152505.68	15.251	2050.99	38.8	8.9	2150	2	2.45	39A
									2148	1	0.945	39B
	2	3	47	66495.57	6.650	1406.44	38.8	8.9	2132	0	0.383	39F
	6	7	41	120825.44	12.083	2101.49	38.8	8.9	2129	1	1.183	39G
									2112	2	7.95	39L

	10	18	44	71498.40	7.150	1461.85	38.8	8.9	2134	2	1.822	39H
									2126	1	1.73	39I
	13	21	36	210088.34	21.009	2770.46	38.8	8.9	2148	12	9.123	39D
									2144	2	1.471	39E
	16	24	33	143350.86	14.335	2320.48	38.8	8.9	2124	1	4.52	39J
	20	29	34	82382.67	8.238	1335.95	38.8	8.9	2118	1	1.144	39K
	23	32	17	95903.96	9.590	1350.11	38.8	8.9	2089	3	8.52	39N
									2089	1	0.678	39O
	24	33	15	239471.34	23.947	2193.34	38.8	8.9	2089	7	18.11	39P
	27	36	25	162181.95	16.218	2198.94	38.8	8.9	2103	1	1.57	39M
	30	40	13	54869.33	5.487	1042.49	38.8	8.9	2072	1	1.519	39Q
									2072	1	2.85	39R
	31	42	12	52532.35	5.253	1031.72	38.8	8.9	2071	0	0.352	39X
	43	57	11	183738.13	18.374	2427.32	38.8	8.9	2070	1	1.16	39U
									2079	3	3.28	39Y
	44	58	5	95617.58	9.562	1666.16	38.8	8.9	2069	1	1.746	39S
	45	59	9	146385.66	14.639	1782.41	38.8	8.9	2071	1	1.66	39T
									2074	3	3.23	39V
	48	62	3	93846.41	9.385	1611.50	38.8	8.9	2061	4	4.07	39W
Basin 40	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes	water_leve	Volume	SArea	
	0	1	12	198764.95	19.876	2190.90	38.8	8.9	2078	1	1.392	40T
	1	2	11	59565.58	5.957	986.12	38.8	8.9	2061	2	2.22	40R
									2061	0	1.254	40S
	2	3	10	78246.44	7.825	1364.98	38.8	8.9	2070	5	7.43	40N
									2070	3	3.841	40Q
	3	4	9	56650.26	5.665	1015.78	38.8	8.9	2067	3	7.075	40P
	4	5	8	91828.29	9.183	1392.49	38.8	8.9	2067	1	1.166	40O
	5	6	7	57060.28	5.706	1117.64	38.8	8.9	2067	1	2.097	40M
	7	8	6	244494.57	24.449	2561.39	38.8	8.9	2073	3	3.691	40H
	8	9	4	409897.84	40.990	3997.39	38.8	8.9	2074	2	1.949	40D
									2076	5	4.715	40E
									2076	3	3.328	40F
									2076	4	6.488	40G
	9	10	2	131692.82	13.169	1518.06	38.8	8.9	2075	3	4.338	40A
	10	11	3	53568.53	5.357	1004.42	38.8	8.9	2066	0	0.189	40I
									2067	1	1.176	40J
									2067	0	0.85	40L
									2067	2	3.393	40K
	11	12	1	104078.88	10.408	1637.35	38.8	8.9	2075	2	1.832	40B
									2075	6	8.27	40C
Basin 41	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes				
	2	3	39	187548.65	18.755	2084.67	38.8	8.9	2143	7	2.851	41F2
									2129	12	19.83	41I
	7	11	33	67557.59	6.756	1395.10	38.8	8.9	2100	1	1.498	E2
	8	13	24	113477.68	11.348	1943.94	38.8	8.9	2087	1	1.576	41A2
	9	14	26	67748.40	6.775	1478.80	38.8	8.9	2108	6	5.075	41D2
	13	18	25	66752.62	6.675	1149.00	38.8	8.9	2087	2	2.668	41B2
	14	20	21	134015.33	13.402	2471.27	38.8	8.9	2091	4	6.107	41C2
	15	21	22	53334.26	5.333	1028.63	38.8	8.9	2077	2	4.081	41Z
	20	28	19	125646.24	12.565	1731.82	38.8	8.9	2075	1	1.473	41W
									2078	2	1.666	41X
									2078	4	4.126	41Y
	21	29	28	252970.66	25.297	2634.50	38.8	8.9	2070	3	2.444	41U
	22	30	29	69338.40	6.934	1377.09	38.8	8.9	2069	2	5.175	41R
									2069	1	1.779	41S
	24	32	14	246581.21	24.658	2397.01	38.8	8.9	2070	2	1.144	41Q
									2074	5	4.639	41T
									2076	1	2.062	41V
	28	36	5	79134.41	7.913	1385.18	38.8	8.9	2066	4	5.333	41E
	29	37	15	211376.82	21.138	2526.56	38.8	8.9	2073	5	10.404	41M
									2073	3	2.567	41P
	30	38	2	102105.26	10.211	1521.44	38.8	8.9	2070	3	3.043	41C
									2069	1	1.047	41D
	32	41	12	173972.65	17.397	2295.56	38.8	8.9	2072	2	1.876	41L
									2075	1	0.715	41N
									2075	1	1.18	41O
	34	43	8	176583.65	17.658	2045.16	38.8	8.9	2070	4	5.484	41F
									2070	4	4.082	41G

	35	44	1	168249.55	16.825	2197.87	38.8	8.9	2066	2	1.962	41A
									2066	2	1.426	41B
	36	45	13	135511.24	13.551	1598.96	38.8	8.9	2073	1	1.382	36K
	37	46	9	69950.18	6.995	1274.48	38.8	8.9	2072	1	2.041	41H
									2072	2	2.543	41J
Basin 42	FID	Sub Basin Id	gridcode	Area		perimeter	Longitudes	Latitudes				
	1	2	13	144828.35	14.483	144828.35	38.7	8.9	2084	4	1.205	42A
									2138	1	1.917	42H
	8	9	6	41679.04	4.168	41679.04	38.7	8.9	2061	1	1.124	42B
	9	11	3	178612.58	17.861	178612.58	38.8	8.9	2082	1	1.041	42G
	12	16	2	178683.27	17.868	178683.27	38.8	8.9	2078	4	4.244	42E
									2081	2	2.303	42F
									2078	4	3.426	42D
	13	17	1	60128.67	6.013	60128.67	38.8	8.9	2065	1	1.631	42C
Basin 43	FID	Sub basin Id	gridcode	Area		perimeter	Longitude	Latitude	water_leve	Volume	SArea	
	0	1	53	93098.32	9.310	1401.57	38.8	8.9	2180	2	4.696	43O
	3	4	52	53810.69	5.381	1149.12	38.8	8.9	2166	1	2.053	43M
									2166	2	5.923	43N
	6	7	49	55327.99	5.533	1272.29	38.8	8.9	2161	5	5.909	43L
	8	10	46	79037.31	7.904	1223.05	38.8	8.9	2177	2	2.016	43R
	10	12	43	118388.03	11.839	1640.26	38.8	8.9	2177	2	1.623	43Q
	11	14	41	45924.05	4.592	996.96	38.8	8.9	2151	2	1.929	43K
	13	17	47	63453.36	6.345	1147.18	38.8	8.9	2184	6	10.591	43S
	14	20	37	189930.31	18.993	2314.99	38.8	8.9	2150	2	1.348	43I
									2159	3	2.852	43J
									2167	0	0.608	43P
	15	22	45	69379.06	6.938	1487.50	38.8	8.9	2175	2	4.138	43T
	18	25	35	218470.17	21.847	2217.51	38.8	8.9	2140	7	5.521	43E
									2140	2	1.658	43F
									2140	0	0.468	43G
	20	28	34	148486.44	14.849	1830.13	38.8	8.9	2131	3	4.514	43D
	22	31	32	60195.12	6.020	1288.11	38.8	8.9	2163	3	4.597	43W
	25	36	16	102632.28	10.263	1487.06	38.8	8.9	2138	4	4.01	43H
	26	38	20	145905.91	14.591	2252.14	38.8	8.9	2171	2	1.41	43U
	27	39	25	70851.42	7.085	1552.40	38.8	8.9	2165	1	1.188	43V
	31	43	12	100577.65	10.058	1830.15	38.7	8.9	2123	1	1.576	43C
	35	48	33	107124.48	10.712	1467.38	38.8	8.9	2161	1	0.984	43X
	37	51	5	51706.30	5.171	1318.83	38.7	8.9	2112	0	0.121	43B
	43	58	3	227454.10	22.745	2023.58	38.7	8.9	2112	6	4.347	43A
	44	59	31	83155.95	8.316	1399.45	38.8	8.9	2160	1	1.344	43Y
	52	68	27	171885.81	17.189	2081.75	38.8	8.9	2169	1	0.593	43Z
	53	69	21	185350.56	18.535	2558.56	38.8	8.9	2190	4	10.75	43A2

Annex_2

Table A-2:Peak runoff value of blue spot depression areas in natural surface catchment, in Semi urban area surface catchment and in urbanized area surface catchment.

Basin	FID	Sub Basin Id	gridcode	Area in Ha	B.Spot No	Intensity of rainfall/Hr			Peak runoff rate on Natural state area C= 0.2			Peak runoff rate on Semi urbanized areas C=0.55			Peak runoff rate on City Business areas C=0.85		
						Dry Season(Nov)	Mid wet season(Apr)	Wet Season(Aug)	Dry Season(Nov)	Mid wet season(Apr)	Wet Season(Aug)	Dry Season(Nov)	Mid wet season(Apr)	Wet Season(Aug)	Dry Season(Nov)	Mid wet season(Apr)	Wet Season(Augt)
Basin 48	1158	1502	291	9.844	133	0.146	3.096	8.016	0.0008	0.0171	0.0442	0.0022	0.0469	0.1215	0.0034	0.0725	0.1878
					134	0.146	3.096	8.016									
	1242	1594	281	8.814	131	0.146	3.096	8.016	0.0007	0.0153	0.0396	0.0020	0.0420	0.1088	0.0031	0.0649	0.1682
	1262	1615	273	10.767	66b	0.146	3.096	8.016	0.0009	0.0187	0.0483	0.0024	0.0513	0.1329	0.0037	0.0793	0.2054
	1267	1620	279	6.108	130	0.146	3.096	8.016	0.0005	0.0106	0.0274	0.0014	0.0291	0.0754	0.0021	0.0450	0.1165
	1354	1729	196	15.884	62a	0.146	3.096	8.016	0.0013	0.0275	0.0713	0.0036	0.0757	0.1961	0.0055	0.1170	0.3030
					64	0.146	3.096	8.016									
					65	0.146	3.096	8.016									
	1359	1735	179	6.117	62b	0.146	3.096	8.016	0.0005	0.0106	0.0275	0.0014	0.0292	0.0755	0.0021	0.0451	0.1167
	1360	1736	180	10.170	63	0.146	3.096	8.016	0.0008	0.0176	0.0457	0.0023	0.0485	0.1255	0.0035	0.0749	0.1940
	1378	1762	191	9.618	61	0.146	3.096	8.016	0.0008	0.0167	0.0432	0.0022	0.0459	0.1187	0.0033	0.0709	0.1835
	1408	1803	189	8.493	60	0.146	3.096	8.016	0.0007	0.0147	0.0381	0.0019	0.0405	0.1048	0.0030	0.0626	0.1620
	1411	1807	185	5.629	59	0.146	3.096	8.016	0.0005	0.0098	0.0253	0.0013	0.0268	0.0695	0.0020	0.0415	0.1074
	1428	1832	186	7.904	58b	0.146	3.096	8.016	0.0006	0.0137	0.0355	0.0018	0.0377	0.0976	0.0027	0.0582	0.1508
	1431	1836	161	17.912	45	0.146	3.096	8.016	0.0015	0.0311	0.0804	0.0040	0.0854	0.2211	0.0062	0.1320	0.3417
	1432	1837	173	6.350	47	0.146	3.096	8.016	0.0005	0.0110	0.0285	0.0014	0.0303	0.0784	0.0022	0.0468	0.1211
	1438	1844	182	11.412	55	0.146	3.096	8.016	0.0009	0.0198	0.0512	0.0026	0.0544	0.1409	0.0040	0.0841	0.2177
					56	0.146	3.096	8.016									
					58a	0.146	3.096	8.016									
	1444	1852	176	21.325	50	0.146	3.096	8.016	0.0017	0.0370	0.0957	0.0048	0.1017	0.2633	0.0074	0.1571	0.4068
					52	0.146	3.096	8.016									
					53	0.146	3.096	8.016									
					54	0.146	3.096	8.016									
	1452	1863	145	5.194	42a	0.146	3.096	8.016	0.0004	0.0090	0.0233	0.0012	0.0248	0.0641	0.0018	0.0383	0.0991
	1458	1870	143	5.672	44	0.146	3.096	8.016	0.0005	0.0098	0.0255	0.0013	0.0270	0.0700	0.0020	0.0418	0.1082
	1469	1887	152	16.844	48	0.146	3.096	8.016	0.0014	0.0292	0.0756	0.0038	0.0803	0.2079	0.0059	0.1241	0.3214
					49	0.146	3.096	8.016									
	1483	1903	142	10.430	42b	0.146	3.096	8.016	0.0009	0.0181	0.0468	0.0023	0.0497	0.1287	0.0036	0.0768	0.1990
					43	0.146	3.096	8.016									
	1499	1924	125	7.973	19	0.146	3.096	8.016	0.0007	0.0138	0.0358	0.0018	0.0380	0.0984	0.0028	0.0588	0.1521
	1501	1926	146	10.488	17	0.146	3.096	8.016	0.0009	0.0182	0.0471	0.0024	0.0500	0.1295	0.0036	0.0773	0.2001
					18	0.146	3.096	8.016									
	1504	1929	148	10.150	16	0.146	3.096	8.016	0.0008	0.0176	0.0456	0.0023	0.0484	0.1253	0.0035	0.0748	0.1936
	1511	1939	111	13.839	9	0.146	3.096	8.016	0.0011	0.0240	0.0621	0.0031	0.0660	0.1708	0.0048	0.1020	0.2640
					10	0.146	3.096	8.016									
	1513	1941	115	27.784	20	0.146	3.096	8.016	0.0023	0.0482	0.1247	0.0062	0.1325	0.3430	0.0097	0.2047	0.5301
	1514	1942	100	6.822	14	0.146	3.096	8.016	0.0006	0.0118	0.0306	0.0015	0.0325	0.0842	0.0024	0.0503	0.1301
	1519	1948	113	9.653	15	0.146	3.096	8.016	0.0008	0.0167	0.0433	0.0022	0.0460	0.1192	0.0034	0.0711	0.1842
	1523	1954	114	5.663	8	0.146	3.096	8.016	0.0005	0.0098	0.0254	0.0013	0.0270	0.0699	0.0020	0.0417	0.1080
	1543	1989	97	18.989	7	0.146	3.096	8.016	0.0016	0.0329	0.0852	0.0043	0.0905	0.2344	0.0066	0.1399	0.3623
	1546	1993	98	8.555	5	0.146	3.096	8.016	0.0007	0.0148	0.0384	0.0019	0.0408	0.1056	0.0030	0.0630	0.1632
					6	0.146	3.096	8.016									
	1557	2005	3	9.698	1	0.146	3.096	8.016	0.0008	0.0168	0.0435	0.0022	0.0462	0.1197	0.0034	0.0715	0.1850
Basin 49	922	1271	1006	9.635	239	0.146	3.096	8.016	0.0008	0.0167	0.0433	0.0022	0.0459	0.1189	0.0033	0.0710	0.1838
	939	1303	1002	11.595	240	0.146	3.096	8.016	0.0009	0.0201	0.0520	0.0026	0.0553	0.1431	0.0040	0.0854	0.2212
	945	1310	880	11.577	611	0.146	3.096	8.016	0.0009	0.0201	0.0520	0.0026	0.0552	0.1429	0.0040	0.0853	0.2209
	951	1319	908	6.928	601	0.146	3.096	8.016	0.0006	0.0120	0.0311	0.0016	0.0330	0.0855	0.0024	0.0511	0.1322
	954	1323	991	3.751	242	0.146	3.096	8.016	0.0003	0.0065	0.0168	0.0008	0.0179	0.0463	0.0013	0.0276	0.0716
	960	1332	882	5.540	612	0.146	3.096	8.016	0.0005	0.0096	0.0249	0.0012	0.0264	0.0684	0.0019	0.0408	0.1057
	964	1338	883	6.304	613	0.146	3.096	8.016	0.0005	0.0109	0.0283	0.0014	0.0301	0.0778	0.0022	0.0465	0.1203
					614a	0.146	3.096	8.016									
	968	1344	905	4.937	604	0.146	3.096	8.016	0.0004	0.0086	0.0222	0.0011	0.0235	0.0609	0.0017	0.0364	0.0942
	972	1349	904	13.027	603	0.146	3.096	8.016	0.0011	0.0226	0.0585	0.0029	0.0621	0.1608	0.0045	0.0960	0.2485
					607	0.146	3.096	8.016									
	978	1356	827	13.414	615	0.146	3.096	8.016	0.0011	0.0233	0.0602	0.0030	0.0640	0.1656	0.0047	0.0988	0.2559
	979	1357	906	5.221	602	0.146	3.096	8.016	0.0004	0.0091	0.0234	0.0012	0.0249	0.0645	0.0018	0.0385	0.0996
	986	1366	995	31.645	238	0.146	3.096	8.016	0.0026	0.0549	0.1421	0.0071	0.1509	0.3907	0.0110	0.2332	0.6037

	987	1369	815	8.743	625	0.146	3.096	8.016	0.0007	0.0152	0.0392	0.0020	0.0417	0.1079	0.0030	0.0644	0.1668
	990	1373	998	27.609	241	0.146	3.096	8.016	0.0023	0.0479	0.1239	0.0062	0.1316	0.3408	0.0096	0.2034	0.5267
	994	1377	823	12.602	616	0.146	3.096	8.016	0.0010	0.0218	0.0566	0.0028	0.0601	0.1556	0.0044	0.0929	0.2404
	997	1381	810	9.899	626	0.146	3.096	8.016	0.0008	0.0172	0.0444	0.0022	0.0472	0.1222	0.0034	0.0729	0.1888
	998	1382	751	6.043	605	0.146	3.096	8.016	0.0005	0.0105	0.0271	0.0014	0.0288	0.0746	0.0021	0.0445	0.1153
					606	0.146	3.096	8.016									
	999	1383	938	5.718	535	0.146	3.096	8.016	0.0005	0.0099	0.0257	0.0013	0.0273	0.0706	0.0020	0.0421	0.1091
	1000	1384	798	8.879	627	0.146	3.096	8.016	0.0007	0.0154	0.0399	0.0020	0.0423	0.1096	0.0031	0.0654	0.1694
	1002	1387	748	7.841	608	0.146	3.096	8.016	0.0006	0.0136	0.0352	0.0018	0.0374	0.0968	0.0027	0.0578	0.1496
	1013	1402	785	18.924	632	0.146	3.096	8.016	0.0015	0.0328	0.0849	0.0043	0.0902	0.2336	0.0066	0.1394	0.3610
	1015	1404	745	7.431	548	0.146	3.096	8.016	0.0006	0.0129	0.0334	0.0017	0.0354	0.0917	0.0026	0.0548	0.1418
	1019	1408	784	28.493	225	0.146	3.096	8.016	0.0023	0.0494	0.1279	0.0064	0.1358	0.3517	0.0099	0.2099	0.5436
	1023	1412	927	7.331	547	0.146	3.096	8.016	0.0006	0.0127	0.0329	0.0016	0.0350	0.0905	0.0025	0.0540	0.1399
	1024	1413	928	8.521	545	0.146	3.096	8.016	0.0007	0.0148	0.0382	0.0019	0.0406	0.1052	0.0030	0.0628	0.1626
	1025	1414	779	6.918	243	0.146	3.096	8.016	0.0006	0.0120	0.0311	0.0016	0.0330	0.0854	0.0024	0.0510	0.1320
					244	0.146	3.096	8.016									
	1026	1415	778	5.308	245	0.146	3.096	8.016	0.0004	0.0092	0.0238	0.0012	0.0253	0.0655	0.0018	0.0391	0.1013
	1029	1419	945	19.760	519	0.146	3.096	8.016	0.0016	0.0343	0.0887	0.0044	0.0942	0.2439	0.0069	0.1456	0.3770
					520a	0.146	3.096	8.016									
					523	0.146	3.096	8.016									
					524	0.146	3.096	8.016									
	1030	1420	735	20.855	609	0.146	3.096	8.016	0.0017	0.0362	0.0936	0.0047	0.0994	0.2574	0.0072	0.1537	0.3979
					610	0.146	3.096	8.016									
	1035	1426	929	14.627	544	0.146	3.096	8.016	0.0012	0.0254	0.0657	0.0033	0.0697	0.1806	0.0051	0.1078	0.2791
	1038	1429	783	7.459	631	0.146	3.096	8.016	0.0006	0.0129	0.0335	0.0017	0.0356	0.0921	0.0026	0.0550	0.1423
	1040	1432	775	6.782	246	0.146	3.096	8.016	0.0006	0.0118	0.0304	0.0015	0.0323	0.0837	0.0024	0.0500	0.1294
	1041	1433	731	9.566	621	0.146	3.096	8.016	0.0008	0.0166	0.0429	0.0022	0.0456	0.1181	0.0033	0.0705	0.1825
					633	0.146	3.096	8.016									
	1043	1435	931	21.300	536	0.146	3.096	8.016	0.0017	0.0369	0.0956	0.0048	0.1016	0.2629	0.0074	0.1569	0.4064
					541	0.146	3.096	8.016									
					542	0.146	3.096	8.016									
					543	0.146	3.096	8.016									
	1044	1436	937	16.804	525	0.146	3.096	8.016	0.0014	0.0291	0.0754	0.0038	0.0801	0.2074	0.0058	0.1238	0.3206
	1047	1441	730	6.810	622	0.146	3.096	8.016	0.0006	0.0118	0.0306	0.0015	0.0325	0.0841	0.0024	0.0502	0.1299
	1049	1443	765	19.138	628	0.146	3.096	8.016	0.0016	0.0332	0.0859	0.0043	0.0912	0.2363	0.0067	0.1410	0.3651
	1051	1445	739	15.107	549	0.146	3.096	8.016	0.0012	0.0262	0.0678	0.0034	0.0720	0.1865	0.0052	0.1113	0.2882
					552	0.146	3.096	8.016									
	1055	1450	725	15.704	619	0.146	3.096	8.016	0.0013	0.0272	0.0705	0.0035	0.0749	0.1939	0.0055	0.1157	0.2996
	1058	1454	781	7.100	247	0.146	3.096	8.016	0.0006	0.0123	0.0319	0.0016	0.0339	0.0876	0.0025	0.0523	0.1355
	1060	1456	769	11.427	251	0.146	3.096	8.016	0.0009	0.0198	0.0513	0.0026	0.0545	0.1411	0.0040	0.0842	0.2180
	1064	1461	716	14.027	624	0.146	3.096	8.016	0.0011	0.0243	0.0630	0.0032	0.0669	0.1732	0.0049	0.1034	0.2676
	1065	1462	718	25.077	617	0.146	3.096	8.016	0.0021	0.0435	0.1126	0.0056	0.1196	0.3096	0.0087	0.1848	0.4784
					618	0.146	3.096	8.016									
	1068	1467	721	4.884	623	0.146	3.096	8.016	0.0004	0.0085	0.0219	0.0011	0.0233	0.0603	0.0017	0.0360	0.0932
	1070	1469	332	12.876	532	0.146	3.096	8.016	0.0011	0.0223	0.0578	0.0029	0.0614	0.1589	0.0045	0.0949	0.2456
					533	0.146	3.096	8.016									
					534	0.146	3.096	8.016									
	1072	1471	354	10.159	517	0.146	3.096	8.016	0.0008	0.0176	0.0456	0.0023	0.0484	0.1254	0.0035	0.0749	0.1938
	1074	1475	708	10.426	629	0.146	3.096	8.016	0.0009	0.0181	0.0468	0.0023	0.0497	0.1287	0.0036	0.0768	0.1989
	1076	1477	330	10.957	538	0.146	3.096	8.016	0.0009	0.0190	0.0492	0.0025	0.0522	0.1353	0.0038	0.0807	0.2090
	1078	1481	331	8.877	537	0.146	3.096	8.016	0.0007	0.0154	0.0398	0.0020	0.0423	0.1096	0.0031	0.0654	0.1694
	1079	1482	333	14.534	531	0.146	3.096	8.016	0.0012	0.0252	0.0652	0.0033	0.0693	0.1794	0.0051	0.1071	0.2773
	1084	1488	350	8.949	518	0.146	3.096	8.016	0.0007	0.0155	0.0402	0.0020	0.0427	0.1105	0.0031	0.0659	0.1707
	1085	1489	773	12.904	248	0.146	3.096	8.016	0.0011	0.0224	0.0579	0.0029	0.0615	0.1593	0.0045	0.0951	0.2462
	1089	1496	758	8.608	630	0.146	3.096	8.016	0.0007	0.0149	0.0386	0.0019	0.0410	0.1063	0.0030	0.0634	0.1642
	1092	1499	346	12.556	520b	0.146	3.096	8.016	0.0010	0.0218	0.0564	0.0028	0.0599	0.1550	0.0044	0.0925	0.2395
					526	0.146	3.096	8.016									
	1097	1505	343	16.190	527	0.146	3.096	8.016	0.0013	0.0281	0.0727	0.0036	0.0772	0.1999	0.0056	0.1193	0.3089
	1098	1507	709	10.604	600	0.146	3.096	8.016	0.0009	0.0184	0.0476	0.0024	0.0506	0.1309	0.0037	0.0781	0.2023
	1102	1512	319	7.818	539	0.146	3.096	8.016	0.0006	0.0136	0.0351	0.0018	0.0373	0.0965	0.0027	0.0576	0.1491
	1103	1514	339	10.486	529	0.146	3.096	8.016	0.0009	0.0182	0.0471	0.0024	0.0500	0.1294	0.0036	0.0773	0.2001
	1109	1520	715	7.343	597	0.146	3.096	8.016	0.0006	0.0127	0.0330	0.0017	0.0350	0.0906	0.0026	0.0541	0.1401
	1110	1521	720	5.488	596	0.146	3.096	8.016	0.0004	0.0095	0.0246	0.0012	0.0262	0.0677	0.0019	0.0404	0.1047
	1112	1524	335	7.862	530	0.146	3.096	8.016	0.0006	0.0136	0.0353	0.0018	0.0375	0.0970	0.0027	0.0579	0.1500
	1117	1530	320	23.696	540	0.146	3.096	8.016	0.0019	0.0411	0.1064	0.0053	0.1130	0.2925	0.0082	0.1746	0.4521
					550	0.146	3.096	8.016									
					551	0.146	3.096	8.016									
	1124	1538	695	7.965	592	0.146	3.096	8.016	0.0007	0.0138	0.0358	0.0018	0.0380	0.0983	0.0028	0.0587	0.1520
	1127	1542	770	12.032	252	0.146	3.096	8.016	0.0010	0.0209	0.0540	0.0027	0.0574	0.1485	0.0042	0.0887	0.2295
	1129	1544	696	17.115	557	0.146	3.096	8.016	0.0014	0.0297	0.0768	0.0038	0.0816	0.2113	0.0059	0.1261	0.3265

					558	0.146	3.096	8.016										
	1132	1548	303	7.683	554	0.146	3.096	8.016	0.0006	0.0133	0.0345	0.0017	0.0366	0.0948	0.0027	0.0566	0.1466	
	1133	1549	348	6.941	487	0.146	3.096	8.016	0.0006	0.0120	0.0312	0.0016	0.0331	0.0857	0.0024	0.0511	0.1324	
	1134	1550	352	32.509	484	0.146	3.096	8.016	0.0027	0.0564	0.1459	0.0073	0.1550	0.4013	0.0113	0.2395	0.6202	
					486	0.146	3.096	8.016										
	1137	1553	304	13.803	553	0.146	3.096	8.016	0.0011	0.0239	0.0620	0.0031	0.0658	0.1704	0.0048	0.1017	0.2633	
	1140	1557	340	9.851	493	0.146	3.096	8.016	0.0008	0.0171	0.0442	0.0022	0.0470	0.1216	0.0034	0.0726	0.1879	
	1141	1560	325	8.048	501	0.146	3.096	8.016	0.0007	0.0140	0.0361	0.0018	0.0384	0.0993	0.0028	0.0593	0.1535	
	1143	1563	469	11.748	483	0.146	3.096	8.016	0.0010	0.0204	0.0527	0.0026	0.0560	0.1450	0.0041	0.0866	0.2241	
	1144	1564	639	14.324	249	0.146	3.096	8.016	0.0012	0.0248	0.0643	0.0032	0.0683	0.1768	0.0050	0.1055	0.2733	
	1145	1565	640	7.526	250	0.146	3.096	8.016	0.0006	0.0130	0.0338	0.0017	0.0359	0.0929	0.0026	0.0555	0.1436	
	1146	1566	761	11.446	259a	0.146	3.096	8.016	0.0009	0.0198	0.0514	0.0026	0.0546	0.1413	0.0040	0.0843	0.2184	
	1148	1569	688	4.861	593	0.146	3.096	8.016	0.0004	0.0084	0.0218	0.0011	0.0232	0.0600	0.0017	0.0358	0.0927	
	1150	1572	689	11.858	594	0.146	3.096	8.016	0.0010	0.0206	0.0532	0.0027	0.0565	0.1464	0.0041	0.0874	0.2262	
					595	0.146	3.096	8.016										
	1151	1573	698	12.114	599	0.146	3.096	8.016	0.0010	0.0210	0.0544	0.0027	0.0578	0.1495	0.0042	0.0893	0.2311	
	1152	1575	316	7.620	555	0.146	3.096	8.016	0.0006	0.0132	0.0342	0.0017	0.0363	0.0941	0.0026	0.0562	0.1454	
	1153	1576	345	24.049	492	0.146	3.096	8.016	0.0020	0.0417	0.1080	0.0054	0.1147	0.2969	0.0084	0.1772	0.4588	
	1157	1581	341	12.964	494	0.146	3.096	8.016	0.0011	0.0225	0.0582	0.0029	0.0618	0.1600	0.0045	0.0955	0.2473	
	1159	1583	756	7.778	259b	0.146	3.096	8.016	0.0006	0.0135	0.0349	0.0017	0.0371	0.0960	0.0027	0.0573	0.1484	
	1160	1585	693	10.260	560	0.146	3.096	8.016	0.0008	0.0178	0.0461	0.0023	0.0489	0.1267	0.0036	0.0756	0.1957	
	1168	1595	301	11.857	559	0.146	3.096	8.016	0.0010	0.0206	0.0532	0.0027	0.0565	0.1464	0.0041	0.0874	0.2262	
	1170	1598	638	9.454	309	0.146	3.096	8.016	0.0008	0.0164	0.0424	0.0021	0.0451	0.1167	0.0033	0.0697	0.1804	
					310	0.146	3.096	8.016										
	1172	1600	612	8.440	255	0.146	3.096	8.016	0.0007	0.0146	0.0379	0.0019	0.0402	0.1042	0.0029	0.0622	0.1610	
	1178	1608	754	9.597	260	0.146	3.096	8.016	0.0008	0.0166	0.0431	0.0022	0.0458	0.1185	0.0033	0.0707	0.1831	
					261	0.146	3.096	8.016										
	1183	1613	691	7.657	563	0.146	3.096	8.016	0.0006	0.0133	0.0344	0.0017	0.0365	0.0945	0.0027	0.0564	0.1461	
	1185	1615	322	10.681	500	0.146	3.096	8.016	0.0009	0.0185	0.0479	0.0024	0.0509	0.1319	0.0037	0.0787	0.2038	
	1191	1621	687	5.563	569	0.146	3.096	8.016	0.0005	0.0096	0.0250	0.0013	0.0265	0.0687	0.0019	0.0410	0.1061	
	1193	1627	635	5.878	256	0.146	3.096	8.016	0.0005	0.0102	0.0264	0.0013	0.0280	0.0726	0.0020	0.0433	0.1121	
	1196	1631	644	10.064	307	0.146	3.096	8.016	0.0008	0.0174	0.0452	0.0023	0.0480	0.1242	0.0035	0.0742	0.1920	
					308	0.146	3.096	8.016										
	1197	1632	682	19.777	598	0.146	3.096	8.016	0.0016	0.0343	0.0888	0.0044	0.0943	0.2441	0.0069	0.1457	0.3773	
	1200	1636	643	10.042	305	0.146	3.096	8.016	0.0008	0.0174	0.0451	0.0023	0.0479	0.1240	0.0035	0.0740	0.1916	
					306	0.146	3.096	8.016										
	1204	1640	307	9.379	556	0.146	3.096	8.016	0.0008	0.0163	0.0421	0.0021	0.0447	0.1158	0.0033	0.0691	0.1789	
	1207	1643	692	8.342	567	0.146	3.096	8.016	0.0007	0.0145	0.0374	0.0019	0.0398	0.1030	0.0029	0.0615	0.1591	
	1209	1645	462	5.989	482	0.146	3.096	8.016	0.0005	0.0104	0.0269	0.0013	0.0286	0.0739	0.0021	0.0441	0.1143	
	1211	1648	315	20.252	502	0.146	3.096	8.016	0.0017	0.0351	0.0909	0.0046	0.0966	0.2500	0.0070	0.1492	0.3864	
	1217	1658	610	19.138	253	0.146	3.096	8.016	0.0016	0.0332	0.0859	0.0043	0.0912	0.2363	0.0067	0.1410	0.3651	
					257	0.146	3.096	8.016										
					258	0.146	3.096	8.016										
	1222	1663	460	9.173	485	0.146	3.096	8.016	0.0007	0.0159	0.0412	0.0021	0.0437	0.1132	0.0032	0.0676	0.1750	
	1226	1668	683	19.421	568	0.146	3.096	8.016	0.0016	0.0337	0.0872	0.0044	0.0926	0.2397	0.0067	0.1431	0.3705	
					570	0.146	3.096	8.016										
	1229	1673	676	8.656	265	0.146	3.096	8.016	0.0007	0.0150	0.0389	0.0019	0.0413	0.1068	0.0030	0.0638	0.1651	
					266	0.146	3.096	8.016										
	1234	1678	604	7.622	264b	0.146	3.096	8.016	0.0006	0.0132	0.0342	0.0017	0.0363	0.0941	0.0026	0.0562	0.1454	
	1235	1679	609	10.115	262	0.146	3.096	8.016	0.0008	0.0175	0.0454	0.0023	0.0482	0.1249	0.0035	0.0745	0.1930	
					263	0.146	3.096	8.016										
	1236	1680	311	7.922	503	0.146	3.096	8.016	0.0006	0.0137	0.0356	0.0018	0.0378	0.0978	0.0028	0.0584	0.1511	
					504	0.146	3.096	8.016										
	1239	1683	421	6.607	497	0.146	3.096	8.016	0.0005	0.0115	0.0297	0.0015	0.0315	0.0816	0.0023	0.0487	0.1261	
					498	0.146	3.096	8.016										
	1247	1692	458	9.354	488	0.146	3.096	8.016	0.0008	0.0162	0.0420	0.0021	0.0446	0.1155	0.0033	0.0689	0.1785	
					489	0.146	3.096	8.016										
	1252	1699	618	5.336	264a	0.146	3.096	8.016	0.0004	0.0093	0.0240	0.0012	0.0254	0.0659	0.0019	0.0393	0.1018	
	1259	1707	312	4.732	506	0.146	3.096	8.016	0.0004	0.0082	0.0212	0.0011	0.0226	0.0584	0.0016	0.0349	0.0903	
	1264	1712	645	13.492	304	0.146	3.096	8.016	0.0011	0.0234	0.0606	0.0030	0.0643	0.1666	0.0047	0.0994	0.2574	
	1267	1715	296	26.583	561	0.146	3.096	8.016	0.0022	0.0461	0.1193	0.0060	0.1267	0.3282	0.0092	0.1959	0.5071	
					562	0.146	3.096	8.016										
	1273	1722	617	22.651	254	0.146	3.096	8.016	0.0019	0.0393	0.1017	0.0051	0.1080	0.2796	0.0079	0.1669	0.4321	
	1274	1723	674	9.718	267	0.146	3.096	8.016	0.0008	0.0168	0.0436	0.0022	0.0463	0.1200	0.0034	0.0716	0.1854	
					268	0.146	3.096	8.016										
	1275	1724	292	12.225	565	0.146	3.096	8.016	0.0010	0.0212	0.0549	0.0027	0.0583	0.1509	0.0042	0.0901	0.2332	
					566	0.146	3.096	8.016										
	1280	1731	619	6.531	301	0.146	3.096	8.016	0.0005	0.0113	0.0293	0.0015	0.0311	0.0806	0.0023	0.0481	0.1246	
	1283	1735	291	7.144	571	0.146	3.096	8.016	0.0006	0.0124	0.0321	0.0016	0.0341	0.0882	0.0025	0.0526	0.1363	
	1285	1737	454	32.457	490	0.146	3.096	8.016	0.0027	0.0563	0.1457	0.0073	0.1547	0.4007	0.0113	0.2392	0.6192	

					491	0.146	3.096	8.016									
	1296	1752	299	10.474	509	0.146	3.096	8.016	0.0009	0.0182	0.0470	0.0024	0.0499	0.1293	0.0036	0.0772	0.1998
	1299	1755	672	6.133	578	0.146	3.096	8.016	0.0005	0.0106	0.0275	0.0014	0.0292	0.0757	0.0021	0.0452	0.1170
	1303	1760	646	9.304	302	0.146	3.096	8.016	0.0008	0.0161	0.0418	0.0021	0.0444	0.1149	0.0032	0.0686	0.1775
					303	0.146	3.096	8.016									
	1304	1761	602	8.899	269	0.146	3.096	8.016	0.0007	0.0154	0.0399	0.0020	0.0424	0.1099	0.0031	0.0656	0.1698
	1305	1763	293	10.239	510	0.146	3.096	8.016	0.0008	0.0178	0.0460	0.0023	0.0488	0.1264	0.0036	0.0754	0.1953
					564	0.146	3.096	8.016									
	1309	1769	624	9.465	300	0.146	3.096	8.016	0.0008	0.0164	0.0425	0.0021	0.0451	0.1168	0.0033	0.0697	0.1806
	1315	1776	430	6.106	496	0.146	3.096	8.016	0.0005	0.0106	0.0274	0.0014	0.0291	0.0754	0.0021	0.0450	0.1165
	1321	1784	599	18.631	270	0.146	3.096	8.016	0.0015	0.0323	0.0836	0.0042	0.0888	0.2300	0.0065	0.1373	0.3554
	1322	1785	287	9.172	575	0.146	3.096	8.016	0.0007	0.0159	0.0412	0.0021	0.0437	0.1132	0.0032	0.0676	0.1750
					576	0.146	3.096	8.016									
	1324	1789	455	8.214	456	0.146	3.096	8.016	0.0007	0.0142	0.0369	0.0018	0.0392	0.1014	0.0029	0.0605	0.1567
	1326	1793	414	33.950	495	0.146	3.096	8.016	0.0028	0.0589	0.1524	0.0076	0.1619	0.4191	0.0118	0.2502	0.6477
					499	0.146	3.096	8.016									
	1344	1812	626	13.339	299	0.146	3.096	8.016	0.0011	0.0231	0.0599	0.0030	0.0636	0.1647	0.0046	0.0983	0.2545
	1356	1825	616	9.890	297	0.146	3.096	8.016	0.0008	0.0171	0.0444	0.0022	0.0472	0.1221	0.0034	0.0729	0.1887
	1358	1827	409	12.506	505	0.146	3.096	8.016	0.0010	0.0217	0.0561	0.0028	0.0596	0.1544	0.0043	0.0922	0.2386
	1368	1838	569	5.460	276	0.146	3.096	8.016	0.0004	0.0095	0.0245	0.0012	0.0260	0.0674	0.0019	0.0402	0.1042
	1369	1840	369	19.298	507b	0.146	3.096	8.016	0.0016	0.0335	0.0866	0.0043	0.0920	0.2382	0.0067	0.1422	0.3682
					508	0.146	3.096	8.016									
					511	0.146	3.096	8.016									
	1375	1846	407	9.657	507a	0.146	3.096	8.016	0.0008	0.0167	0.0433	0.0022	0.0460	0.1192	0.0034	0.0712	0.1842
	1379	1850	658	21.356	572	0.146	3.096	8.016	0.0017	0.0370	0.0959	0.0048	0.1018	0.2636	0.0074	0.1574	0.4074
					573	0.146	3.096	8.016									
	1387	1859	281	22.268	574	0.146	3.096	8.016	0.0018	0.0386	0.1000	0.0050	0.1062	0.2749	0.0077	0.1641	0.4248
					577	0.146	3.096	8.016									
	1390	1862	589	15.920	271	0.146	3.096	8.016	0.0013	0.0276	0.0715	0.0036	0.0759	0.1965	0.0055	0.1173	0.3037
					273	0.146	3.096	8.016									
	1397	1869	363	14.073	512	0.146	3.096	8.016	0.0012	0.0244	0.0632	0.0032	0.0671	0.1737	0.0049	0.1037	0.2685
					513	0.146	3.096	8.016									
					514	0.146	3.096	8.016									
	1413	1887	591	4.787	298	0.146	3.096	8.016	0.0004	0.0083	0.0215	0.0011	0.0228	0.0591	0.0017	0.0353	0.0913
	1414	1888	572	5.606	275	0.146	3.096	8.016	0.0005	0.0097	0.0252	0.0013	0.0267	0.0692	0.0019	0.0413	0.1069
	1426	1904	585	16.146	295	0.146	3.096	8.016	0.0013	0.0280	0.0725	0.0036	0.0770	0.1993	0.0056	0.1190	0.3080
					296	0.146	3.096	8.016									
	1428	1907	568	22.276	272	0.146	3.096	8.016	0.0018	0.0386	0.1000	0.0050	0.1062	0.2750	0.0077	0.1641	0.4250
					274	0.146	3.096	8.016									
	1429	1908	659	29.345	580	0.146	3.096	8.016	0.0024	0.0509	0.1317	0.0066	0.1399	0.3623	0.0102	0.2162	0.5599
					581	0.146	3.096	8.016									
					582	0.146	3.096	8.016									
	1431	1910	277	7.362	432	0.146	3.096	8.016	0.0006	0.0128	0.0330	0.0017	0.0351	0.0909	0.0026	0.0542	0.1404
	1436	1916	271	8.332	579	0.146	3.096	8.016	0.0007	0.0144	0.0374	0.0019	0.0397	0.1029	0.0029	0.0614	0.1590
					584	0.146	3.096	8.016									
	1437	1917	424	10.017	452	0.146	3.096	8.016	0.0008	0.0174	0.0450	0.0023	0.0478	0.1237	0.0035	0.0738	0.1911
	1438	1919	428	19.332	451	0.146	3.096	8.016	0.0016	0.0335	0.0868	0.0043	0.0922	0.2386	0.0067	0.1424	0.3688
	1439	1920	581	11.266	289a	0.146	3.096	8.016	0.0009	0.0195	0.0506	0.0025	0.0537	0.1391	0.0039	0.0830	0.2149
	1447	1934	377	14.998	448	0.146	3.096	8.016	0.0012	0.0260	0.0673	0.0034	0.0715	0.1851	0.0052	0.1105	0.2861
	1448	1935	415	13.272	449	0.146	3.096	8.016	0.0011	0.0230	0.0596	0.0030	0.0633	0.1638	0.0046	0.0978	0.2532
					450	0.146	3.096	8.016									
	1451	1939	556	5.208	277	0.146	3.096	8.016	0.0004	0.0090	0.0234	0.0012	0.0248	0.0643	0.0018	0.0384	0.0994
	1452	1940	655	6.469	587	0.146	3.096	8.016	0.0005	0.0112	0.0290	0.0015	0.0308	0.0799	0.0022	0.0477	0.1234
	1456	1944	439	6.534	442	0.146	3.096	8.016	0.0005	0.0113	0.0293	0.0015	0.0312	0.0807	0.0023	0.0481	0.1247
	1461	1951	269	5.189	586	0.146	3.096	8.016	0.0004	0.0090	0.0233	0.0012	0.0247	0.0641	0.0018	0.0382	0.0990
	1464	1954	367	7.886	404	0.146	3.096	8.016	0.0006	0.0137	0.0354	0.0018	0.0376	0.0973	0.0027	0.0581	0.1504
	1470	1960	488	12.360	455	0.146	3.096	8.016	0.0010	0.0214	0.0555	0.0028	0.0589	0.1526	0.0043	0.0911	0.2358
	1473	1963	567	12.275	278	0.146	3.096	8.016	0.0010	0.0213	0.0551	0.0028	0.0585	0.1515	0.0043	0.0904	0.2342
					290	0.146	3.096	8.016									
	1476	1968	653	5.500	588	0.146	3.096	8.016	0.0004	0.0095	0.0247	0.0012	0.0262	0.0679	0.0019	0.0405	0.1049
					589	0.146	3.096	8.016									
	1477	1970	359	10.825	430	0.146	3.096	8.016	0.0009	0.0188	0.0486	0.0024	0.0516	0.1336	0.0038	0.0798	0.2065
	1479	1972	263	5.224	591	0.146	3.096	8.016	0.0004	0.0091	0.0235	0.0012	0.0249	0.0645	0.0018	0.0385	0.0997
	1480	1973	270	8.103	585	0.146	3.096	8.016	0.0007	0.0140	0.0364	0.0018	0.0386	0.1000	0.0028	0.0597	0.1546
	1481	1974	397	5.156	447	0.146	3.096	8.016	0.0004	0.0089	0.0231	0.0012	0.0246	0.0636	0.0018	0.0380	0.0984
	1482	1975	398	6.540	445	0.146	3.096	8.016	0.0005	0.0113	0.0294	0.0015	0.0312	0.0807	0.0023	0.0482	0.1248
					446	0.146	3.096	8.016									
	1483	1976	273	7.805	431	0.146	3.096	8.016	0.0006	0.0135	0.0350	0.0018	0.0372	0.0964	0.0027	0.0575	0.1489
					433	0.146	3.096	8.016									
	1484	1979	651	9.934	590	0.146	3.096	8.016	0.0008	0.0172	0.0446	0.0022	0.0474	0.1226	0.0035	0.0732	0.1895

	1488	1983	587	17.171	294	0.146	3.096	8.016	0.0014	0.0298	0.0771	0.0039	0.0819	0.2120	0.0060	0.1265	0.3276
	1491	1987	403	7.603	443	0.146	3.096	8.016	0.0006	0.0132	0.0341	0.0017	0.0363	0.0939	0.0026	0.0560	0.1451
	1493	1989	576	11.183	291	0.146	3.096	8.016	0.0009	0.0194	0.0502	0.0025	0.0533	0.1380	0.0039	0.0824	0.2133
					292	0.146	3.096	8.016									
	1495	1992	381	5.894	401b	0.146	3.096	8.016	0.0005	0.0102	0.0265	0.0013	0.0281	0.0728	0.0020	0.0434	0.1124
	1496	1993	400	6.593	444	0.146	3.096	8.016	0.0005	0.0114	0.0296	0.0015	0.0314	0.0814	0.0023	0.0486	0.1258
	1507	2005	492	15.122	454	0.146	3.096	8.016	0.0012	0.0262	0.0679	0.0034	0.0721	0.1867	0.0053	0.1114	0.2885
	1509	2007	266	13.836	437	0.146	3.096	8.016	0.0011	0.0240	0.0621	0.0031	0.0660	0.1708	0.0048	0.1019	0.2640
	1512	2014	583	16.161	293	0.146	3.096	8.016	0.0013	0.0280	0.0725	0.0036	0.0771	0.1995	0.0056	0.1191	0.3083
	1516	2019	256	5.714	436	0.146	3.096	8.016	0.0005	0.0099	0.0257	0.0013	0.0272	0.0705	0.0020	0.0421	0.1090
	1518	2021	365	11.521	400	0.146	3.096	8.016	0.0009	0.0200	0.0517	0.0026	0.0549	0.1422	0.0040	0.0849	0.2198
					403	0.146	3.096	8.016									
					405	0.146	3.096	8.016									
	1519	2022	561	9.898	280	0.146	3.096	8.016	0.0008	0.0172	0.0444	0.0022	0.0472	0.1222	0.0034	0.0729	0.1888
	1522	2026	578	10.187	288b	0.146	3.096	8.016	0.0008	0.0177	0.0457	0.0023	0.0486	0.1258	0.0035	0.0751	0.1944
					289b	0.146	3.096	8.016									
	1525	2029	267	5.172	438	0.146	3.096	8.016	0.0004	0.0090	0.0232	0.0012	0.0247	0.0638	0.0018	0.0381	0.0987
	1527	2031	121	9.110	407	0.146	3.096	8.016	0.0007	0.0158	0.0409	0.0020	0.0434	0.1125	0.0032	0.0671	0.1738
	1528	2032	123	12.284	406	0.146	3.096	8.016	0.0010	0.0213	0.0551	0.0028	0.0586	0.1516	0.0043	0.0905	0.2344
	1529	2033	364	14.864	397	0.146	3.096	8.016	0.0012	0.0258	0.0667	0.0033	0.0709	0.1835	0.0052	0.1095	0.2836
					398	0.146	3.096	8.016									
					402	0.146	3.096	8.016									
	1532	2036	552	6.608	279	0.146	3.096	8.016	0.0005	0.0115	0.0297	0.0015	0.0315	0.0816	0.0023	0.0487	0.1261
	1535	2039	255	14.339	434	0.146	3.096	8.016	0.0012	0.0249	0.0644	0.0032	0.0684	0.1770	0.0050	0.1057	0.2736
	1537	2041	222	18.286	377	0.146	3.096	8.016	0.0015	0.0317	0.0821	0.0041	0.0872	0.2257	0.0064	0.1347	0.3489
	1539	2045	387	10.204	453	0.146	3.096	8.016	0.0008	0.0177	0.0458	0.0023	0.0487	0.1260	0.0035	0.0752	0.1947
	1543	2049	203	7.205	380	0.146	3.096	8.016	0.0006	0.0125	0.0323	0.0016	0.0344	0.0889	0.0025	0.0531	0.1375
					381	0.146	3.096	8.016									
	1544	2050	564	5.729	282	0.146	3.096	8.016	0.0005	0.0099	0.0257	0.0013	0.0273	0.0707	0.0020	0.0422	0.1093
	1547	2053	386	7.344	390	0.146	3.096	8.016	0.0006	0.0127	0.0330	0.0017	0.0350	0.0907	0.0026	0.0541	0.1401
	1551	2057	153	6.605	399	0.146	3.096	8.016	0.0005	0.0115	0.0296	0.0015	0.0315	0.0815	0.0023	0.0487	0.1260
	1552	2058	383	13.672	396	0.146	3.096	8.016	0.0011	0.0237	0.0614	0.0031	0.0652	0.1688	0.0048	0.1007	0.2608
					401a	0.146	3.096	8.016									
	1554	2060	565	7.039	281	0.146	3.096	8.016	0.0006	0.0122	0.0316	0.0016	0.0336	0.0869	0.0024	0.0519	0.1343
	1557	2064	253	6.688	439	0.146	3.096	8.016	0.0005	0.0116	0.0300	0.0015	0.0319	0.0826	0.0023	0.0493	0.1276
					441	0.146	3.096	8.016									
	1559	2066	251	5.656	440	0.146	3.096	8.016	0.0005	0.0098	0.0254	0.0013	0.0270	0.0698	0.0020	0.0417	0.1079
	1561	2070	124	6.899	415	0.146	3.096	8.016	0.0006	0.0120	0.0310	0.0016	0.0329	0.0852	0.0024	0.0508	0.1316
					416	0.146	3.096	8.016									
	1562	2071	60	6.228	286	0.146	3.096	8.016	0.0005	0.0108	0.0280	0.0014	0.0297	0.0769	0.0022	0.0459	0.1188
					288a	0.146	3.096	8.016									
	1563	2072	59	5.219	285	0.146	3.096	8.016	0.0004	0.0090	0.0234	0.0012	0.0249	0.0644	0.0018	0.0385	0.0996
	1564	2073	58	6.952	287	0.146	3.096	8.016	0.0006	0.0121	0.0312	0.0016	0.0331	0.0858	0.0024	0.0512	0.1326
	1575	2092	56	14.431	283	0.146	3.096	8.016	0.0012	0.0250	0.0648	0.0032	0.0688	0.1782	0.0050	0.1063	0.2753
					284	0.146	3.096	8.016									
	1577	2094	120	36.684	418	0.146	3.096	8.016	0.0030	0.0636	0.1647	0.0082	0.1749	0.4529	0.0127	0.2703	0.6999
	1580	2097	249	4.827	420	0.146	3.096	8.016	0.0004	0.0084	0.0217	0.0011	0.0230	0.0596	0.0017	0.0356	0.0921
	1581	2098	200	10.256	384	0.146	3.096	8.016	0.0008	0.0178	0.0460	0.0023	0.0489	0.1266	0.0036	0.0756	0.1957
	1585	2103	125	23.680	417	0.146	3.096	8.016	0.0019	0.0411	0.1063	0.0053	0.1129	0.2923	0.0082	0.1745	0.4518
	1586	2105	202	6.464	383b	0.146	3.096	8.016	0.0005	0.0112	0.0290	0.0015	0.0308	0.0798	0.0022	0.0476	0.1233
	1589	2108	201	11.695	378	0.146	3.096	8.016	0.0010	0.0203	0.0525	0.0026	0.0558	0.1444	0.0041	0.0862	0.2231
					382	0.146	3.096	8.016									
					383a	0.146	3.096	8.016									
	1590	2109	224	11.768	375	0.146	3.096	8.016	0.0010	0.0204	0.0528	0.0026	0.0561	0.1453	0.0041	0.0867	0.2245
	1592	2113	174	13.317	391	0.146	3.096	8.016	0.0011	0.0231	0.0598	0.0030	0.0635	0.1644	0.0046	0.0981	0.2541
					392	0.146	3.096	8.016									
	1595	2116	78	7.744	311	0.146	3.096	8.016	0.0006	0.0134	0.0348	0.0017	0.0369	0.0956	0.0027	0.0571	0.1477
	1597	2120	245	7.311	424	0.146	3.096	8.016	0.0006	0.0127	0.0328	0.0016	0.0349	0.0903	0.0025	0.0539	0.1395
	1605	2129	118	8.887	419	0.146	3.096	8.016	0.0007	0.0154	0.0399	0.0020	0.0424	0.1097	0.0031	0.0655	0.1696
	1610	2134	117	14.739	413	0.146	3.096	8.016	0.0012	0.0256	0.0662	0.0033	0.0703	0.1819	0.0051	0.1086	0.2812
					414	0.146	3.096	8.016									
	1615	2140	164	9.080	393	0.146	3.096	8.016	0.0007	0.0157	0.0408	0.0020	0.0433	0.1121	0.0032	0.0669	0.1732
	1623	2149	115	15.951	411	0.146	3.096	8.016	0.0013	0.0277	0.0716	0.0036	0.0760	0.1969	0.0055	0.1175	0.3043
					412a	0.146	3.096	8.016									
	1624	2150	137	14.950	408	0.146	3.096	8.016	0.0012	0.0259	0.0671	0.0034	0.0713	0.1845	0.0052	0.1102	0.2852
	1625	2151	146	9.671	395	0.146	3.096	8.016	0.0008	0.0168	0.0434	0.0022	0.0461	0.1194	0.0034	0.0713	0.1845
	1628	2156	199	10.819	379	0.146	3.096	8.016	0.0009	0.0188	0.0486	0.0024	0.0516	0.1336	0.0038	0.0797	0.2064
	1629	2157	232	43.208	315	0.146	3.096	8.016	0.0035	0.0749	0.1940	0.0097	0.2060	0.5334	0.0150	0.3184	0.8243
	1633	2163	172	12.852	385	0.146	3.096	8.016	0.0011	0.0223	0.0577	0.0029	0.0613	0.1587	0.0045	0.0947	0.2452
	1635	2165	96	10.955	421	0.146	3.096	8.016	0.0009	0.0190	0.0492	0.0025	0.0522	0.1352	0.0038	0.0807	0.2090

					422	0.146	3.096	8.016									
	1637	2167	165	4.767	394	0.146	3.096	8.016	0.0004	0.0083	0.0214	0.0011	0.0227	0.0588	0.0017	0.0351	0.0909
	1638	2168	77	11.032	312	0.146	3.096	8.016	0.0009	0.0191	0.0495	0.0025	0.0526	0.1362	0.0038	0.0813	0.2105
	1645	2177	214	11.724	376	0.146	3.096	8.016	0.0010	0.0203	0.0526	0.0026	0.0559	0.1447	0.0041	0.0864	0.2237
	1651	2185	112	12.086	423	0.146	3.096	8.016	0.0010	0.0210	0.0543	0.0027	0.0576	0.1492	0.0042	0.0891	0.2306
	1653	2188	45	7.726	313	0.146	3.096	8.016	0.0006	0.0134	0.0347	0.0017	0.0368	0.0954	0.0027	0.0569	0.1474
	1656	2191	26	8.948	318	0.146	3.096	8.016	0.0007	0.0155	0.0402	0.0020	0.0427	0.1105	0.0031	0.0659	0.1707
	1665	2204	126	8.677	410	0.146	3.096	8.016	0.0007	0.0150	0.0390	0.0020	0.0414	0.1071	0.0030	0.0639	0.1655
	1670	2210	28	19.218	314	0.146	3.096	8.016	0.0016	0.0333	0.0863	0.0043	0.0916	0.2372	0.0067	0.1416	0.3666
	1674	2218	90	7.405	425	0.146	3.096	8.016	0.0006	0.0128	0.0332	0.0017	0.0353	0.0914	0.0026	0.0546	0.1413
	1676	2224	145	7.074	409	0.146	3.096	8.016	0.0006	0.0123	0.0318	0.0016	0.0337	0.0873	0.0025	0.0521	0.1350
	1678	2226	108	6.128	427	0.146	3.096	8.016	0.0005	0.0106	0.0275	0.0014	0.0292	0.0756	0.0021	0.0452	0.1169
					428	0.146	3.096	8.016									
	1680	2229	158	4.898	388	0.146	3.096	8.016	0.0004	0.0085	0.0220	0.0011	0.0234	0.0605	0.0017	0.0361	0.0934
	1684	2233	195	7.663	386	0.146	3.096	8.016	0.0006	0.0133	0.0344	0.0017	0.0365	0.0946	0.0027	0.0565	0.1462
	1685	2234	94	14.500	426	0.146	3.096	8.016	0.0012	0.0251	0.0651	0.0033	0.0691	0.1790	0.0050	0.1068	0.2766
					429	0.146	3.096	8.016									
	1686	2235	206	5.820	373	0.146	3.096	8.016	0.0005	0.0101	0.0261	0.0013	0.0277	0.0718	0.0020	0.0429	0.1110
	1694	2245	129	3.780	359	0.146	3.096	8.016	0.0003	0.0066	0.0170	0.0008	0.0180	0.0467	0.0013	0.0279	0.0721
	1695	2246	155	4.984	389	0.146	3.096	8.016	0.0004	0.0086	0.0224	0.0011	0.0238	0.0615	0.0017	0.0367	0.0951
	1697	2249	74	10.233	316	0.146	3.096	8.016	0.0008	0.0177	0.0459	0.0023	0.0488	0.1263	0.0036	0.0754	0.1952
	1700	2253	211	8.492	374	0.146	3.096	8.016	0.0007	0.0147	0.0381	0.0019	0.0405	0.1048	0.0030	0.0626	0.1620
	1701	2254	27	8.929	317	0.146	3.096	8.016	0.0007	0.0155	0.0401	0.0020	0.0426	0.1102	0.0031	0.0658	0.1703
	1704	2258	189	6.911	387	0.146	3.096	8.016	0.0006	0.0120	0.0310	0.0016	0.0329	0.0853	0.0024	0.0509	0.1318
	1716	2271	134	7.210	360	0.146	3.096	8.016	0.0006	0.0125	0.0324	0.0016	0.0344	0.0890	0.0025	0.0531	0.1376
	1726	2285	186	6.136	372	0.146	3.096	8.016	0.0005	0.0106	0.0275	0.0014	0.0293	0.0757	0.0021	0.0452	0.1171
	1728	2288	142	9.853	361	0.146	3.096	8.016	0.0008	0.0171	0.0442	0.0022	0.0470	0.1216	0.0034	0.0726	0.1880
					362a	0.146	3.096	8.016									
					363	0.146	3.096	8.016									
	1729	2289	156	11.446	362b	0.146	3.096	8.016	0.0009	0.0198	0.0514	0.0026	0.0546	0.1413	0.0040	0.0843	0.2184
	1732	2292	106	15.240	357	0.146	3.096	8.016	0.0012	0.0264	0.0684	0.0034	0.0727	0.1881	0.0053	0.1123	0.2907
					358	0.146	3.096	8.016									
	1734	2294	180	6.593	364	0.146	3.096	8.016	0.0005	0.0114	0.0296	0.0015	0.0314	0.0814	0.0023	0.0486	0.1258
	1736	2296	228	7.766	368	0.146	3.096	8.016	0.0006	0.0135	0.0349	0.0017	0.0370	0.0959	0.0027	0.0572	0.1482
	1740	2301	227	3.445	365b	0.146	3.096	8.016	0.0003	0.0060	0.0155	0.0008	0.0164	0.0425	0.0012	0.0254	0.0657
	1741	2305	25	15.916	320	0.146	3.096	8.016	0.0013	0.0276	0.0714	0.0036	0.0759	0.1965	0.0055	0.1173	0.3036
	1742	2306	101	8.641	356	0.146	3.096	8.016	0.0007	0.0150	0.0388	0.0019	0.0412	0.1067	0.0030	0.0637	0.1649
	1745	2309	98	8.365	354	0.146	3.096	8.016	0.0007	0.0145	0.0376	0.0019	0.0399	0.1033	0.0029	0.0616	0.1596
	1746	2310	43	43.460	319	0.146	3.096	8.016	0.0036	0.0753	0.1951	0.0098	0.2072	0.5365	0.0151	0.3202	0.8291
	1748	2312	100	11.375	355	0.146	3.096	8.016	0.0009	0.0197	0.0511	0.0026	0.0542	0.1404	0.0040	0.0838	0.2170
	1750	2314	44	6.722	321	0.146	3.096	8.016	0.0005	0.0117	0.0302	0.0015	0.0320	0.0830	0.0023	0.0495	0.1282
					324	0.146	3.096	8.016									
	1755	2319	183	15.592	365a	0.146	3.096	8.016	0.0013	0.0270	0.0700	0.0035	0.0743	0.1925	0.0054	0.1149	0.2975
					366	0.146	3.096	8.016									
					367	0.146	3.096	8.016									
	1756	2320	230	11.487	371	0.146	3.096	8.016	0.0009	0.0199	0.0516	0.0026	0.0548	0.1418	0.0040	0.0846	0.2192
	1761	2325	229	6.105	369	0.146	3.096	8.016	0.0005	0.0106	0.0274	0.0014	0.0291	0.0754	0.0021	0.0450	0.1165
	1766	2331	231	11.743	370	0.146	3.096	8.016	0.0010	0.0204	0.0527	0.0026	0.0560	0.1450	0.0041	0.0865	0.2240
	1768	2333	22	11.974	323	0.146	3.096	8.016	0.0010	0.0208	0.0537	0.0027	0.0571	0.1478	0.0042	0.0882	0.2284
	1770	2335	37	10.259	350	0.146	3.096	8.016	0.0008	0.0178	0.0461	0.0023	0.0489	0.1266	0.0036	0.0756	0.1957
	1771	2336	23	19.967	322	0.146	3.096	8.016	0.0016	0.0346	0.0896	0.0045	0.0952	0.2465	0.0069	0.1471	0.3809
					325	0.146	3.096	8.016									
					326	0.146	3.096	8.016									
					328	0.146	3.096	8.016									
	1772	2337	66	12.793	353	0.146	3.096	8.016	0.0010	0.0222	0.0574	0.0029	0.0610	0.1579	0.0044	0.0943	0.2441
	1773	2338	64	10.011	351	0.146	3.096	8.016	0.0008	0.0174	0.0449	0.0023	0.0477	0.1236	0.0035	0.0738	0.1910
	1774	2339	42	13.198	327	0.146	3.096	8.016	0.0011	0.0229	0.0592	0.0030	0.0629	0.1629	0.0046	0.0972	0.2518
	1775	2340	67	7.633	352	0.146	3.096	8.016	0.0006	0.0132	0.0343	0.0017	0.0364	0.0942	0.0027	0.0562	0.1456
	1777	2342	34	7.716	348	0.146	3.096	8.016	0.0006	0.0134	0.0346	0.0017	0.0368	0.0952	0.0027	0.0569	0.1472
					349	0.146	3.096	8.016									
	1781	2346	14	14.056	329	0.146	3.096	8.016	0.0011	0.0244	0.0631	0.0032	0.0670	0.1735	0.0049	0.1036	0.2682
	1782	2347	13	8.050	330	0.146	3.096	8.016	0.0007	0.0140	0.0361	0.0018	0.0384	0.0994	0.0028	0.0593	0.1536
					331	0.146	3.096	8.016									
	1784	2349	35	25.811	346	0.146	3.096	8.016	0.0021	0.0448	0.1159	0.0058	0.1231	0.3186	0.0090	0.1902	0.4924
					347	0.146	3.096	8.016									
	1787	2352	16	11.780	332	0.146	3.096	8.016	0.0010	0.0204	0.0529	0.0026	0.0562	0.1454	0.0041	0.0868	0.2247
					333	0.146	3.096	8.016									
	1790	2355	18	6.090	334	0.146	3.096	8.016	0.0005	0.0106	0.0273	0.0014	0.0290	0.0752	0.0021	0.0449	0.1162
	1792	2357	15	9.014	336	0.146	3.096	8.016	0.0007	0.0156	0.0405	0.0020	0.0430	0.1113	0.0031	0.0664	0.1720
	1793	2358	7	26.907	339	0.146	3.096	8.016	0.0022	0.0467	0.1208	0.0060	0.1283	0.3322	0.0093	0.1983	0.5133

					340	0.146	3.096	8.016									
					341	0.146	3.096	8.016									
					343	0.146	3.096	8.016									
					344	0.146	3.096	8.016									
	1794	2359	4	7.267	337	0.146	3.096	8.016	0.0006	0.0126	0.0326	0.0016	0.0346	0.0897	0.0025	0.0535	0.1386
	1795	2360	19	6.177	335	0.146	3.096	8.016	0.0005	0.0107	0.0277	0.0014	0.0295	0.0763	0.0021	0.0455	0.1178
	1799	2364	6	5.513	342	0.146	3.096	8.016	0.0005	0.0096	0.0247	0.0012	0.0263	0.0680	0.0019	0.0406	0.1052
	1800	2365	1	6.875	338	0.146	3.096	8.016	0.0006	0.0119	0.0309	0.0015	0.0328	0.0849	0.0024	0.0507	0.1312
Basin 23	1	2	1	2.867	23E	0.146	3.096	8.016	0.0002	0.0050	0.0129	0.0006	0.0137	0.0354	0.0010	0.0211	0.0547
	5	7	5	14.232	23A	0.146	3.096	8.016	0.0012	0.0247	0.0639	0.0032	0.0679	0.1757	0.0049	0.1049	0.2715
	6	8	7	5.855	23B	0.146	3.096	8.016	0.0005	0.0102	0.0263	0.0013	0.0279	0.0723	0.0020	0.0431	0.1117
	7	9	6	17.150	23C	0.146	3.096	8.016	0.0014	0.0297	0.0770	0.0039	0.0818	0.2117	0.0060	0.1264	0.3272
					23D	0.146	3.096	8.016									
Basin 24	FID	Sub Basin Id	gridcode														
	4	5	4	7.590	24A	0.146	3.096	8.016	0.0006	0.0132	0.0341	0.0017	0.0362	0.0937	0.0026	0.0559	0.1448
	7	12	9	6.017	24B	0.146	3.096	8.016	0.0005	0.0104	0.0270	0.0014	0.0287	0.0743	0.0021	0.0443	0.1148
Basin 25	FID	Sub Basin Id	gridcode														
	3	6	6	13.708	25D	0.146	3.096	8.016	0.0011	0.0238	0.0615	0.0031	0.0654	0.1692	0.0048	0.1010	0.2615
	4	8	7	20.523	25A	0.146	3.096	8.016	0.0017	0.0356	0.0921	0.0046	0.0978	0.2533	0.0071	0.1512	0.3915
	5	9	4	13.534	25B	0.146	3.096	8.016	0.0011	0.0235	0.0608	0.0030	0.0645	0.1671	0.0047	0.0997	0.2582
	6	10	5	18.073	25C	0.146	3.096	8.016	0.0015	0.0313	0.0811	0.0041	0.0862	0.2231	0.0063	0.1332	0.3448
Basin 26	FID	Sub Basin Id	gridcode														
	5	7	7	10.389	26B	0.146	3.096	8.016	0.0008	0.0180	0.0466	0.0023	0.0495	0.1282	0.0036	0.0766	0.1982
	6	8	4	8.805	26A	0.146	3.096	8.016	0.0007	0.0153	0.0395	0.0020	0.0420	0.1087	0.0031	0.0649	0.1680
	7	9	8	7.336	26C	0.146	3.096	8.016	0.0006	0.0127	0.0329	0.0016	0.0350	0.0906	0.0025	0.0541	0.1400
	9	11	9	21.781	26D	0.146	3.096	8.016	0.0018	0.0378	0.0978	0.0049	0.1039	0.2689	0.0076	0.1605	0.4155
Basin 27	FID	Sub Basin Id	gridcode														
	0	1	1	6.017	27B	0.146	3.096	8.016	0.0005	0.0104	0.0270	0.0014	0.0287	0.0743	0.0021	0.0443	0.1148
	7	8	6	19.245	27A	0.146	3.096	8.016	0.0016	0.0334	0.0864	0.0043	0.0918	0.2376	0.0067	0.1418	0.3671
	8	9	11	8.696	27E	0.146	3.096	8.016	0.0007	0.0151	0.0390	0.0020	0.0415	0.1073	0.0030	0.0641	0.1659
	9	10	7	9.106	27C	0.146	3.096	8.016	0.0007	0.0158	0.0409	0.0020	0.0434	0.1124	0.0032	0.0671	0.1737
	11	13	12	8.943	27D	0.146	3.096	8.016	0.0007	0.0155	0.0401	0.0020	0.0426	0.1104	0.0031	0.0659	0.1706
	12	14	13	29.788	27F	0.146	3.096	8.016	0.0024	0.0516	0.1337	0.0067	0.1420	0.3677	0.0104	0.2195	0.5683
					27G	0.146	3.096	8.016									
Basin 28	FID	Sub Basin Id	gridcode														
	3	4	17	11.220	28A	0.146	3.096	8.016	0.0009	0.0195	0.0504	0.0025	0.0535	0.1385	0.0039	0.0827	0.2141
	6	7	16	4.817	28B	0.146	3.096	8.016	0.0004	0.0084	0.0216	0.0011	0.0230	0.0595	0.0017	0.0355	0.0919
					28C	0.146	3.096	8.016									
					28D1	0.146	3.096	8.016									
	7	8	8	10.118	28E	0.146	3.096	8.016	0.0008	0.0175	0.0454	0.0023	0.0482	0.1249	0.0035	0.0746	0.1930
	8	9	11	9.194	28F	0.146	3.096	8.016	0.0008	0.0159	0.0413	0.0021	0.0438	0.1135	0.0032	0.0677	0.1754
	11	14	9	12.717	28D2	0.146	3.096	8.016	0.0010	0.0220	0.0571	0.0029	0.0606	0.1570	0.0044	0.0937	0.2426
	12	16	10	8.290	28G	0.146	3.096	8.016	0.0007	0.0144	0.0372	0.0019	0.0395	0.1023	0.0029	0.0611	0.1582
	15	20	7	19.066	28H	0.146	3.096	8.016	0.0016	0.0331	0.0856	0.0043	0.0909	0.2354	0.0066	0.1405	0.3638
					28I	0.146	3.096	8.016									
	18	24	2	13.538	28J	0.146	3.096	8.016	0.0011	0.0235	0.0608	0.0030	0.0645	0.1671	0.0047	0.0998	0.2583
	20	26	3	6.416	28K	0.146	3.096	8.016	0.0005	0.0111	0.0288	0.0014	0.0306	0.0792	0.0022	0.0473	0.1224
					28M	0.146	3.096	8.016									
Basin 29	FID	Sub Basin Id	gridcode														
	0	1	1	6.759	29A	0.146	3.096	8.016	0.0006	0.0117	0.0303	0.0015	0.0322	0.0834	0.0023	0.0498	0.1290
	1	2	2	5.800	29B	0.146	3.096	8.016	0.0005	0.0101	0.0260	0.0013	0.0277	0.0716	0.0020	0.0427	0.1106
					29C	0.146	3.096	8.016									
	2	3	3	21.103	29F	0.146	3.096	8.016	0.0017	0.0366	0.0947	0.0047	0.1006	0.2605	0.0073	0.1555	0.4026
					29H	0.146	3.096	8.016									
	3	4	4	18.043	29G	0.146	3.096	8.016	0.0015	0.0313	0.0810	0.0041	0.0860	0.2227	0.0063	0.1330	0.3442
					29J	0.146	3.096	8.016									
	4	5	5	29.864	29I	0.146	3.096	8.016	0.0024	0.0518	0.1341	0.0067	0.1424	0.3687	0.0104	0.2201	0.5698

Basin 30	FID	Sub Basin Id	gridcode														
	5	7	27	10.010	30H	0.146	3.096	8.016	0.0008	0.0174	0.0449	0.0023	0.0477	0.1236	0.0035	0.0738	0.1910
	12	15	51	19.107	30I	0.146	3.096	8.016	0.0016	0.0331	0.0858	0.0043	0.0911	0.2359	0.0066	0.1408	0.3645
	13	16	22	6.125	30F	0.146	3.096	8.016	0.0005	0.0106	0.0275	0.0014	0.0292	0.0756	0.0021	0.0451	0.1169
					30G	0.146	3.096	8.016									
	23	29	15	12.372	30D	0.146	3.096	8.016	0.0010	0.0214	0.0555	0.0028	0.0590	0.1527	0.0043	0.0912	0.2360
	24	30	16	5.957	30E	0.146	3.096	8.016	0.0005	0.0103	0.0267	0.0013	0.0284	0.0735	0.0021	0.0439	0.1136
	25	31	45	6.969	30K	0.146	3.096	8.016	0.0006	0.0121	0.0313	0.0016	0.0332	0.0860	0.0024	0.0513	0.1329
	26	32	46	10.620	30J	0.146	3.096	8.016	0.0009	0.0184	0.0477	0.0024	0.0506	0.1311	0.0037	0.0782	0.2026
	34	41	14	10.974	30C	0.146	3.096	8.016	0.0009	0.0190	0.0493	0.0025	0.0523	0.1355	0.0038	0.0809	0.2094
	42	49	37	11.913	30N	0.146	3.096	8.016	0.0010	0.0207	0.0535	0.0027	0.0568	0.1471	0.0041	0.0878	0.2273
					30O	0.146	3.096	8.016									
	44	52	9	13.134	30B	0.146	3.096	8.016	0.0011	0.0228	0.0590	0.0030	0.0626	0.1621	0.0046	0.0968	0.2506
	45	55	7	6.096	30A	0.146	3.096	8.016	0.0005	0.0106	0.0274	0.0014	0.0291	0.0753	0.0021	0.0449	0.1163
	47	57	34	8.352	30M	0.146	3.096	8.016	0.0007	0.0145	0.0375	0.0019	0.0398	0.1031	0.0029	0.0615	0.1593
Basin 31	FID	Sub Basin Id	gridcode														
	0	1	5	4.985	31D	0.146	3.096	8.016	0.0004	0.0086	0.0224	0.0011	0.0238	0.0615	0.0017	0.0367	0.0951
	3	4	6	8.698	31B	0.146	3.096	8.016	0.0007	0.0151	0.0390	0.0020	0.0415	0.1074	0.0030	0.0641	0.1659
	4	5	2	10.176	31A	0.146	3.096	8.016	0.0008	0.0176	0.0457	0.0023	0.0485	0.1256	0.0035	0.0750	0.1941
	5	6	3	5.138	31C	0.146	3.096	8.016	0.0004	0.0089	0.0231	0.0012	0.0245	0.0634	0.0018	0.0379	0.0980
Basin 32	FID	Sub Basin Id	gridcode														
	7	9	6	26.409	32A	0.146	3.096	8.016	0.0022	0.0458	0.1185	0.0059	0.1259	0.3260	0.0092	0.1946	0.5038
Basin 33	FID	Sub Basin Id	gridcode														
	0	1	3	14.444	33B	0.146	3.096	8.016	0.0012	0.0250	0.0648	0.0032	0.0689	0.1783	0.0050	0.1064	0.2756
	1	2	4	6.744	33C	0.146	3.096	8.016	0.0006	0.0117	0.0303	0.0015	0.0322	0.0833	0.0023	0.0497	0.1287
	2	3	2	14.099	33A	0.146	3.096	8.016	0.0012	0.0244	0.0633	0.0032	0.0672	0.1741	0.0049	0.1039	0.2690
	3	4	5	7.547	33D	0.146	3.096	8.016	0.0006	0.0131	0.0339	0.0017	0.0360	0.0932	0.0026	0.0556	0.1440
	7	11	8	14.933	33E	0.146	3.096	8.016	0.0012	0.0259	0.0670	0.0034	0.0712	0.1843	0.0052	0.1100	0.2849
	8	12	10	8.184	33F	0.146	3.096	8.016	0.0007	0.0142	0.0367	0.0018	0.0390	0.1010	0.0028	0.0603	0.1561
	10	15	11	5.755	33G	0.146	3.096	8.016	0.0005	0.0100	0.0258	0.0013	0.0274	0.0710	0.0020	0.0424	0.1098
Basin 34	FID	Sub Basin Id	gridcode														
	1	2	15	4.846	34B	0.146	3.096	8.016	0.0004	0.0084	0.0218	0.0011	0.0231	0.0598	0.0017	0.0357	0.0925
	2	3	20	7.035	34F	0.146	3.096	8.016	0.0006	0.0122	0.0316	0.0016	0.0335	0.0868	0.0024	0.0518	0.1342
	4	5	17	8.666	34H	0.146	3.096	8.016	0.0007	0.0150	0.0389	0.0019	0.0413	0.1070	0.0030	0.0639	0.1653
	8	10	12	26.267	34A	0.146	3.096	8.016	0.0021	0.0455	0.1179	0.0059	0.1252	0.3243	0.0091	0.1935	0.5011
					34C	0.146	3.096	8.016									
					34I	0.146	3.096	8.016									
	10	13	7	14.673	34E	0.146	3.096	8.016	0.0012	0.0254	0.0659	0.0033	0.0700	0.1811	0.0051	0.1081	0.2799
	11	14	8	11.076	34D	0.146	3.096	8.016	0.0009	0.0192	0.0497	0.0025	0.0528	0.1367	0.0038	0.0816	0.2113
	18	21	4	11.273	34J	0.146	3.096	8.016	0.0009	0.0195	0.0506	0.0025	0.0538	0.1392	0.0039	0.0831	0.2151
Basin 35	FID	Sub Basin Id	gridcode														
	0	1	8	15.518	35B	0.146	3.096	8.016	0.0013	0.0269	0.0697	0.0035	0.0740	0.1916	0.0054	0.1143	0.2960
	1	2	6	16.463	35C	0.146	3.096	8.016	0.0013	0.0285	0.0739	0.0037	0.0785	0.2032	0.0057	0.1213	0.3141
					35D	0.146	3.096	8.016									
	3	4	4	6.248	35F	0.146	3.096	8.016	0.0005	0.0108	0.0280	0.0014	0.0298	0.0771	0.0022	0.0460	0.1192
	4	5	5	8.931	35E	0.146	3.096	8.016	0.0007	0.0155	0.0401	0.0020	0.0426	0.1102	0.0031	0.0658	0.1704
	5	6	9	12.927	35A	0.146	3.096	8.016	0.0011	0.0224	0.0580	0.0029	0.0616	0.1596	0.0045	0.0953	0.2466
	6	7	2	5.204	35H	0.146	3.096	8.016	0.0004	0.0090	0.0234	0.0012	0.0248	0.0642	0.0018	0.0383	0.0993
	9	10	10	9.841	35G	0.146	3.096	8.016	0.0008	0.0171	0.0442	0.0022	0.0469	0.1215	0.0034	0.0725	0.1878
Basin 36	FID	Sub Basin Id	gridcode														
	1	3	20	40.539	36C	0.146	3.096	8.016	0.0033	0.0703	0.1820	0.0091	0.1933	0.5004	0.0141	0.2987	0.7734
					36D	0.146	3.096	8.016									
					36E	0.146	3.096	8.016									
					36F	0.146	3.096	8.016									
					36G	0.146	3.096	8.016									
	2	4	23	6.615	36A	0.146	3.096	8.016	0.0005	0.0115	0.0297	0.0015	0.0315	0.0817	0.0023	0.0487	0.1262

					36B	0.146	3.096	8.016									
	3	5	21	6.748	36H	0.146	3.096	8.016	0.0006	0.0117	0.0303	0.0015	0.0322	0.0833	0.0023	0.0497	0.1287
	4	7	18	13.026	36I	0.146	3.096	8.016	0.0011	0.0226	0.0585	0.0029	0.0621	0.1608	0.0045	0.0960	0.2485
	5	8	8	5.893	36L	0.146	3.096	8.016	0.0005	0.0102	0.0265	0.0013	0.0281	0.0727	0.0020	0.0434	0.1124
					36M	0.146	3.096	8.016									
	6	9	9	12.864	36K	0.146	3.096	8.016	0.0011	0.0223	0.0577	0.0029	0.0613	0.1588	0.0045	0.0948	0.2454
	8	11	5	6.630	36N	0.146	3.096	8.016	0.0005	0.0115	0.0298	0.0015	0.0316	0.0818	0.0023	0.0489	0.1265
	9	12	2	18.518	36P	0.146	3.096	8.016	0.0015	0.0321	0.0831	0.0042	0.0883	0.2286	0.0064	0.1364	0.3533
	11	14	11	6.820	36J	0.146	3.096	8.016	0.0006	0.0118	0.0306	0.0015	0.0325	0.0842	0.0024	0.0503	0.1301
	12	15	14	6.103	36S	0.146	3.096	8.016	0.0005	0.0106	0.0274	0.0014	0.0291	0.0753	0.0021	0.0450	0.1164
					36T	0.146	3.096	8.016									
	16	21	16	5.897	36R	0.146	3.096	8.016	0.0005	0.0102	0.0265	0.0013	0.0281	0.0728	0.0020	0.0435	0.1125
					36U	0.146	3.096	8.016									
	17	22	4	11.794	36O	0.146	3.096	8.016	0.0010	0.0204	0.0529	0.0027	0.0562	0.1456	0.0041	0.0869	0.2250
	20	25	12	10.128	36Q	0.146	3.096	8.016	0.0008	0.0176	0.0455	0.0023	0.0483	0.1250	0.0035	0.0746	0.1932
Basin 37	FID	Sub Basin Id	gridcode														
	0	1	84	17.337	37A	0.146	3.096	8.016	0.0014	0.0301	0.0778	0.0039	0.0827	0.2140	0.0060	0.1277	0.3308
	1	2	60	8.459	37E	0.146	3.096	8.016	0.0007	0.0147	0.0380	0.0019	0.0403	0.1044	0.0029	0.0623	0.1614
					37F	0.146	3.096	8.016									
					37G	0.146	3.096	8.016									
	2	3	61	6.904	37D	0.146	3.096	8.016	0.0006	0.0120	0.0310	0.0016	0.0329	0.0852	0.0024	0.0509	0.1317
	8	13	79	10.165	37B	0.146	3.096	8.016	0.0008	0.0176	0.0456	0.0023	0.0485	0.1255	0.0035	0.0749	0.1939
	11	16	77	13.446	37C	0.146	3.096	8.016	0.0011	0.0233	0.0604	0.0030	0.0641	0.1660	0.0047	0.0991	0.2565
	12	17	58	22.395	37H	0.146	3.096	8.016	0.0018	0.0388	0.1005	0.0050	0.1068	0.2765	0.0078	0.1650	0.4273
	13	18	59	6.890	37I	0.146	3.096	8.016	0.0006	0.0119	0.0309	0.0015	0.0329	0.0851	0.0024	0.0508	0.1315
					37J	0.146	3.096	8.016									
	23	30	82	14.340	37V	0.146	3.096	8.016	0.0012	0.0249	0.0644	0.0032	0.0684	0.1770	0.0050	0.1057	0.2736
					37W	0.146	3.096	8.016									
	25	32	64	27.312	37K	0.146	3.096	8.016	0.0022	0.0474	0.1226	0.0061	0.1302	0.3372	0.0095	0.2012	0.5211
	27	34	50	16.744	37L	0.146	3.096	8.016	0.0014	0.0290	0.0752	0.0038	0.0798	0.2067	0.0058	0.1234	0.3194
	29	36	63	4.353	37Q	0.146	3.096	8.016	0.0004	0.0075	0.0195	0.0010	0.0208	0.0537	0.0015	0.0321	0.0831
	32	41	83	9.870	37U	0.146	3.096	8.016	0.0008	0.0171	0.0443	0.0022	0.0471	0.1218	0.0034	0.0727	0.1883
	37	46	46	6.983	37M1b	0.146	3.096	8.016	0.0006	0.0121	0.0313	0.0016	0.0333	0.0862	0.0024	0.0515	0.1332
	39	48	69	7.075	37R	0.146	3.096	8.016	0.0006	0.0123	0.0318	0.0016	0.0337	0.0873	0.0025	0.0521	0.1350
	40	49	47	8.444	37M1	0.146	3.096	8.016	0.0007	0.0146	0.0379	0.0019	0.0403	0.1042	0.0029	0.0622	0.1611
	41	50	52	20.607	37O	0.146	3.096	8.016	0.0017	0.0357	0.0925	0.0046	0.0983	0.2544	0.0072	0.1518	0.3931
					37P	0.146	3.096	8.016									
	43	52	44	18.204	37N	0.146	3.096	8.016	0.0015	0.0316	0.0817	0.0041	0.0868	0.2247	0.0063	0.1341	0.3473
	52	63	33	5.616	37I2	0.146	3.096	8.016	0.0005	0.0097	0.0252	0.0013	0.0268	0.0693	0.0020	0.0414	0.1071
	56	68	30	9.726	37G2	0.146	3.096	8.016	0.0008	0.0169	0.0437	0.0022	0.0464	0.1201	0.0034	0.0717	0.1856
	59	71	17	5.860	37B2	0.146	3.096	8.016	0.0005	0.0102	0.0263	0.0013	0.0279	0.0723	0.0020	0.0432	0.1118
	60	72	15	11.630	37A2	0.146	3.096	8.016	0.0010	0.0202	0.0522	0.0026	0.0554	0.1436	0.0040	0.0857	0.2219
					37C2	0.146	3.096	8.016									
	61	74	31	5.725	37P2	0.146	3.096	8.016	0.0005	0.0099	0.0257	0.0013	0.0273	0.0707	0.0020	0.0422	0.1092
	62	75	27	6.655	37H2	0.146	3.096	8.016	0.0005	0.0115	0.0299	0.0015	0.0317	0.0822	0.0023	0.0490	0.1270
	64	77	28	5.948	37K2	0.146	3.096	8.016	0.0005	0.0103	0.0267	0.0013	0.0284	0.0734	0.0021	0.0438	0.1135
	65	78	7	5.023	37S2	0.146	3.096	8.016	0.0004	0.0087	0.0225	0.0011	0.0239	0.0620	0.0017	0.0370	0.0958
	66	79	11	7.751	37Q2	0.146	3.096	8.016	0.0006	0.0134	0.0348	0.0017	0.0370	0.0957	0.0027	0.0571	0.1479
					37R2	0.146	3.096	8.016									
	68	81	21	32.317	37Z	0.146	3.096	8.016	0.0026	0.0560	0.1451	0.0073	0.1541	0.3989	0.0112	0.2381	0.6166
					37D2	0.146	3.096	8.016									
					E2	0.146	3.096	8.016									
					37F2	0.146	3.096	8.016									
	69	83	8	9.301	37T2	0.146	3.096	8.016	0.0008	0.0161	0.0417	0.0021	0.0443	0.1148	0.0032	0.0685	0.1774
	71	85	29	6.540	37L2	0.146	3.096	8.016	0.0005	0.0113	0.0294	0.0015	0.0312	0.0807	0.0023	0.0482	0.1248
					37M2	0.146	3.096	8.016									
	74	89	23	8.112	37O2	0.146	3.096	8.016	0.0007	0.0141	0.0364	0.0018	0.0387	0.1001	0.0028	0.0598	0.1548
	75	90	25	13.117	37N2	0.146	3.096	8.016	0.0011	0.0227	0.0589	0.0029	0.0625	0.1619	0.0046	0.0967	0.2502
	76	91	5	5.989	37Y2	0.146	3.096	8.016	0.0005	0.0104	0.0269	0.0013	0.0286	0.0739	0.0021	0.0441	0.1143
	81	97	4	10.470	37W2	0.146	3.096	8.016	0.0009	0.0182	0.0470	0.0024	0.0499	0.1293	0.0036	0.0771	0.1998
					37X2	0.146	3.096	8.016									
	86	103	9	8.406	37U2	0.146	3.096	8.016	0.0007	0.0146	0.0377	0.0019	0.0401	0.1038	0.0029	0.0619	0.1604
					37V2	0.146	3.096	8.016									
Basin 38	FID	Sub BasinId	gridcode														
	1	2	11	15.493	38B	0.146	3.096	8.016	0.0013	0.0269	0.0695	0.0035	0.0739	0.1913	0.0054	0.1142	0.2956
					38E	0.146	3.096	8.016									

	3	4	12	17.367	38A	0.146	3.096	8.016	0.0014	0.0301	0.0780	0.0039	0.0828	0.2144	0.0060	0.1280	0.3313
					38C	0.146	3.096	8.016									
					38D	0.146	3.096	8.016									
	5	6	8	16.185	38G	0.146	3.096	8.016	0.0013	0.0281	0.0727	0.0036	0.0772	0.1998	0.0056	0.1193	0.3088
					38H	0.146	3.096	8.016									
	6	7	13	6.691	38F	0.146	3.096	8.016	0.0005	0.0116	0.0300	0.0015	0.0319	0.0826	0.0023	0.0493	0.1276
	7	8	5	11.449	38J	0.146	3.096	8.016	0.0009	0.0198	0.0514	0.0026	0.0546	0.1413	0.0040	0.0844	0.2184
					38K	0.146	3.096	8.016									
	9	11	6	10.074	38I	0.146	3.096	8.016	0.0008	0.0175	0.0452	0.0023	0.0480	0.1244	0.0035	0.0742	0.1922
	12	14	1	28.050	38N	0.146	3.096	8.016	0.0023	0.0486	0.1259	0.0063	0.1337	0.3463	0.0097	0.2067	0.5351
					38O	0.146	3.096	8.016									
Basin 39	FID	Sub Basin Id	gridcode														
	0	1	48	6.853	39C	0.146	3.096	8.016	0.0006	0.0119	0.0308	0.0015	0.0327	0.0846	0.0024	0.0505	0.1307
	1	2	49	15.251	39A	0.146	3.096	8.016	0.0012	0.0264	0.0685	0.0034	0.0727	0.1883	0.0053	0.1124	0.2910
					39B	0.146	3.096	8.016									
	2	3	47	6.650	39F	0.146	3.096	8.016	0.0005	0.0115	0.0298	0.0015	0.0317	0.0821	0.0023	0.0490	0.1269
	6	7	41	12.083	39G	0.146	3.096	8.016	0.0010	0.0209	0.0542	0.0027	0.0576	0.1492	0.0042	0.0890	0.2305
					39L	0.146	3.096	8.016									
	10	18	44	7.150	39H	0.146	3.096	8.016	0.0006	0.0124	0.0321	0.0016	0.0341	0.0883	0.0025	0.0527	0.1364
					39I	0.146	3.096	8.016									
	13	21	36	21.009	39D	0.146	3.096	8.016	0.0017	0.0364	0.0943	0.0047	0.1002	0.2593	0.0073	0.1548	0.4008
					39E	0.146	3.096	8.016									
	16	24	33	14.335	39J	0.146	3.096	8.016	0.0012	0.0249	0.0643	0.0032	0.0683	0.1770	0.0050	0.1056	0.2735
	20	29	34	8.238	39K	0.146	3.096	8.016	0.0007	0.0143	0.0370	0.0019	0.0393	0.1017	0.0029	0.0607	0.1572
	23	32	17	9.590	39N	0.146	3.096	8.016	0.0008	0.0166	0.0431	0.0022	0.0457	0.1184	0.0033	0.0707	0.1830
					39O	0.146	3.096	8.016									
	24	33	15	23.947	39P	0.146	3.096	8.016	0.0020	0.0415	0.1075	0.0054	0.1142	0.2956	0.0083	0.1765	0.4569
	27	36	25	16.218	39M	0.146	3.096	8.016	0.0013	0.0281	0.0728	0.0036	0.0773	0.2002	0.0056	0.1195	0.3094
	30	40	13	5.487	39Q	0.146	3.096	8.016	0.0004	0.0095	0.0246	0.0012	0.0262	0.0677	0.0019	0.0404	0.1047
					39R	0.146	3.096	8.016									
	31	42	12	5.253	39X	0.146	3.096	8.016	0.0004	0.0091	0.0236	0.0012	0.0250	0.0648	0.0018	0.0387	0.1002
	43	57	11	18.374	39U	0.146	3.096	8.016	0.0015	0.0319	0.0825	0.0041	0.0876	0.2268	0.0064	0.1354	0.3505
					39Y	0.146	3.096	8.016									
	44	58	5	9.562	39S	0.146	3.096	8.016	0.0008	0.0166	0.0429	0.0021	0.0456	0.1180	0.0033	0.0705	0.1824
	45	59	9	14.639	39T	0.146	3.096	8.016	0.0012	0.0254	0.0657	0.0033	0.0698	0.1807	0.0051	0.1079	0.2793
					39V	0.146	3.096	8.016									
	48	62	3	9.385	39W	0.146	3.096	8.016	0.0008	0.0163	0.0421	0.0021	0.0447	0.1159	0.0033	0.0692	0.1790
Basin 40	FID	Sub Basin Id	gridcode														
	0	1	12	19.876	40T	0.146	3.096	8.016	0.0016	0.0345	0.0892	0.0045	0.0948	0.2454	0.0069	0.1465	0.3792
	1	2	11	5.957	40R	0.146	3.096	8.016	0.0005	0.0103	0.0267	0.0013	0.0284	0.0735	0.0021	0.0439	0.1136
					40S	0.146	3.096	8.016									
	2	3	10	7.825	40N	0.146	3.096	8.016	0.0006	0.0136	0.0351	0.0018	0.0373	0.0966	0.0027	0.0577	0.1493
					40Q	0.146	3.096	8.016									
	3	4	9	5.665	40P	0.146	3.096	8.016	0.0005	0.0098	0.0254	0.0013	0.0270	0.0699	0.0020	0.0417	0.1081
	4	5	8	9.183	40O	0.146	3.096	8.016	0.0008	0.0159	0.0412	0.0021	0.0438	0.1134	0.0032	0.0677	0.1752
	5	6	7	5.706	40M	0.146	3.096	8.016	0.0005	0.0099	0.0256	0.0013	0.0272	0.0704	0.0020	0.0420	0.1089
	7	8	6	24.449	40H	0.146	3.096	8.016	0.0020	0.0424	0.1098	0.0055	0.1166	0.3018	0.0085	0.1802	0.4664
	8	9	4	40.990	40D	0.146	3.096	8.016	0.0034	0.0711	0.1840	0.0092	0.1954	0.5060	0.0142	0.3020	0.7820
					40E	0.146	3.096	8.016									
					40F	0.146	3.096	8.016									
					40G	0.146	3.096	8.016									
	9	10	2	13.169	40A	0.146	3.096	8.016	0.0011	0.0228	0.0591	0.0030	0.0628	0.1626	0.0046	0.0970	0.2512
	10	11	3	5.357	40I	0.146	3.096	8.016	0.0004	0.0093	0.0240	0.0012	0.0255	0.0661	0.0019	0.0395	0.1022
					40J	0.146	3.096	8.016									
					40L	0.146	3.096	8.016									
					40K	0.146	3.096	8.016									
	11	12	1	10.408	40B	0.146	3.096	8.016	0.0009	0.0180	0.0467	0.0023	0.0496	0.1285	0.0036	0.0767	0.1986
					40C	0.146	3.096	8.016									
Basin 41	FID	Sub Basin Id	gridcode														
	2	3	39	18.755	41F2	0.146	3.096	8.016	0.0015	0.0325	0.0842	0.0042	0.0894	0.2315	0.0065	0.1382	0.3578
					41I	0.146	3.096	8.016									
	7	11	33	6.756	E2	0.146	3.096	8.016	0.0006	0.0117	0.0303	0.0015	0.0322	0.0834	0.0023	0.0498	0.1289
	8	13	24	11.348	41A2	0.146	3.096	8.016	0.0009	0.0197	0.0509	0.0026	0.0541	0.1401	0.0039	0.0836	0.2165
	9	14	26	6.775	41D2	0.146	3.096	8.016	0.0006	0.0117	0.0304	0.0015	0.0323	0.0836	0.0024	0.0499	0.1293

	13	18	25	6.675	41B2	0.146	3.096	8.016	0.0005	0.0116	0.0300	0.0015	0.0318	0.0824	0.0023	0.0492	0.1274
	14	20	21	13.402	41C2	0.146	3.096	8.016	0.0011	0.0232	0.0602	0.0030	0.0639	0.1654	0.0047	0.0987	0.2557
	15	21	22	5.333	41Z	0.146	3.096	8.016	0.0004	0.0092	0.0239	0.0012	0.0254	0.0658	0.0019	0.0393	0.1018
	20	28	19	12.565	41W	0.146	3.096	8.016	0.0010	0.0218	0.0564	0.0028	0.0599	0.1551	0.0044	0.0926	0.2397
					41X	0.146	3.096	8.016									
					41Y	0.146	3.096	8.016									
	21	29	28	25.297	41U	0.146	3.096	8.016	0.0021	0.0439	0.1136	0.0057	0.1206	0.3123	0.0088	0.1864	0.4826
	22	30	29	6.934	41R	0.146	3.096	8.016	0.0006	0.0120	0.0311	0.0016	0.0331	0.0856	0.0024	0.0511	0.1323
					41S	0.146	3.096	8.016									
	24	32	14	24.658	41Q	0.146	3.096	8.016	0.0020	0.0428	0.1107	0.0055	0.1176	0.3044	0.0086	0.1817	0.4704
					41T	0.146	3.096	8.016									
					41V	0.146	3.096	8.016									
	28	36	5	7.913	41E	0.146	3.096	8.016	0.0006	0.0137	0.0355	0.0018	0.0377	0.0977	0.0027	0.0583	0.1510
	29	37	15	21.138	41M	0.146	3.096	8.016	0.0017	0.0366	0.0949	0.0048	0.1008	0.2609	0.0073	0.1558	0.4033
					41P	0.146	3.096	8.016									
	30	38	2	10.211	41C	0.146	3.096	8.016	0.0008	0.0177	0.0458	0.0023	0.0487	0.1260	0.0035	0.0752	0.1948
					41D	0.146	3.096	8.016									
	32	41	12	17.397	41L	0.146	3.096	8.016	0.0014	0.0302	0.0781	0.0039	0.0829	0.2148	0.0060	0.1282	0.3319
					41N	0.146	3.096	8.016									
					41O	0.146	3.096	8.016									
	34	43	8	17.658	41F	0.146	3.096	8.016	0.0014	0.0306	0.0793	0.0040	0.0842	0.2180	0.0061	0.1301	0.3369
					41G	0.146	3.096	8.016									
	35	44	1	16.825	41A	0.146	3.096	8.016	0.0014	0.0292	0.0755	0.0038	0.0802	0.2077	0.0058	0.1240	0.3210
					41B	0.146	3.096	8.016									
	36	45	13	13.551	36K	0.146	3.096	8.016	0.0011	0.0235	0.0608	0.0030	0.0646	0.1673	0.0047	0.0999	0.2585
	37	46	9	6.995	41H	0.146	3.096	8.016	0.0006	0.0121	0.0314	0.0016	0.0334	0.0864	0.0024	0.0515	0.1335
					41J	0.146	3.096	8.016									
Basin 42	FID	Sub Basin Id	gridcode														
	1	2	13	14.483	42A	0.146	3.096	8.016	0.0012	0.0251	0.0650	0.0033	0.0691	0.1788	0.0050	0.1067	0.2763
					42H	0.146	3.096	8.016									
	8	9	6	4.168	42B	0.146	3.096	8.016	0.0003	0.0072	0.0187	0.0009	0.0199	0.0515	0.0014	0.0307	0.0795
	9	11	3	17.861	42G	0.146	3.096	8.016	0.0015	0.0310	0.0802	0.0040	0.0852	0.2205	0.0062	0.1316	0.3408
	12	16	2	17.868	42E	0.146	3.096	8.016	0.0015	0.0310	0.0802	0.0040	0.0852	0.2206	0.0062	0.1317	0.3409
					42F	0.146	3.096	8.016									
					42D	0.146	3.096	8.016									
	13	17	1	6.013	42C	0.146	3.096	8.016	0.0005	0.0104	0.0270	0.0014	0.0287	0.0742	0.0021	0.0443	0.1147
Basin 43	FID	Sub basin Id	gridcode														
	0	1	53	9.310	43O	0.146	3.096	8.016	0.0008	0.0161	0.0418	0.0021	0.0444	0.1149	0.0032	0.0686	0.1776
	3	4	52	5.381	43M	0.146	3.096	8.016	0.0004	0.0093	0.0242	0.0012	0.0257	0.0664	0.0019	0.0397	0.1027
					43N	0.146	3.096	8.016									
	6	7	49	5.533	43L	0.146	3.096	8.016	0.0005	0.0096	0.0248	0.0012	0.0264	0.0683	0.0019	0.0408	0.1056
	8	10	46	7.904	43R	0.146	3.096	8.016	0.0006	0.0137	0.0355	0.0018	0.0377	0.0976	0.0027	0.0582	0.1508
	10	12	43	11.839	43Q	0.146	3.096	8.016	0.0010	0.0205	0.0531	0.0027	0.0564	0.1461	0.0041	0.0872	0.2259
	11	14	41	4.592	43K	0.146	3.096	8.016	0.0004	0.0080	0.0206	0.0010	0.0219	0.0567	0.0016	0.0338	0.0876
	13	17	47	6.345	43S	0.146	3.096	8.016	0.0005	0.0110	0.0285	0.0014	0.0303	0.0783	0.0022	0.0468	0.1211
	14	20	37	18.993	43I	0.146	3.096	8.016	0.0016	0.0329	0.0853	0.0043	0.0906	0.2345	0.0066	0.1399	0.3624
					43J	0.146	3.096	8.016									
					43P	0.146	3.096	8.016									
	15	22	45	6.938	43T	0.146	3.096	8.016	0.0006	0.0120	0.0311	0.0016	0.0331	0.0856	0.0024	0.0511	0.1324
	18	25	35	21.847	43E	0.146	3.096	8.016	0.0018	0.0379	0.0981	0.0049	0.1042	0.2697	0.0076	0.1610	0.4168
					43F	0.146	3.096	8.016									
					43G	0.146	3.096	8.016									
	20	28	34	14.849	43D	0.146	3.096	8.016	0.0012	0.0257	0.0667	0.0033	0.0708	0.1833	0.0052	0.1094	0.2833
	22	31	32	6.020	43W	0.146	3.096	8.016	0.0005	0.0104	0.0270	0.0014	0.0287	0.0743	0.0021	0.0444	0.1148
	25	36	16	10.263	43H	0.146	3.096	8.016	0.0008	0.0178	0.0461	0.0023	0.0489	0.1267	0.0036	0.0756	0.1958
	26	38	20	14.591	43U	0.146	3.096	8.016	0.0012	0.0253	0.0655	0.0033	0.0696	0.1801	0.0051	0.1075	0.2784
	27	39	25	7.085	43V	0.146	3.096	8.016	0.0006	0.0123	0.0318	0.0016	0.0338	0.0875	0.0025	0.0522	0.1352
	31	43	12	10.058	43C	0.146	3.096	8.016	0.0008	0.0174	0.0451	0.0023	0.0480	0.1242	0.0035	0.0741	0.1919
	35	48	33	10.712	43X	0.146	3.096	8.016	0.0009	0.0186	0.0481	0.0024	0.0511	0.1322	0.0037	0.0789	0.2044
	37	51	5	5.171	43B	0.146	3.096	8.016	0.0004	0.0090	0.0232	0.0012	0.0247	0.0638	0.0018	0.0381	0.0986
	43	58	3	22.745	43A	0.146	3.096	8.016	0.0019	0.0394	0.1021	0.0051	0.1084	0.2808	0.0079	0.1676	0.4339
	44	59	31	8.316	43Y	0.146	3.096	8.016	0.0007	0.0144	0.0373	0.0019	0.0396	0.1027	0.0029	0.0613	0.1586
	52	68	27	17.189	43Z	0.146	3.096	8.016	0.0014	0.0298	0.0772	0.0039	0.0820	0.2122	0.0060	0.1267	0.3279
	53	69	21	18.535	43A2	0.146	3.096	8.016	0.0015	0.0321	0.0832	0.0042	0.0884	0.2288	0.0064	0.1366	0.3536

Annex_3

Table A-3:Peak runoff Volume of depression areas in natural surface catchment, in Semi urban area surface catchment and in urbanized area surface catchment.

	FID	Id	gridcode	Area in Ha	bluspot name	Depresion	Runoff volume(m^3) on Natural state area			Runoff volume(m^3) on Semi urbanized areas			Runoff volume(m^3) on City Business areas		
						Actual volume(m3)	Dry Season (Nov)	Mid wet season (Apr)	Wet Season(Aug)	Dry Season (Nov)	Mid wet season (Apr)	Wet Season(Aug)	Dry Season (Nov)	Mid wet season (Apr)	Wet Season(Aug)
Basin 48	1158	1502	291	9.84	133	3	2.897	6.144	15.908	7.968	16.897	43.748	12.314	26.113	67.610
					134	4									
	1242	1594	281	8.81	131	2	2.594	5.502	14.244	7.135	15.129	39.172	11.026	23.382	60.538
	1262	1615	273	10.77	66b	1	3.169	6.720	17.400	8.715	18.481	47.850	13.469	28.561	73.950
	1267	1620	279	6.11	130	2	1.798	3.812	9.871	4.944	10.484	27.145	7.641	16.202	41.951
	1354	1729	196	15.88	62a	0	4.675	9.914	25.669	12.857	27.263	70.589	19.870	42.134	109.092
					64	0									
					65	0									
	1359	1735	179	6.12	62b	1	1.800	3.818	9.885	4.951	10.499	27.185	7.652	16.226	42.013
	1360	1736	180	10.17	63	1	2.994	6.348	16.436	8.232	17.457	45.198	12.722	26.979	69.851
	1378	1762	191	9.62	61	2	2.831	6.003	15.544	7.785	16.509	42.745	12.032	25.514	66.060
	1408	1803	189	8.49	60	6	2.500	5.301	13.725	6.874	14.577	37.743	10.624	22.529	58.330
	1411	1807	185	5.63	59	1	1.657	3.514	9.097	4.557	9.663	25.018	7.042	14.933	38.664
	1428	1832	186	7.90	58b	0	2.326	4.933	12.773	6.397	13.566	35.124	9.887	20.966	54.283
	1431	1836	161	17.91	45	3	5.272	11.180	28.947	14.499	30.745	79.604	22.407	47.515	123.024
	1432	1837	173	6.35	47	1	1.869	3.964	10.262	5.140	10.900	28.221	7.944	16.845	43.614
	1438	1844	182	11.41	55	3	3.359	7.123	18.442	9.237	19.588	50.716	14.276	30.273	78.380
					56	1									
					58a	1									
	1444	1852	176	21.33	50	5	6.277	13.310	34.462	17.261	36.603	94.770	26.676	56.568	146.463
					52	2									
					53	1									
					54	4									
	1452	1863	145	5.19	42a	2	1.529	3.242	8.394	4.204	8.916	23.084	6.498	13.779	35.675
	1458	1870	143	5.67	44	3	1.669	3.540	9.166	4.591	9.736	25.207	7.095	15.046	38.956
	1469	1887	152	16.84	48	1	4.958	10.513	27.221	13.634	28.912	74.857	21.071	44.682	115.688
					49	2									
	1483	1903	142	10.43	42b	1	3.070	6.510	16.854	8.442	17.902	46.350	13.047	27.666	71.631
					43	16									
	1499	1924	125	7.97	19	6	2.347	4.977	12.885	6.454	13.685	35.433	9.974	21.150	54.761
	1501	1926	146	10.49	17	3	3.087	6.546	16.948	8.489	18.001	46.608	13.119	27.820	72.030
					18	9									
	1504	1929	148	10.15	16	1	2.987	6.335	16.402	8.215	17.421	45.106	12.696	26.923	69.709
	1511	1939	111	13.84	9	1	4.073	8.638	22.364	11.201	23.753	61.501	17.311	36.710	95.047
					10	1									
	1513	1941	115	27.78	20	23	8.178	17.342	44.900	22.489	47.689	123.475	34.756	73.702	190.824
	1514	1942	100	6.82	14	2	2.008	4.258	11.024	5.522	11.709	30.316	8.534	18.096	46.853
	1519	1948	113	9.65	15	5	2.841	6.025	15.599	7.813	16.568	42.898	12.075	25.606	66.297
	1523	1954	114	5.66	8	2	1.667	3.534	9.151	4.584	9.720	25.166	7.084	15.022	38.893
	1543	1989	97	18.99	7	6	5.589	11.852	30.686	15.370	32.593	84.387	23.754	50.371	130.417
	1546	1993	98	8.56	5	5	2.518	5.340	13.826	6.925	14.685	38.021	10.702	22.694	58.759
					6	3									
	1557	2005	3	9.70	1	1	2.855	6.053	15.673	7.850	16.646	43.100	12.132	25.726	66.609
Basin 49	922	1271	1006	9.64	239	2	2.836	6.014	15.571	7.799	16.538	42.820	12.053	25.559	66.177
	939	1303	1002	11.59	240	1	3.413	7.237	18.737	9.385	19.901	51.527	14.504	30.756	79.633
	945	1310	880	11.58	611	6	3.408	7.226	18.709	9.371	19.872	51.451	14.483	30.711	79.515
	951	1319	908	6.93	601	1	2.039	4.324	11.196	5.608	11.892	30.790	8.667	18.378	47.584
	954	1323	991	3.75	242	1	1.104	2.341	6.061	3.036	6.438	16.668	4.692	9.949	25.760
	960	1332	882	5.54	612	2	1.631	3.458	8.952	4.484	9.508	24.619	6.930	14.695	38.047
	964	1338	883	6.30	613	1	1.856	3.935	10.188	5.103	10.821	28.017	7.886	16.723	43.299
					614a	0									
	968	1344	905	4.94	604	1	1.453	3.081	7.978	3.996	8.473	21.939	6.175	13.095	33.905
	972	1349	904	13.03	603	1	3.834	8.131	21.052	10.544	22.360	57.892	16.296	34.556	89.470
					607	2									
	978	1356	827	13.41	615	3	3.948	8.372	21.677	10.857	23.024	59.612	16.780	35.582	92.127
	979	1357	906	5.22	602	1	1.537	3.259	8.438	4.226	8.962	23.204	6.531	13.850	35.861
	986	1366	995	31.65	238	4	9.314	19.752	51.140	25.615	54.317	140.634	39.586	83.944	217.344

	987	1369	815	8.74	625	3	2.573	5.457	14.129	7.077	15.007	38.855	10.937	23.192	60.048
	990	1373	998	27.61	241	1	8.126	17.232	44.616	22.347	47.388	122.695	34.536	73.236	189.619
	994	1377	823	12.60	616	2	3.709	7.866	20.365	10.200	21.631	56.005	15.764	33.429	86.553
	997	1381	810	9.90	626	2	2.914	6.178	15.997	8.012	16.991	43.991	12.383	26.258	67.986
	998	1382	751	6.04	605	0	1.779	3.772	9.766	4.891	10.372	26.856	7.559	16.030	41.504
					606	1									
	999	1383	938	5.72	535	1	1.683	3.569	9.240	4.628	9.814	25.410	7.152	15.167	39.270
	1000	1384	798	8.88	627	1	2.613	5.542	14.348	7.187	15.240	39.458	11.107	23.552	60.981
	1002	1387	748	7.84	608	1	2.308	4.894	12.671	6.346	13.458	34.845	9.808	20.799	53.851
	1013	1402	785	18.92	632	7	5.570	11.811	30.581	15.317	32.481	84.098	23.672	50.198	129.970
	1015	1404	745	7.43	548	2	2.187	4.638	12.009	6.015	12.755	33.025	9.296	19.713	51.039
	1019	1408	784	28.49	225	3	8.386	17.784	46.045	23.063	48.906	126.624	35.643	75.582	195.692
	1023	1412	927	7.33	547	0	2.158	4.575	11.846	5.934	12.582	32.578	9.170	19.446	50.347
	1024	1413	928	8.52	545	2	2.508	5.318	13.770	6.897	14.625	37.867	10.659	22.603	58.521
	1025	1414	779	6.92	243	1	2.036	4.318	11.180	5.600	11.875	30.746	8.655	18.352	47.517
					244	5									
	1026	1415	778	5.31	245	1	1.562	3.313	8.578	4.297	9.111	23.590	6.640	14.081	36.457
	1029	1419	945	19.76	519	3	5.816	12.333	31.933	15.994	33.917	87.816	24.719	52.417	135.715
					520a	1									
					523	3									
					524	1									
	1030	1420	735	20.86	609	3	6.138	13.017	33.702	16.881	35.796	92.682	26.088	55.321	143.235
					610	1									
	1035	1426	929	14.63	544	2	4.305	9.130	23.638	11.840	25.106	65.004	18.298	38.801	100.461
	1038	1429	783	7.46	631	3	2.195	4.655	12.053	6.037	12.802	33.147	9.330	19.785	51.226
	1040	1432	775	6.78	246	2	1.996	4.233	10.960	5.490	11.641	30.140	8.484	17.991	46.580
	1041	1433	731	9.57	621	1	2.816	5.970	15.458	7.743	16.419	42.511	11.966	25.375	65.699
					633	4									
	1043	1435	931	21.30	536	4	6.269	13.294	34.421	17.240	36.559	94.657	26.644	56.501	146.289
					541	2									
					542	1									
					543	1									
	1044	1436	937	16.80	525	0	4.946	10.488	27.155	13.601	28.842	74.677	21.020	44.574	115.410
	1047	1441	730	6.81	622	0	2.004	4.251	11.005	5.512	11.689	30.265	8.519	18.065	46.773
	1049	1443	765	19.14	628	1	5.633	11.945	30.928	15.491	32.850	85.052	23.941	50.768	131.445
	1051	1445	739	15.11	549	4	4.446	9.429	24.413	12.228	25.930	67.135	18.897	40.073	103.755
					552	1									
	1055	1450	725	15.70	619	1	4.622	9.802	25.378	12.711	26.955	69.790	19.645	41.658	107.858
	1058	1454	781	7.10	247	3	2.090	4.431	11.474	5.747	12.186	31.552	8.881	18.833	48.763
	1060	1456	769	11.43	251	2	3.363	7.132	18.466	9.249	19.613	50.782	14.294	30.312	78.481
	1064	1461	716	14.03	624	1	4.129	8.755	22.669	11.354	24.077	62.339	17.547	37.210	96.341
	1065	1462	718	25.08	617	1	7.381	15.652	40.524	20.298	43.042	111.442	31.369	66.520	172.229
					618	0									
	1068	1467	721	4.88	623	0	1.437	3.048	7.892	3.953	8.383	21.704	6.109	12.955	33.542
	1070	1469	332	12.88	532	1	3.790	8.036	20.808	10.422	22.100	57.221	16.107	34.155	88.432
					533	1									
					534	2									
	1072	1471	354	10.16	517	2	2.990	6.341	16.418	8.223	17.438	45.148	12.708	26.949	69.775
	1074	1475	708	10.43	629	2	3.069	6.507	16.848	8.439	17.895	46.332	13.042	27.655	71.604
	1076	1477	330	10.96	538	2	3.225	6.839	17.707	8.869	18.807	48.695	13.707	29.066	75.256
	1078	1481	331	8.88	537	1	2.613	5.541	14.345	7.185	15.236	39.449	11.104	23.547	60.967
	1079	1482	333	14.53	531	0	4.278	9.072	23.488	11.764	24.947	64.591	18.181	38.554	99.823
	1084	1488	350	8.95	518	0	2.634	5.586	14.463	7.244	15.361	39.772	11.195	23.740	61.466
	1085	1489	773	12.90	248	2	3.798	8.054	20.852	10.444	22.148	57.344	16.141	34.229	88.623
	1089	1496	758	8.61	630	2	2.534	5.373	13.910	6.967	14.774	38.253	10.768	22.833	59.118
	1092	1499	346	12.56	520b	0	3.696	7.837	20.291	10.163	21.551	55.800	15.707	33.307	86.236
					526	0									
	1097	1505	343	16.19	527	0	4.765	10.105	26.163	13.105	27.789	71.949	20.252	42.946	111.194
	1098	1507	709	10.60	600	2	3.121	6.619	17.137	8.583	18.201	47.126	13.265	28.129	72.831
	1102	1512	319	7.82	539	2	2.301	4.879	12.634	6.328	13.419	34.743	9.779	20.738	53.693
	1103	1514	339	10.49	529	2	3.086	6.545	16.945	8.488	17.998	46.600	13.117	27.815	72.018
	1109	1520	715	7.34	597	1	2.161	4.583	11.866	5.943	12.603	32.631	9.185	19.477	50.429
	1110	1521	720	5.49	596	0	1.615	3.425	8.868	4.442	9.419	24.388	6.865	14.557	37.690
	1112	1524	335	7.86	530	3	2.314	4.907	12.705	6.363	13.494	34.938	9.834	20.854	53.994
	1117	1530	320	23.70	540	3	6.975	14.790	38.294	19.180	40.673	105.307	29.642	62.858	162.748
					550	1									
					551	1									
	1124	1538	695	7.97	592	1	2.344	4.971	12.872	6.447	13.671	35.397	9.964	21.128	54.705
	1127	1542	770	12.03	252	1	3.541	7.510	19.443	9.739	20.651	53.469	15.051	31.915	82.634
	1129	1544	696	17.11	557	1	5.037	10.682	27.658	13.853	29.376	76.058	21.409	45.399	117.545

					558	2									
	1132	1548	303	7.68	554	2	2.261	4.795	12.415	6.218	13.186	34.142	9.610	20.379	52.764
	1133	1549	348	6.94	487	1	2.043	4.332	11.217	5.618	11.914	30.848	8.683	18.413	47.674
	1134	1550	352	32.51	484	8	9.568	20.290	52.535	26.313	55.798	144.470	40.666	86.234	223.273
					486	1									
	1137	1553	304	13.80	553	4	4.063	8.615	22.306	11.172	23.692	61.342	17.267	36.615	94.801
	1140	1557	340	9.85	493	1	2.899	6.148	15.919	7.973	16.908	43.777	12.322	26.130	67.655
	1141	1560	325	8.05	501	2	2.369	5.023	13.006	6.514	13.813	35.765	10.067	21.348	55.273
	1143	1563	469	11.75	483	1	3.458	7.332	18.985	9.509	20.164	52.208	14.696	31.163	80.685
	1144	1564	639	14.32	249	0	4.216	8.941	23.148	11.594	24.586	63.658	17.919	37.997	98.381
	1145	1565	640	7.53	250	1	2.215	4.697	12.162	6.092	12.918	33.447	9.415	19.964	51.690
	1146	1566	761	11.45	259a	3	3.369	7.144	18.498	9.265	19.647	50.869	14.319	30.364	78.616
	1148	1569	688	4.86	593	0	1.431	3.034	7.855	3.934	8.343	21.601	6.080	12.894	33.383
	1150	1572	689	11.86	594	2	3.490	7.401	19.163	9.598	20.354	52.699	14.834	31.456	81.445
					595	1									
	1151	1573	698	12.11	599	2	3.566	7.561	19.576	9.805	20.793	53.835	15.154	32.134	83.199
	1152	1575	316	7.62	555	1	2.243	4.756	12.315	6.168	13.080	33.866	9.533	20.214	52.338
	1153	1576	345	24.05	492	1	7.078	15.010	38.864	19.466	41.278	106.875	30.083	63.793	165.170
	1157	1581	341	12.96	494	1	3.816	8.092	20.951	10.494	22.252	57.615	16.218	34.390	89.041
	1159	1583	756	7.78	259b	8	2.289	4.855	12.570	6.296	13.351	34.568	9.730	20.634	53.424
	1160	1585	693	10.26	560	5	3.020	6.404	16.581	8.305	17.611	45.598	12.835	27.217	70.469
	1168	1595	301	11.86	559	1	3.490	7.400	19.161	9.597	20.351	52.692	14.832	31.452	81.433
	1170	1598	638	9.45	309	1	2.783	5.901	15.278	7.652	16.227	42.015	11.827	25.079	64.933
					310	5									
	1172	1600	612	8.44	255	4	2.484	5.268	13.639	6.832	14.487	37.508	10.558	22.388	57.967
	1178	1608	754	9.60	260	7	2.825	5.990	15.509	7.768	16.473	42.650	12.005	25.458	65.914
					261	0									
	1183	1613	691	7.66	563	1	2.254	4.779	12.374	6.198	13.143	34.029	9.579	20.312	52.590
	1185	1615	322	10.68	500	1	3.144	6.666	17.260	8.645	18.333	47.466	13.361	28.332	73.357
	1191	1621	687	5.56	569	3	1.637	3.472	8.990	4.503	9.548	24.722	6.959	14.757	38.207
	1193	1627	635	5.88	256	1	1.730	3.668	9.498	4.757	10.088	26.120	7.352	15.591	40.368
	1196	1631	644	10.06	307	1	2.962	6.281	16.264	8.146	17.274	44.725	12.589	26.696	69.120
					308	0									
	1197	1632	682	19.78	598	4	5.821	12.344	31.960	16.008	33.945	87.890	24.739	52.461	135.830
	1200	1636	643	10.04	305	3	2.956	6.268	16.228	8.128	17.236	44.626	12.562	26.637	68.968
					306	0									
	1204	1640	307	9.38	556	1	2.761	5.854	15.157	7.592	16.099	41.683	11.733	24.880	64.419
	1207	1643	692	8.34	567	1	2.455	5.206	13.480	6.752	14.318	37.071	10.435	22.127	57.291
	1209	1645	462	5.99	482	0	1.763	3.738	9.678	4.848	10.280	26.616	7.492	15.887	41.133
	1211	1648	315	20.25	502	1	5.961	12.640	32.727	16.392	34.761	90.000	25.333	53.721	139.091
	1217	1658	610	19.14	253	4	5.633	11.945	30.928	15.491	32.849	85.051	23.940	50.767	131.442
					257	1									
					258	1									
	1222	1663	460	9.17	485	4	2.700	5.725	14.823	7.425	15.744	40.764	11.474	24.332	62.998
	1226	1668	683	19.42	568	2	5.716	12.122	31.385	15.720	33.334	86.308	24.294	51.517	133.384
					570	1									
	1229	1673	676	8.66	265	1	2.548	5.402	13.988	7.006	14.857	38.466	10.827	22.960	59.447
					266	2									
	1234	1678	604	7.62	264b	2	2.243	4.757	12.318	6.170	13.083	33.873	9.535	20.219	52.350
	1235	1679	609	10.11	262	4	2.977	6.313	16.345	8.187	17.361	44.950	12.653	26.830	69.468
					263	4									
	1236	1680	311	7.92	503	2	2.332	4.945	12.803	6.413	13.598	35.208	9.910	21.015	54.412
					504	0									
	1239	1683	421	6.61	497	3	1.945	4.124	10.677	5.348	11.341	29.363	8.265	17.527	45.379
					498	1									
	1247	1692	458	9.35	488	1	2.753	5.839	15.117	7.572	16.056	41.572	11.702	24.814	64.247
					489	2									
	1252	1699	618	5.34	264a	2	1.571	3.331	8.623	4.319	9.159	23.714	6.675	14.155	36.650
	1259	1707	312	4.73	506	1	1.393	2.953	7.646	3.830	8.121	21.028	5.919	12.551	32.497
	1264	1712	645	13.49	304	1	3.971	8.421	21.804	10.921	23.158	59.960	16.878	35.790	92.666
	1267	1715	296	26.58	561	0	7.824	16.592	42.958	21.517	45.627	118.135	33.253	70.514	182.572
					562	1									
	1273	1722	617	22.65	254	4	6.667	14.138	36.604	18.334	38.878	100.662	28.334	60.085	155.568
	1274	1723	674	9.72	267	1	2.860	6.066	15.705	7.866	16.681	43.189	12.157	25.779	66.747
					268	0									
	1275	1724	292	12.22	565	1	3.598	7.630	19.756	9.895	20.983	54.328	15.292	32.428	83.962
					566	1									
	1280	1731	619	6.53	301	0	1.922	4.076	10.554	5.286	11.210	29.024	8.170	17.324	44.855
	1283	1735	291	7.14	571	3	2.103	4.459	11.544	5.782	12.262	31.747	8.936	18.950	49.063
	1285	1737	454	32.46	490	2	9.553	20.258	52.451	26.271	55.710	144.240	40.601	86.097	222.917

					491	1									
	1296	1752	299	10.47	509	1	3.083	6.538	16.927	8.478	17.978	46.548	13.103	27.784	71.938
	1299	1755	672	6.13	578	2	1.805	3.828	9.911	4.964	10.527	27.255	7.672	16.268	42.121
	1303	1760	646	9.30	302	0	2.739	5.807	15.036	7.531	15.970	41.350	11.639	24.682	63.904
					303	0									
	1304	1761	602	8.90	269	3	2.619	5.554	14.381	7.203	15.274	39.548	11.132	23.606	61.119
	1305	1763	293	10.24	510	1	3.014	6.391	16.547	8.288	17.575	45.505	12.809	27.162	70.326
					564	0									
	1309	1769	624	9.46	300	1	2.786	5.908	15.296	7.661	16.246	42.063	11.840	25.107	65.006
	1315	1776	430	6.11	496	1	1.797	3.811	9.868	4.943	10.481	27.137	7.639	16.198	41.939
	1321	1784	599	18.63	270	2	5.484	11.628	30.107	15.080	31.978	82.795	23.305	49.420	127.956
	1322	1785	287	9.17	575	1	2.700	5.725	14.822	7.424	15.743	40.761	11.474	24.330	62.994
					576	0									
	1324	1789	455	8.21	456	4	2.418	5.127	13.274	6.648	14.098	36.503	10.275	21.788	56.413
	1326	1793	414	33.95	495	2	9.993	21.190	54.865	27.480	58.273	150.878	42.470	90.059	233.175
					499	0									
	1344	1812	626	13.34	299	2	3.926	8.325	21.556	10.797	22.895	59.278	16.686	35.383	91.611
	1356	1825	616	9.89	297	3	2.911	6.173	15.983	8.006	16.976	43.954	12.372	26.236	67.929
	1358	1827	409	12.51	505	0	3.681	7.806	20.211	10.123	21.466	55.580	15.645	33.175	85.896
	1368	1838	569	5.46	276	2	1.607	3.408	8.824	4.420	9.372	24.266	6.831	14.485	37.503
	1369	1840	369	19.30	507b	0	5.680	12.045	31.186	15.620	33.123	85.761	24.140	51.190	132.539
					508	1									
					511	2									
	1375	1846	407	9.66	507a	0	2.842	6.027	15.606	7.816	16.575	42.916	12.080	25.616	66.324
	1379	1850	658	21.36	572	1	6.286	13.330	34.512	17.286	36.656	94.909	26.715	56.651	146.677
					573	1									
	1387	1859	281	22.27	574	1	6.554	13.899	35.985	18.024	38.221	98.960	27.855	59.069	152.937
					577	2									
	1390	1862	589	15.92	271	4	4.686	9.936	25.727	12.886	27.325	70.749	19.915	42.230	109.339
					273	6									
	1397	1869	363	14.07	512	1	4.142	8.784	22.743	11.391	24.155	62.542	17.604	37.331	96.656
					513	1									
					514	1									
	1413	1887	591	4.79	298	1	1.409	2.988	7.737	3.875	8.217	21.276	5.989	12.699	32.881
	1414	1888	572	5.61	275	1	1.650	3.499	9.059	4.538	9.622	24.913	7.013	14.870	38.502
	1426	1904	585	16.15	295	2	4.752	10.077	26.092	13.069	27.713	71.752	20.197	42.829	110.889
					296	0									
	1428	1907	568	22.28	272	3	6.557	13.904	35.999	18.031	38.236	98.998	27.866	59.092	152.997
					274	2									
	1429	1908	659	29.35	580	5	8.637	18.316	47.423	23.753	50.369	130.413	36.709	77.843	201.547
					581	2									
					582	4									
	1431	1910	277	7.36	432	2	2.167	4.595	11.897	5.959	12.636	32.716	9.209	19.528	50.561
	1436	1916	271	8.33	579	0	2.452	5.200	13.464	6.744	14.301	37.026	10.422	22.101	57.222
					584	0									
	1437	1917	424	10.02	452	0	2.948	6.252	16.188	8.108	17.194	44.517	12.531	26.572	68.799
	1438	1919	428	19.33	451	1	5.690	12.066	31.241	15.648	33.182	85.914	24.183	51.282	132.776
	1439	1920	581	11.27	289a	0	3.316	7.032	18.206	9.119	19.337	50.066	14.093	29.884	77.375
	1447	1934	377	15.00	448	0	4.415	9.361	24.238	12.140	25.743	66.653	18.762	39.785	103.010
	1448	1935	415	13.27	449	1	3.907	8.284	21.448	10.743	22.781	58.983	16.603	35.207	91.156
					450	0									
	1451	1939	556	5.21	277	3	1.533	3.250	8.416	4.215	8.939	23.144	6.515	13.814	35.767
	1452	1940	655	6.47	587	1	1.904	4.038	10.454	5.236	11.103	28.748	8.092	17.160	44.429
	1456	1944	439	6.53	442	1	1.923	4.078	10.559	5.289	11.215	29.037	8.173	17.332	44.875
	1461	1951	269	5.19	586	2	1.527	3.239	8.386	4.200	8.907	23.062	6.492	13.766	35.642
	1464	1954	367	7.89	404	1	2.321	4.922	12.743	6.383	13.535	35.044	9.864	20.918	54.159
	1470	1960	488	12.36	455	1	3.638	7.714	19.974	10.004	21.214	54.927	15.461	32.786	84.887
	1473	1963	567	12.27	278	5	3.613	7.661	19.836	9.936	21.069	54.550	15.355	32.561	84.305
					290	2									
	1476	1968	653	5.50	588	1	1.619	3.433	8.887	4.452	9.440	24.441	6.880	14.589	37.772
					589	3									
	1477	1970	359	10.82	430	1	3.186	6.756	17.493	8.762	18.580	48.105	13.541	28.714	74.344
	1479	1972	263	5.22	591	0	1.538	3.261	8.443	4.229	8.967	23.218	6.535	13.859	35.882
	1480	1973	270	8.10	585	1	2.385	5.057	13.094	6.558	13.907	36.008	10.136	21.493	55.649
	1481	1974	397	5.16	447	0	1.518	3.218	8.332	4.173	8.850	22.913	6.450	13.677	35.412
	1482	1975	398	6.54	445	0	1.925	4.082	10.569	5.294	11.226	29.066	8.182	17.349	44.920
					446	1									
	1483	1976	273	7.81	431	0	2.297	4.872	12.614	6.318	13.397	34.687	9.764	20.705	53.608
					433	1									
	1484	1979	651	9.93	590	1	2.924	6.201	16.054	8.041	17.051	44.149	12.427	26.352	68.230

	1488	1983	587	17.17	294	1	5.054	10.717	27.748	13.898	29.472	76.308	21.479	45.548	117.930
	1491	1987	403	7.60	443	1	2.238	4.745	12.287	6.154	13.050	33.788	9.511	20.168	52.219
	1493	1989	576	11.18	291	5	3.291	6.980	18.071	9.051	19.194	49.696	13.989	29.663	76.803
					292	1									
	1495	1992	381	5.89	401b	0	1.735	3.679	9.525	4.771	10.117	26.194	7.373	15.635	40.482
	1496	1993	400	6.59	444	2	1.941	4.115	10.655	5.337	11.317	29.301	8.248	17.490	45.283
	1507	2005	492	15.12	454	3	4.451	9.438	24.437	12.240	25.956	67.203	18.916	40.113	103.859
	1509	2007	266	13.84	437	1	4.072	8.636	22.359	11.199	23.748	61.488	17.308	36.702	95.027
	1512	2014	583	16.16	293	3	4.757	10.087	26.116	13.081	27.739	71.819	20.216	42.869	110.994
	1516	2019	256	5.71	436	1	1.682	3.567	9.234	4.625	9.808	25.395	7.148	15.158	39.246
	1518	2021	365	11.52	400	1	3.391	7.191	18.617	9.325	19.774	51.198	14.411	30.560	79.124
					403	1									
					405	0									
	1519	2022	561	9.90	280	1	2.913	6.178	15.995	8.011	16.989	43.986	12.381	26.255	67.979
	1522	2026	578	10.19	288b	0	2.998	6.358	16.463	8.246	17.485	45.272	12.743	27.023	69.967
					289b	1									
	1525	2029	267	5.17	438	4	1.522	3.228	8.358	4.186	8.877	22.984	6.469	13.719	35.520
	1527	2031	121	9.11	407	0	2.681	5.686	14.722	7.374	15.637	40.485	11.396	24.166	62.568
	1528	2032	123	12.28	406	6	3.616	7.667	19.851	9.943	21.084	54.590	15.366	32.585	84.366
	1529	2033	364	14.86	397	2	4.375	9.278	24.021	12.031	25.513	66.057	18.594	39.429	102.089
					398	1									
					402	0									
	1532	2036	552	6.61	279	3	1.945	4.125	10.679	5.349	11.343	29.368	8.266	17.530	45.386
	1535	2039	255	14.34	434	1	4.220	8.950	23.172	11.606	24.612	63.723	17.937	38.036	98.482
	1537	2041	222	18.29	377	4	5.382	11.413	29.550	14.801	31.386	81.263	22.874	48.506	125.589
	1539	2045	387	10.20	453	0	3.004	6.369	16.490	8.260	17.515	45.349	12.765	27.069	70.085
	1543	2049	203	7.20	380	1	2.121	4.497	11.643	5.832	12.367	32.019	9.013	19.112	49.483
					381	1									
	1544	2050	564	5.73	282	1	1.686	3.575	9.257	4.637	9.833	25.458	7.166	15.196	39.344
	1547	2053	386	7.34	390	1	2.162	4.584	11.868	5.944	12.605	32.636	9.187	19.480	50.438
	1551	2057	153	6.60	399	5	1.944	4.123	10.674	5.346	11.337	29.353	8.262	17.521	45.364
	1552	2058	383	13.67	396	1	4.024	8.533	22.094	11.066	23.467	60.758	17.102	36.267	93.899
					401a	0									
	1554	2060	565	7.04	281	1	2.072	4.394	11.376	5.698	12.083	31.284	8.806	18.673	48.348
	1557	2064	253	6.69	439	1	1.969	4.175	10.809	5.414	11.480	29.724	8.367	17.742	45.937
					441	1									
	1559	2066	251	5.66	440	1	1.665	3.530	9.141	4.578	9.709	25.138	7.076	15.005	38.849
	1561	2070	124	6.90	415	1	2.031	4.306	11.149	5.584	11.841	30.659	8.630	18.300	47.382
					416	1									
	1562	2071	60	6.23	286	3	1.833	3.887	10.064	5.041	10.689	27.677	7.790	16.520	42.773
					288a	0									
	1563	2072	59	5.22	285	0	1.536	3.257	8.434	4.224	8.958	23.192	6.528	13.843	35.843
	1564	2073	58	6.95	287	2	2.046	4.339	11.235	5.627	11.933	30.896	8.697	18.442	47.748
	1575	2092	56	14.43	283	1	4.248	9.007	23.322	11.681	24.771	64.135	18.053	38.282	99.117
					284	1									
	1577	2094	120	36.68	418	3	10.798	22.897	59.283	29.693	62.966	163.028	45.889	97.311	251.952
	1580	2097	249	4.83	420	1	1.421	3.013	7.800	3.907	8.285	21.451	6.038	12.804	33.151
	1581	2098	200	10.26	384	1	3.019	6.401	16.574	8.302	17.604	45.579	12.830	27.206	70.440
	1585	2103	125	23.68	417	2	6.970	14.780	38.267	19.167	40.645	105.235	29.622	62.815	162.637
	1586	2105	202	6.46	383b	0	1.903	4.035	10.447	5.232	11.096	28.728	8.086	17.148	44.398
	1589	2108	201	11.70	378	1	3.442	7.300	18.900	9.466	20.074	51.974	14.630	31.023	80.324
					382	2									
					383a	0									
	1590	2109	224	11.77	375	1	3.464	7.345	19.017	9.525	20.199	52.298	14.721	31.216	80.824
	1592	2113	174	13.32	391	3	3.920	8.312	21.520	10.779	22.857	59.181	16.658	35.325	91.461
					392	1									
	1595	2116	78	7.74	311	1	2.279	4.833	12.514	6.268	13.291	34.413	9.687	20.541	53.184
	1597	2120	245	7.31	424	5	2.152	4.563	11.815	5.918	12.549	32.491	9.146	19.394	50.213
	1605	2129	118	8.89	419	1	2.616	5.547	14.362	7.194	15.255	39.496	11.118	23.575	61.040
	1610	2134	117	14.74	413	0	4.338	9.199	23.819	11.930	25.298	65.501	18.437	39.097	101.229
					414	1									
	1615	2140	164	9.08	393	3	2.672	5.667	14.673	7.349	15.585	40.351	11.358	24.085	62.360
	1623	2149	115	15.95	411	0	4.695	9.956	25.777	12.911	27.378	70.886	19.953	42.311	109.550
					412a	0									
	1624	2150	137	14.95	408	1	4.400	9.331	24.159	12.101	25.660	66.438	18.701	39.656	102.676
	1625	2151	146	9.67	395	1	2.846	6.036	15.628	7.828	16.599	42.978	12.098	25.654	66.421
	1628	2156	199	10.82	379	1	3.184	6.753	17.483	8.757	18.569	48.079	13.533	28.698	74.304
	1629	2157	232	43.21	315	1	12.718	26.969	69.826	34.974	74.164	192.021	54.051	114.617	296.760
	1633	2163	172	12.85	385	1	3.783	8.022	20.769	10.403	22.059	57.115	16.077	34.092	88.269
	1635	2165	96	10.95	421	1	3.224	6.837	17.703	8.867	18.803	48.684	13.704	29.059	75.239

					422	0									
	1637	2167	165	4.77	394	1	1.403	2.975	7.704	3.859	8.182	21.186	5.963	12.646	32.741
	1638	2168	77	11.03	312	5	3.247	6.885	17.827	8.929	18.935	49.025	13.800	29.263	75.766
	1645	2177	214	11.72	376	1	3.451	7.318	18.947	9.490	20.124	52.103	14.666	31.100	80.524
	1651	2185	112	12.09	423	1	3.557	7.543	19.531	9.783	20.745	53.711	15.119	32.060	83.008
	1653	2188	45	7.73	313	1	2.274	4.822	12.486	6.254	13.262	34.337	9.665	20.495	53.066
	1656	2191	26	8.95	318	2	2.634	5.585	14.460	7.243	15.358	39.765	11.193	23.735	61.455
	1665	2204	126	8.68	410	3	2.554	5.416	14.023	7.024	14.894	38.563	10.855	23.018	59.597
	1670	2210	28	19.22	314	2	5.657	11.995	31.057	15.555	32.986	85.406	24.040	50.979	131.991
	1674	2218	90	7.40	425	0	2.180	4.622	11.967	5.994	12.710	32.908	9.263	19.643	50.858
	1676	2224	145	7.07	409	1	2.082	4.415	11.432	5.726	12.142	31.437	8.849	18.765	48.584
	1678	2226	108	6.13	427	0	1.804	3.825	9.903	4.960	10.518	27.232	7.665	16.255	42.086
					428	2									
	1680	2229	158	4.90	388	0	1.442	3.057	7.915	3.964	8.407	21.766	6.127	12.992	33.638
	1684	2233	195	7.66	386	3	2.256	4.783	12.384	6.203	13.154	34.056	9.586	20.328	52.633
	1685	2234	94	14.50	426	1	4.268	9.050	23.432	11.736	24.888	64.438	18.138	38.463	99.586
					429	4									
	1686	2235	206	5.82	373	1	1.713	3.633	9.405	4.711	9.990	25.865	7.280	15.439	39.973
	1694	2245	129	3.78	359	1	1.113	2.359	6.109	3.060	6.488	16.799	4.729	10.028	25.963
	1695	2246	155	4.98	389	1	1.467	3.111	8.055	4.035	8.555	22.151	6.235	13.222	34.234
	1697	2249	74	10.23	316	2	3.012	6.387	16.537	8.283	17.564	45.476	12.801	27.145	70.281
	1700	2253	211	8.49	374	1	2.500	5.300	13.724	6.874	14.576	37.740	10.623	22.527	58.326
	1701	2254	27	8.93	317	3	2.628	5.573	14.429	7.227	15.326	39.680	11.169	23.685	61.324
	1704	2258	189	6.91	387	1	2.034	4.313	11.168	5.594	11.862	30.712	8.645	18.332	47.464
	1716	2271	134	7.21	360	6	2.122	4.500	11.652	5.836	12.376	32.043	9.019	19.126	49.520
	1726	2285	186	6.14	372	1	1.806	3.830	9.916	4.966	10.532	27.268	7.675	16.276	42.142
	1728	2288	142	9.85	361	1	2.900	6.150	15.922	7.975	16.912	43.787	12.325	26.136	67.670
					362a	0									
					363	2									
	1729	2289	156	11.45	362b	1	3.369	7.144	18.496	9.264	19.645	50.865	14.318	30.361	78.609
	1732	2292	106	15.24	357	4	4.486	9.512	24.628	12.335	26.158	67.727	19.064	40.426	104.668
					358	1									
	1734	2294	180	6.59	364	4	1.941	4.115	10.655	5.337	11.317	29.301	8.248	17.489	45.283
	1736	2296	228	7.77	368	0	2.286	4.847	12.550	6.286	13.330	34.514	9.715	20.601	53.340
	1740	2301	227	3.44	365b	0	1.014	2.150	5.567	2.788	5.913	15.310	4.309	9.138	23.661
	1741	2305	25	15.92	320	3	4.685	9.934	25.720	12.883	27.318	70.731	19.910	42.219	109.312
	1742	2306	101	8.64	356	5	2.543	5.393	13.964	6.994	14.832	38.402	10.810	22.922	59.349
	1745	2309	98	8.37	354	1	2.462	5.221	13.518	6.771	14.358	37.175	10.464	22.190	57.452
	1746	2310	43	43.46	319	3	12.792	27.125	70.232	35.177	74.595	193.137	54.365	115.283	298.485
	1748	2312	100	11.37	355	0	3.348	7.100	18.382	9.207	19.524	50.550	14.229	30.173	78.122
	1750	2314	44	6.72	321	1	1.978	4.195	10.863	5.441	11.537	29.872	8.409	17.831	46.166
					324	2									
	1755	2319	183	15.59	365a	0	4.589	9.732	25.197	12.621	26.763	69.293	19.505	41.361	107.089
					366	1									
					367	1									
	1756	2320	230	11.49	371	1	3.381	7.170	18.564	9.298	19.717	51.051	14.370	30.472	78.897
	1761	2325	229	6.10	369	0	1.797	3.810	9.866	4.941	10.479	27.131	7.637	16.194	41.929
	1766	2331	231	11.74	370	1	3.456	7.329	18.977	9.505	20.156	52.186	14.689	31.150	80.651
	1768	2333	22	11.97	323	1	3.524	7.473	19.350	9.692	20.552	53.212	14.978	31.762	82.237
	1770	2335	37	10.26	350	1	3.020	6.403	16.579	8.304	17.609	45.591	12.833	27.213	70.459
	1771	2336	23	19.97	322	1	5.877	12.463	32.267	16.162	34.272	88.735	24.977	52.966	137.136
					325	3									
					326	0									
					328	2									
	1772	2337	66	12.79	353	2	3.765	7.985	20.674	10.355	21.958	56.853	16.003	33.936	87.864
	1773	2338	64	10.01	351	2	2.946	6.248	16.177	8.103	17.182	44.488	12.522	26.554	68.753
	1774	2339	42	13.20	327	1	3.885	8.238	21.328	10.683	22.653	58.653	16.510	35.010	90.646
	1775	2340	67	7.63	352	5	2.247	4.764	12.336	6.179	13.102	33.923	9.549	20.249	52.426
	1777	2342	34	7.72	348	1	2.271	4.816	12.469	6.245	13.243	34.289	9.652	20.467	52.992
					349	2									
	1781	2346	14	14.06	329	2	4.137	8.773	22.714	11.377	24.126	62.465	17.583	37.285	96.536
	1782	2347	13	8.05	330	3	2.369	5.025	13.009	6.516	13.818	35.776	10.070	21.355	55.290
					331	2									
	1784	2349	35	25.81	346	6	7.597	16.110	41.711	20.892	44.303	114.706	32.288	68.468	177.273
					347	0									
	1787	2352	16	11.78	332	4	3.467	7.352	19.036	9.535	20.219	52.350	14.736	31.248	80.905
					333	2									
	1790	2355	18	6.09	334	2	1.792	3.801	9.841	4.929	10.453	27.064	7.618	16.154	41.826
	1792	2357	15	9.01	336	1	2.653	5.626	14.566	7.296	15.471	40.058	11.276	23.910	61.907
	1793	2358	7	26.91	339	0	7.920	16.794	43.483	21.780	46.185	119.579	33.659	71.376	184.804

					340	0									
					341	1									
					343	0									
					344	3									
	1794	2359	4	7.27	337	4	2.139	4.536	11.744	5.882	12.474	32.297	9.091	19.278	49.913
	1795	2360	19	6.18	335	2	1.818	3.855	9.982	5.000	10.603	27.452	7.727	16.386	42.425
	1799	2364	6	5.51	342	1	1.623	3.441	8.908	4.462	9.462	24.498	6.896	14.623	37.860
	1800	2365	1	6.87	338	0	2.023	4.291	11.110	5.565	11.800	30.552	8.600	18.236	47.216
Basin 23	1	2	1	2.87	23E	2	0.844	1.789	4.633	2.321	4.921	12.741	3.586	7.605	19.691
	5	7	5	14.23	23A	5	4.189	8.883	23.000	11.520	24.429	63.249	17.804	37.753	97.749
	6	8	7	5.85	23B	3	1.723	3.654	9.461	4.739	10.049	26.019	7.324	15.531	40.211
	7	9	6	17.15	23C	5	5.048	10.704	27.714	13.881	29.436	76.214	21.453	45.492	117.785
					23D	3									
Basin 24	FID	Sub Basin Id	gridcode												
	4	5	4	7.59	24A	4	2.234	4.737	12.266	6.144	13.028	33.731	9.495	20.134	52.130
	7	12	9	6.02	24B	2	1.771	3.756	9.724	4.870	10.328	26.740	7.527	15.961	41.326
Basin 25	FID	Sub Basin Id	gridcode												
	3	6	6	13.71	25D	9	4.035	8.556	22.152	11.095	23.528	60.919	17.148	36.362	94.147
	4	8	7	20.52	25A	6	6.041	12.809	33.165	16.612	35.226	91.205	25.672	54.440	140.953
	5	9	4	13.53	25B	2	3.984	8.447	21.871	10.955	23.230	60.146	16.930	35.901	92.953
	6	10	5	18.07	25C	7	5.319	11.280	29.206	14.628	31.020	80.316	22.608	47.940	124.125
Basin 26	FID	Sub Basin Id	gridcode												
	5	7	7	10.39	26B	1	3.058	6.484	16.789	8.409	17.832	46.170	12.996	27.559	71.353
	6	8	4	8.80	26A	1	2.592	5.496	14.229	7.127	15.113	39.129	11.014	23.356	60.473
	7	9	8	7.34	26C	1	2.159	4.579	11.856	5.938	12.592	32.603	9.177	19.461	50.386
	9	11	9	21.78	26D	3	6.411	13.595	35.199	17.630	37.386	96.798	27.247	57.779	149.597
Basin 27	FID	Sub Basin Id	gridcode			Volume									
	0	1	1	6.02	27B	2	1.771	3.755	9.723	4.870	10.327	26.738	7.526	15.960	41.323
	7	8	6	19.24	27A	4	5.664	12.012	31.100	15.577	33.032	85.524	24.074	51.049	132.174
	8	9	11	8.70	27E	3	2.560	5.428	14.053	7.039	14.926	38.646	10.878	23.068	59.725
	9	10	7	9.11	27C	4	2.680	5.684	14.716	7.371	15.630	40.469	11.391	24.156	62.543
	11	13	12	8.94	27D	2	2.632	5.582	14.452	7.239	15.350	39.742	11.187	23.722	61.420
	12	14	13	29.79	27F	1	8.768	18.593	48.139	24.111	51.130	132.382	37.263	79.018	204.590
					27G	3									
Basin 28	FID	Sub Basin Id	gridcode												
	3	4	17	11.22	28A	1	3.303	7.003	18.133	9.082	19.259	49.864	14.036	29.764	77.063
	6	7	16	4.82	28B	0	1.418	3.006	7.784	3.899	8.268	21.406	6.026	12.777	33.083
					28C	0									
					28D1	0									
	7	8	8	10.12	28E	2	2.978	6.315	16.351	8.190	17.367	44.965	12.657	26.840	69.492
	8	9	11	9.19	28F	1	2.706	5.739	14.858	7.442	15.781	40.859	11.501	24.389	63.146
	11	14	9	12.72	28D2	1	3.743	7.937	20.551	10.293	21.828	56.515	15.908	33.734	87.341
	12	16	10	8.29	28G	0	2.440	5.174	13.397	6.710	14.229	36.841	10.370	21.991	56.937
	15	20	7	19.07	28H	1	5.612	11.900	30.812	15.433	32.726	84.732	23.851	50.577	130.950
					28I	1									
	18	24	2	13.54	28J	2	3.985	8.450	21.877	10.958	23.237	60.163	16.935	35.911	92.979
	20	26	3	6.42	28K	0	1.888	4.004	10.368	5.193	11.012	28.513	8.026	17.019	44.065
					28M	1									
Basin 29	FID	Sub Basin Id	gridcode			Volume									
	0	1	1	6.76	29A	2	1.990	4.219	10.923	5.471	11.602	30.039	8.456	17.930	46.425
	1	2	2	5.80	29B	0	1.707	3.620	9.372	4.694	9.955	25.774	7.255	15.384	39.832
					29C	0									
	2	3	3	21.10	29F	1	6.211	13.171	34.102	17.081	36.221	93.781	26.398	55.978	144.935
					29H	0									
	3	4	4	18.04	29G	1	5.311	11.262	29.158	14.605	30.970	80.185	22.571	47.862	123.922
					29J	1									
	4	5	5	29.86	29I	5	8.790	18.640	48.262	24.173	51.260	132.719	37.358	79.220	205.112
Basin 30	FID	Sub Basin Id	gridcode												
	5	7	27	10.01	30H	1	2.946	6.248	16.176	8.102	17.181	44.483	12.521	26.552	68.747
	12	15	51	19.11	30I	1	5.624	11.925	30.877	15.465	32.795	84.911	23.901	50.683	131.226
	13	16	22	6.13	30F	1	1.803	3.823	9.899	4.958	10.514	27.221	7.662	16.248	42.069
					30G	1									

	23	29	15	12.37	30D	3	3.641	7.722	19.993	10.014	21.235	54.981	15.476	32.818	84.971
	24	30	16	5.96	30E	2	1.753	3.718	9.626	4.822	10.224	26.472	7.451	15.801	40.912
	25	31	45	6.97	30K	1	2.051	4.349	11.261	5.640	11.961	30.969	8.717	18.485	47.860
	26	32	46	10.62	30J	0	3.126	6.628	17.161	8.596	18.228	47.194	13.284	28.170	72.936
	34	41	14	10.97	30C	2	3.230	6.849	17.734	8.882	18.836	48.768	13.727	29.110	75.369
	42	49	37	11.91	30N	3	3.506	7.435	19.251	9.643	20.447	52.942	14.902	31.601	81.819
					30O	2									
	44	52	9	13.13	30B	1	3.866	8.198	21.225	10.631	22.543	58.368	16.430	34.840	90.205
	45	55	7	6.10	30A	1	1.794	3.805	9.851	4.934	10.463	27.091	7.626	16.171	41.868
	47	57	34	8.35	30M	1	2.458	5.213	13.498	6.761	14.336	37.118	10.448	22.156	57.365
Basin 31	FID	Sub Basin Id	gridcode			Volume									
	0	1	5	4.98	31D	2	1.467	3.111	8.055	4.035	8.556	22.152	6.235	13.222	34.235
	3	4	6	8.70	31B	0	2.560	5.429	14.055	7.040	14.929	38.653	10.880	23.072	59.736
	4	5	2	10.18	31A	0	2.995	6.352	16.445	8.237	17.467	45.225	12.730	26.994	69.893
	5	6	3	5.14	31C	0	1.512	3.207	8.304	4.159	8.820	22.836	6.428	13.630	35.291
Basin 32	FID	Sub Basin Id	gridcode												
	7	9	6	26.41	32A	1	7.773	16.483	42.678	21.376	45.329	117.364	33.036	70.054	181.381
Basin 33	FID	Sub Basin Id	gridcode			Volume									
	0	1	3	14.44	33B	3	4.251	9.015	23.342	11.691	24.792	64.191	18.069	38.315	99.204
	1	2	4	6.74	33C	1	1.985	4.209	10.899	5.459	11.576	29.971	8.436	17.890	46.319
	2	3	2	14.10	33A	3	4.150	8.800	22.785	11.412	24.201	62.659	17.637	37.401	96.836
	3	4	5	7.55	33D	7	2.221	4.710	12.196	6.109	12.954	33.539	9.441	20.019	51.833
	7	11	8	14.93	33E	1	4.395	9.320	24.131	12.087	25.631	66.362	18.680	39.611	102.559
	8	12	10	8.18	33F	1	2.409	5.108	13.225	6.624	14.047	36.369	10.237	21.709	56.207
	10	15	11	5.76	33G	0	1.694	3.592	9.301	4.658	9.878	25.577	7.199	15.267	39.528
Basin 34	FID	Sub Basin Id	gridcode			Volume									
	1	2	15	4.85	34B	1	1.426	3.025	7.832	3.923	8.318	21.537	6.062	12.856	33.285
	2	3	20	7.03	34F	2	2.071	4.391	11.369	5.694	12.075	31.263	8.800	18.661	48.316
	4	5	17	8.67	34H	6	2.551	5.409	14.004	7.014	14.874	38.511	10.840	22.987	59.517
	8	10	12	26.27	34A	3	7.731	16.395	42.448	21.261	45.085	116.732	32.858	69.677	180.405
					34C	1									
					34I	1									
	10	13	7	14.67	34E	1	4.319	9.158	23.712	11.877	25.185	65.207	18.355	38.922	100.775
	11	14	8	11.08	34D	-1	3.260	6.913	17.900	8.966	19.012	49.225	13.856	29.382	76.075
	18	21	4	11.27	34J	1	3.318	7.036	18.218	9.125	19.350	50.100	14.102	29.905	77.428
Basin 35	FID	Sub Basin Id	gridcode			Volume									
	0	1	8	15.52	35B	1	4.567	9.685	25.077	12.560	26.635	68.961	19.411	41.163	106.577
	1	2	6	16.46	35C	1	4.846	10.276	26.605	13.326	28.258	73.164	20.595	43.672	113.072
					35D	1									
	3	4	4	6.25	35F	0	1.839	3.900	10.098	5.058	10.725	27.768	7.816	16.575	42.915
	4	5	5	8.93	35E	0	2.629	5.574	14.433	7.229	15.329	39.690	11.172	23.691	61.339
	5	6	9	12.93	35A	0	3.805	8.068	20.890	10.463	22.188	57.448	16.171	34.290	88.783
	6	7	2	5.20	35H	1	1.532	3.248	8.410	4.212	8.932	23.127	6.510	13.805	35.742
	9	10	10	9.84	35G	1	2.897	6.142	15.904	7.966	16.892	43.735	12.311	26.105	67.591
Basin 36	FID	Sub Basin Id	gridcode			Volume									
	1	3	20	40.54	36C	1	11.932	25.302	65.512	32.813	69.581	180.157	50.711	107.535	278.424
					36D	3									
					36E	1									
					36F	2									
					36G	1									
	2	4	23	6.61	36A	1	1.947	4.129	10.690	5.354	11.354	29.397	8.275	17.547	45.431
					36B	2									
	3	5	21	6.75	36H	1	1.986	4.212	10.905	5.462	11.582	29.988	8.441	17.900	46.345
	4	7	18	13.03	36I	3	3.834	8.130	21.050	10.543	22.357	57.887	16.294	34.552	89.462
	5	8	8	5.89	36L	1	1.734	3.678	9.523	4.770	10.115	26.188	7.372	15.632	40.473
					36M	1									
	6	9	9	12.86	36K	1	3.786	8.029	20.789	10.412	22.080	57.169	16.092	34.124	88.352
	8	11	5	6.63	36N	2	1.951	4.138	10.714	5.366	11.379	29.463	8.293	17.586	45.533
	9	12	2	18.52	36P	3	5.451	11.558	29.926	14.989	31.785	82.295	23.165	49.122	127.184
	11	14	11	6.82	36J	1	2.007	4.257	11.021	5.520	11.706	30.308	8.531	18.091	46.840
	12	15	14	6.10	36S	0	1.796	3.809	9.863	4.940	10.476	27.124	7.635	16.190	41.919
					36T	1									
	16	21	16	5.90	36R	0	1.736	3.681	9.530	4.773	10.122	26.208	7.377	15.643	40.503
					36U	0									

	17	22	4	11.79	36O	1	3.471	7.361	19.060	9.546	20.244	52.414	14.754	31.286	81.003
	20	25	12	10.13	36Q	1	2.981	6.322	16.368	8.198	17.384	45.011	12.670	26.867	69.562
Basin 37	FID	Sub Basin Id	gridcode			Volume									
	0	1	84	17.34	37A	5	5.103	10.821	28.017	14.033	29.758	77.047	21.687	45.989	119.072
	1	2	60	8.46	37E	0	2.490	5.280	13.670	6.847	14.519	37.592	10.581	22.438	58.096
					37F	2									
					37G	1									
	2	3	61	6.90	37D	0	2.032	4.309	11.157	5.588	11.851	30.683	8.637	18.315	47.419
	8	13	79	10.17	37B	1	2.992	6.345	16.427	8.228	17.448	45.175	12.716	26.965	69.815
	11	16	77	13.45	37C	1	3.958	8.392	21.729	10.883	23.078	59.753	16.820	35.667	92.346
	12	17	58	22.39	37H	2	6.592	13.978	36.191	18.127	38.439	99.525	28.014	59.406	153.811
	13	18	59	6.89	37I	0	2.028	4.301	11.135	5.577	11.826	30.620	8.619	18.277	47.322
					37J	1									
	23	30	82	14.34	37V	1	4.221	8.950	23.174	11.607	24.613	63.727	17.938	38.039	98.488
					37W	1									
	25	32	64	27.31	37K	5	8.039	17.047	44.136	22.107	46.878	121.375	34.165	72.448	187.579
	27	34	50	16.74	37L	1	4.928	10.451	27.059	13.553	28.740	74.413	20.946	44.417	115.001
	29	36	63	4.35	37Q	1	1.281	2.717	7.035	3.524	7.472	19.346	5.446	11.548	29.899
	32	41	83	9.87	37U	1	2.905	6.161	15.951	7.989	16.942	43.864	12.347	26.182	67.790
	37	46	46	6.98	37M1b	1	2.055	4.359	11.285	5.652	11.986	31.034	8.736	18.524	47.962
	39	48	69	7.08	37R	3	2.083	4.416	11.434	5.727	12.144	31.443	8.851	18.768	48.594
	40	49	47	8.44	37M1	3	2.485	5.270	13.646	6.835	14.494	37.527	10.563	22.400	57.996
	41	50	52	20.61	37O	7	6.065	12.862	33.302	16.680	35.371	91.580	25.778	54.664	141.532
					37P	4									
	43	52	44	18.20	37N	5	5.358	11.362	29.418	14.735	31.246	80.900	22.772	48.289	125.028
	52	63	33	5.62	37I2	1	1.653	3.505	9.075	4.546	9.639	24.957	7.025	14.897	38.570
	56	68	30	9.73	37G2	1	2.863	6.071	15.718	7.873	16.694	43.223	12.167	25.800	66.800
	59	71	17	5.86	37B2	1	1.725	3.658	9.470	4.743	10.059	26.043	7.331	15.545	40.249
	60	72	15	11.63	37A2	1	3.423	7.259	18.794	9.413	19.961	51.683	14.548	30.849	79.874
					37C2	1									
	61	74	31	5.73	37P2	2	1.685	3.573	9.252	4.634	9.827	25.442	7.162	15.187	39.320
	62	75	27	6.66	37H2	2	1.959	4.154	10.755	5.387	11.423	29.576	8.325	17.654	45.709
	64	77	28	5.95	37K2	5	1.751	3.713	9.613	4.815	10.210	26.435	7.441	15.779	40.854
	65	78	7	5.02	37S2	0	1.478	3.135	8.117	4.066	8.622	22.322	6.283	13.324	34.498
	66	79	11	7.75	37Q2	0	2.281	4.838	12.525	6.274	13.303	34.444	9.695	20.560	53.232
					37R2	7									
	68	81	21	32.32	37Z	6	9.512	20.171	52.226	26.158	55.470	143.621	40.427	85.727	221.959
					37D2	3									
					E2	2									
					37F2	1									
	69	83	8	9.30	37T2	1	2.737	5.805	15.030	7.528	15.964	41.332	11.634	24.671	63.877
	71	85	29	6.54	37L2	0	1.925	4.082	10.569	5.294	11.226	29.065	8.181	17.349	44.919
					37M2	1									
	74	89	23	8.11	37O2	1	2.388	5.063	13.109	6.566	13.923	36.050	10.147	21.518	55.713
	75	90	25	13.12	37N2	0	3.861	8.187	21.197	10.617	22.514	58.292	16.408	34.794	90.087
	76	91	5	5.99	37Y2	1	1.763	3.738	9.678	4.847	10.279	26.614	7.491	15.886	41.131
	81	97	4	10.47	37W2	1	3.082	6.535	16.920	8.475	17.971	46.530	13.097	27.774	71.910
					37X2	1									
	86	103	9	8.41	37U2	0	2.474	5.247	13.585	6.804	14.429	37.358	10.516	22.299	57.735
					37V2	1									
Basin 38	FID	Sub BasinId	gridcode												
	1	2	11	15.49	38B	1	4.560	9.670	25.036	12.540	26.592	68.850	19.380	41.096	106.405
					38E	0									
	3	4	12	17.37	38A	0	5.112	10.840	28.066	14.058	29.810	77.182	21.725	46.070	119.282
					38C	2									
					38D	1									
	5	6	8	16.19	38G	1	4.764	10.102	26.156	13.101	27.781	71.929	20.247	42.934	111.163
					38H	1									
	6	7	13	6.69	38F	3	1.969	4.176	10.813	5.416	11.484	29.735	8.370	17.749	45.954
	7	8	5	11.45	38J	1	3.370	7.146	18.502	9.267	19.651	50.880	14.322	30.370	78.632
					38K	1									
	9	11	6	10.07	38I	1	2.965	6.288	16.280	8.154	17.291	44.769	12.602	26.722	69.188
	12	14	1	28.05	38N	1	8.256	17.507	45.329	22.704	48.145	124.655	35.088	74.406	192.648
					38O	4									
Basin 39	FID	Sub Basin Id	gridcode			Volume									
	0	1	48	6.85	39C	4	2.017	4.278	11.075	5.547	11.763	30.457	8.573	18.180	47.070
	1	2	49	15.25	39A	2	4.489	9.519	24.645	12.344	26.176	67.775	19.077	40.454	104.743

					39B	1									
	2	3	47	6.65	39F	0	1.957	4.150	10.746	5.382	11.413	29.551	8.318	17.639	45.670
	6	7	41	12.08	39G	1	3.556	7.541	19.526	9.780	20.739	53.696	15.114	32.051	82.984
					39L	2									
	10	18	44	7.15	39H	2	2.104	4.463	11.554	5.787	12.272	31.774	8.944	18.966	49.106
					39I	1									
	13	21	36	21.01	39D	12	6.184	13.113	33.951	17.005	36.060	93.365	26.281	55.729	144.291
					39E	2									
	16	24	33	14.34	39J	1	4.219	8.947	23.166	11.603	24.605	63.706	17.932	38.026	98.455
	20	29	34	8.24	39K	1	2.425	5.142	13.313	6.668	14.140	36.611	10.305	21.853	56.581
	23	32	17	9.59	39N	3	2.823	5.986	15.498	7.763	16.461	42.620	11.997	25.440	65.868
					39O	1									
	24	33	15	23.95	39P	7	7.049	14.947	38.699	19.383	41.103	106.423	29.956	63.523	164.472
	27	36	25	16.22	39M	1	4.774	10.123	26.209	13.127	27.837	72.075	20.288	43.021	111.388
	30	40	13	5.49	39Q	1	1.615	3.425	8.867	4.441	9.418	24.384	6.864	14.555	37.685
					39R	1									
	31	42	12	5.25	39X	0	1.546	3.279	8.489	4.252	9.017	23.346	6.571	13.935	36.080
	43	57	11	18.37	39U	1	5.408	11.468	29.693	14.872	31.537	81.655	22.984	48.739	126.193
					39Y	3									
	44	58	5	9.56	39S	1	2.814	5.968	15.452	7.740	16.412	42.493	11.961	25.364	65.671
	45	59	9	14.64	39T	1	4.309	9.137	23.656	11.849	25.126	65.055	18.312	38.831	100.539
					39V	3									
	48	62	3	9.38	39W	4	2.762	5.857	15.166	7.596	16.108	41.706	11.740	24.894	64.455
Basin 40	FID	Sub Basin Id	gridcode			Volume									
	0	1	12	19.88	40T	1	5.850	12.406	32.121	16.089	34.116	88.333	24.864	52.725	136.514
	1	2	11	5.96	40R	2	1.753	3.718	9.626	4.821	10.224	26.471	7.451	15.801	40.910
					40S	0									
	2	3	10	7.82	40N	5	2.303	4.884	12.645	6.333	13.430	34.773	9.788	20.756	53.741
					40Q	3									
	3	4	9	5.67	40P	3	1.667	3.536	9.155	4.585	9.724	25.176	7.087	15.027	38.908
	4	5	8	9.18	40O	1	2.703	5.731	14.840	7.433	15.762	40.809	11.487	24.359	63.069
	5	6	7	5.71	40M	1	1.679	3.561	9.221	4.619	9.794	25.358	7.138	15.136	39.190
	7	8	6	24.45	40H	3	7.196	15.260	39.511	19.790	41.966	108.655	30.585	64.856	167.922
	8	9	4	40.99	40D	2	12.065	25.584	66.241	33.178	70.356	182.161	51.275	108.732	281.522
					40E	5									
					40F	3									
					40G	4									
	9	10	2	13.17	40A	3	3.876	8.220	21.282	10.660	22.604	58.525	16.474	34.934	90.448
	10	11	3	5.36	40I	0	1.577	3.343	8.657	4.336	9.195	23.806	6.701	14.210	36.791
					40J	1									
					40L	0									
					40K	2									
	11	12	1	10.41	40B	2	3.063	6.496	16.819	8.424	17.864	46.253	13.020	27.609	71.483
					40C	6									
Basin 41	FID	Sub Basin Id	gridcode												
	2	3	39	18.75	41F2	7	5.520	11.706	30.308	15.181	32.191	83.348	23.461	49.750	128.810
					41I	12									
	7	11	33	6.76	E2	1	1.988	4.217	10.917	5.468	11.596	30.023	8.451	17.921	46.399
	8	13	24	11.35	41A2	1	3.340	7.083	18.338	9.185	19.478	50.430	14.195	30.102	77.938
	9	14	26	6.77	41D2	6	1.994	4.229	10.948	5.484	11.628	30.108	8.475	17.971	46.530
	13	18	25	6.68	41B2	2	1.965	4.166	10.787	5.403	11.458	29.665	8.350	17.707	45.846
	14	20	21	13.40	41C2	4	3.945	8.365	21.657	10.848	23.003	59.557	16.764	35.550	92.043
	15	21	22	5.33	41Z	2	1.570	3.329	8.619	4.317	9.154	23.702	6.672	14.148	36.631
	20	28	19	12.56	41W	1	3.698	7.842	20.305	10.170	21.566	55.838	15.717	33.330	86.295
					41X	2									
					41Y	4									
	21	29	28	25.30	41U	3	7.446	15.789	40.881	20.476	43.420	112.422	31.645	67.104	173.743
	22	30	29	6.93	41R	2	2.041	4.328	11.205	5.612	11.901	30.814	8.674	18.393	47.622
					41S	1									
	24	32	14	24.66	41Q	2	7.258	15.390	39.848	19.959	42.324	109.582	30.846	65.409	169.355
					41T	5									
					41V	1									
	28	36	5	7.91	41E	4	2.329	4.939	12.788	6.405	13.583	35.168	9.899	20.992	54.350
	29	37	15	21.14	41M	5	6.222	13.193	34.159	17.109	36.281	93.937	26.442	56.071	145.176
					41P	3									
	30	38	2	10.21	41C	3	3.005	6.373	16.500	8.265	17.526	45.376	12.773	27.085	70.127
					41D	1									
	32	41	12	17.40	41L	2	5.121	10.859	28.114	14.082	29.861	77.315	21.763	46.149	119.486

					41N	1								
					41O	1								
	34	43	8	17.66	41F	4	5.197	11.022	28.536	14.293	30.309	78.475	22.089	46.842	121.280
					41G	4								
	35	44	1	16.82	41A	2	4.952	10.501	27.190	13.619	28.879	74.771	21.047	44.631	115.556
					41B	2								
	36	45	13	13.55	36K	1	3.989	8.458	21.899	10.969	23.259	60.222	16.951	35.946	93.071
	37	46	9	7.00	41H	1	2.059	4.366	11.304	5.662	12.006	31.086	8.750	18.555	48.043
					41J	2								
Basin 42	FID	Sub Basin Id	gridcode											
	1	2	13	14.48	42A	4	4.263	9.040	23.405	11.723	24.859	64.363	18.117	38.418	99.470
					42H	1								
	8	9	6	4.17	42B	1	1.227	2.601	6.735	3.374	7.154	18.522	5.214	11.056	28.626
	9	11	3	17.86	42G	1	5.257	11.148	28.864	14.457	30.657	79.377	22.343	47.380	122.673
	12	16	2	17.87	42E	4	5.259	11.153	28.876	14.463	30.670	79.408	22.352	47.398	122.722
					42F	2								
					42D	4								
	13	17	1	6.01	42C	1	1.770	3.753	9.717	4.867	10.321	26.722	7.522	15.950	41.297
Basin 43	FID	Sub basin Id	gridcode			Volume								
	0	1	53	9.31	43O	2	2.740	5.811	15.045	7.536	15.980	41.374	11.646	24.696	63.941
	3	4	52	5.38	43M	1	1.584	3.359	8.696	4.356	9.236	23.914	6.731	14.274	36.958
					43N	2								
	6	7	49	5.53	43L	5	1.629	3.453	8.941	4.478	9.497	24.588	6.921	14.677	38.000
	8	10	46	7.90	43R	2	2.326	4.933	12.773	6.397	13.566	35.125	9.887	20.966	54.284
	10	12	43	11.84	43Q	2	3.485	7.389	19.132	9.583	20.320	52.612	14.809	31.404	81.310
	11	14	41	4.59	43K	2	1.352	2.866	7.421	3.717	7.883	20.409	5.745	12.182	31.541
	13	17	47	6.35	43S	6	1.868	3.960	10.254	5.136	10.891	28.199	7.938	16.832	43.580
	14	20	37	18.99	43I	2	5.590	11.855	30.693	15.373	32.600	84.406	23.759	50.382	130.446
					43J	3								
					43P	0								
	15	22	45	6.94	43T	2	2.042	4.330	11.212	5.616	11.908	30.833	8.679	18.404	47.650
	18	25	35	21.85	43E	7	6.430	13.636	35.305	17.683	37.499	97.090	27.329	57.953	150.048
					43F	2								
					43G	0								
	20	28	34	14.85	43D	3	4.370	9.268	23.996	12.019	25.487	65.988	18.575	39.388	101.982
	22	31	32	6.02	43W	3	1.772	3.757	9.728	4.872	10.332	26.751	7.530	15.968	41.343
	25	36	16	10.26	43H	4	3.021	6.406	16.586	8.307	17.616	45.611	12.839	27.225	70.489
	26	38	20	14.59	43U	2	4.295	9.107	23.579	11.810	25.044	64.842	18.252	38.704	100.210
	27	39	25	7.09	43V	1	2.085	4.422	11.450	5.735	12.161	31.487	8.863	18.794	48.662
	31	43	12	10.06	43C	1	2.960	6.278	16.254	8.141	17.263	44.697	12.582	26.680	69.078
	35	48	33	10.71	43X	1	3.153	6.686	17.312	8.671	18.387	47.607	13.401	28.416	73.574
	37	51	5	5.17	43B	0	1.522	3.227	8.356	4.185	8.875	22.979	6.468	13.716	35.512
	43	58	3	22.75	43A	6	6.695	14.197	36.757	18.411	39.041	101.082	28.453	60.336	156.218
	44	59	31	8.32	43Y	1	2.448	5.190	13.438	6.731	14.273	36.955	10.402	22.058	57.112
	52	68	27	17.19	43Z	1	5.059	10.728	27.777	13.913	29.503	76.387	21.502	45.595	118.053
	53	69	21	18.54	43A2	4	5.456	11.569	29.953	15.003	31.814	82.371	23.186	49.167	127.301

Annex_4

Curb extension as a green drainage solution for local streets in waterlogging lands:
The Case of residential areas developed in the low-lying plains of Addis Ababa.

Feburary2021, Addis Ababa, Ethiopia

Curb extension as a green drainage solution for local streets in waterlogging lands: *The Case of residential areas developed in the low-lying plains of Addis Ababa.*

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Abstract

In recent years, rapid expansion and densification of urban centers in different parts of the world resulted in the change of natural landscape into more built-up areas with more impervious contribute to the increases in stormwater runoff. The stormwater runoff from upstream of the urban centers usually affects the downstream areas by flooding and waterlogging effects. In developing countries, the existing sub-standard and conventional pipe-based drainage system failed to accommodate runoff generated from impervious surfaces of rapidly growing urban centers. The application of the bio-retention system is a well-tested nature-based drainage solution in cities of the global North. The system can also apply in the global South as a sustainable drainage infrastructure with additional environmental and socio-economic benefits. In Addis Ababa, due to the ongoing rapid urbanization and increment in impervious surfaces, stormwater runoff causes flooding and surface water pollution. Specifically, those urban areas developed on low-lying plains are seriously affected by waterlogging. The conventional pipe-based drainage systems for settlement in flat terrain failed to accommodate stormwater runoff and create unprecedented damage on roads and other paved surfaces in the area. In this regard, innovative and flat terrain considerate design responses as a Green Infrastructure are a promising solution. The study aims to develop a sustainable stormwater management system for the low-lying waterlogging area of Addis Ababa by designing curb extension as a bio-retention system to reduce the impact of stormwater runoff and waterlogging on the local streets. Specifically, the study identified areas affected by peak stormwater flow that creates a waterlogging problem over Local Streets in the case study neighborhood. The study utilized hydrological, spatial, and numerical data generated from the depression areas (blue spots) in which the waterlogged settlement was established. Arc GIS-based hydrologic analyst tools used for identification of waterlogged areas and estimating runoff volume. The design of the proposed curb extension considers the peak run of volume draining towards the case site (street developed over the blue spot) from the total catchment and overflow based on the rainfall intensity of the study area. The results of the study revealed that the designed curb extension elements can manage the highest intensity of precipitation (40 mm/hr) of 10 years rain event by infiltration and retention mechanism which can reduce the volume of runoff from 22.895 m3 to 8.477 m3, which is 62 % of runoff from the total volume. In a conclusion, applying a curb-extension as a Green Infrastructure on the residential streets developed on flat terrain helps to control on-site waterlogging and downstream flooding. The system is also able to create a Green Street system to improve the livability standard of the neighborhood and boost the environmental quality of the area. The study recommends the full-scale implementation of the system as a pilot project for its performance and competency to provide more co-benefits including economic benefit to local residents by growing crops and vegetables over the surfaces of curb extensions.

Keywords: Blue spot, Peak runoff, IDF curve, Rainfall intensity, bio-retention & Green Street.

1.Introduction

Stormwater runoff and waterlogging problems have a knowable impact on urbanized lands. The precipitation in an urban or suburban area does not evaporate or soak into the ground but instead runs across the land and into the nearest waterway. Due to the impervious surface caused by urbanization stormwater runoff get at its peak rate mainly during the wet season. Accumulation of water occurs in the low-lying area of the city due to unplanned drainage facility usually causing waterlogging problems. Green infrastructure as a sustainable drainage solution can successfully be implemented on lowland areas to manage urban waterlogging, runoff, and flooding. A sustainable stormwater system helps to promote onsite control of stormwater from impervious surfaces to infiltrate into the ground or collect for reuse, often reducing the runoff volume (Lukes & Kloss, 2010). Implementing green infrastructure components is a significant strategy to improve water quality and helps to acquire multiple community benefits. EPA defines green infrastructure as structural or non-structural practices that mimic or restore natural hydrologic processes within the built environment (Soils, 2014). These practices complement conventional stormwater management practices by enhancing infiltration rate, storage competence, and evapotranspiration throughout the built environment and managing runoff at its source.

The design of a sustainable stormwater management system (curb extension) helps to acquire a water balance considering peak runoff volume and saturated overflow (Fabry et al, 2010). As many natural processes occur within these curb extension cells consist of infiltration, storage by retention that can reduce runoff volumes and attenuates peak flows. The vegetation and the soil composition biochemical reactions occur in the mulch and soil matrix filter the stormwater through vegetation and soil (Lukes & Kloss, 2010). Curb extensions also serve as stormwater management systems by upholding the hydrologic balance of an area using withdrawal of groundwater by plantations. This technique avoids waterlogging and pick flows with the rise of groundwater table that helps maintain the water balance of the site (Fabry et al, 2010). Addis Ababa is a city in the Global South which is experiencing rapid urban growth with increments in built-up areas and impervious surfaces in recent years. The current trends of urbanization contribute to flooding and associated environmental challenges in different parts of the city. An increase in the built-up structure, river buffer degradation, poor solid waste management, and low coverage of stormwater drainage structures are the causes for the occurrence of floods in the city (Assefa & Mpyanga, 2016). Considering the surface flooding, the shallow groundwater table of the city also has an impact on the waterlogging and flooding problem. The groundwater depth map of Addis Ababa area is prepared from April/May 2000 based on boreholes inventory data shows that shallower groundwater table exists at the central and the southern part of the town. The confinement is maximum along elongated strip north-south direction (Filwoha, Lideta, Mekanisa, Lafto, Kailty) and the confinement decreases both in the eastern and western direction from this elongated strip (Abiye et al,2009). The site water saturation level due to soil character also contributes to the waterlogging in settlements developed in the low-lying plains of the city even in years of low rainfall. Those areas that have road infrastructural problems mainly in local roads with poor material finishing and workmanship will increase the impact (Cox & Mcfarlane, 1995).

So, considering the site confinement increment, low slop character, the study areas involve areas with high wet spot accommodation majorly found at low land areas of the city especially involves the southern part of Addis Ababa where most of the waterlogging problem occurs.

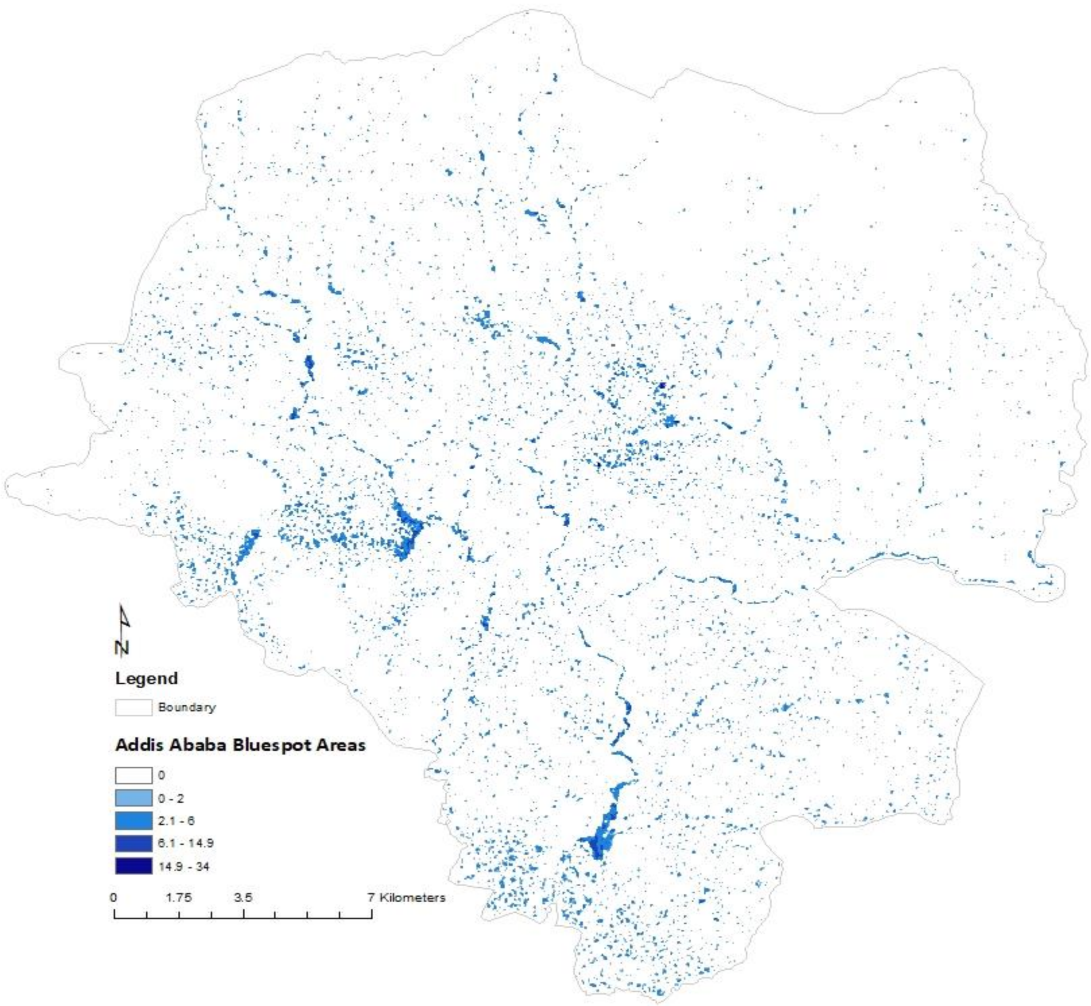

Figure 1 : Addis Ababa city blue spot depression areas found at the lowest and at the highest topographic level of the city.

In those areas, waterlogging intensity close to the soil surface has a consequence of water levels rise, and the water levels stay long close to the surface. Moreover, the waterlogging intensity differs from time to time and it reaches its highest peak during the wet time of the year (Cox & Mcfarlane,1995). It causes a major distraction on the mobility infrastructure system of the urban development. In Addis Ababa, residential streets with cobblestone surface experience such problems. Potholes are created due to stagnant water on the roads making those very risky and the roads remain unrepaired for many days which creates blockage due to the drain.

Uncontrolled urbanization in Addis Ababa leads to increments in impervious surfaces and stormwater runoff generated from these surfaces in low land residential streets couldn't be controlled by using the available conventional pipe-based drainage facilities. Considering sustainable drainage solutions as Green Infrastructure which are widely practiced in the Global North can solve the drainage problem in Addis Ababa in the Global South context. This helps to achieve water balance before the groundwater table rises to the critical depth, by decreasing the runoff volume that contributed by the catchment area to the point where it saturated and drain to the downstream catchment.

1.1. Objective of the study

To develop a sustainable stormwater management system for low land waterlogged residential areas of the urban centers by proposing, designing, and estimating the performance of curb extension to reduce stormwater runoff and waterlogging effects on residential streets.

2.Method and Material

The study is conducted in low land areas of Addis Ababa city, using Akaki Kality sub city as a case study area where the waterlogging problem and uneasy drainage structure occur at a higher scale on the local streets. The data analyzed by hydrological and spatial analysis tools help to identify the peak runoff rate, peak runoff volume, and amount of overflow from depression areas (blue spots). The risk analysis process and the efficiency of the proposed design expressed by maps and tables respectively.

2.1. Input Data

Catchment area character.

The catchment character of the area is expressed by the surface runoff coefficient and the infiltration capacity of the surface area. The site can experience a fully urbanized surface, mid urbanized surface, and natural surface. The infiltration capacity of these surfaces increases accordingly.

The intensity of rainfall.

The rainfall intensity rate in 1 hr duration of time in 33 years of rainfall data and IDF curve generated based on Bole Airport gaging station of Addis Ababa takes into consideration.

- Taking throughout 33 years of data (1985-2017) E.C, from the Ethiopian metrological agency obtaining the daily average intensity rainfall at a certain time in these years with a one-hour time of concentration which equals to the storm duration taken place. Based on these data the dry season (Nov) experience 0.146mm/hr, mid wet season (Apr) 3.096 mm/hr and the wet season (Aug) have 8.016 mm/hr rainfall intensity
- Based on the Intensity duration frequency curve (IDF data) of Addis Ababa taking the storm duration recurrence interval of 2,5, and10 years of monthly rainfall intensity the peak runoff rate and the runoff volume within 1hr storm duration is 30mm/hr,36 mm/hr and 40 mm/hr accordingly.

Actual volume of Depression Area

The actual volume of the blue spot depression areas acquired on ArcGIS. The volumes mainly range from 1m^3 to 7m^3 at the minimum and in some catchment areas it goes beyond 8 m^3 to 23 m^3 were areas near to the river basins. These depression volumes hold the peak runoff volume of their individual catchment flow.

Risk Assessment

Risk analysis of the catchment area is conducted based on the rainfall intensity that occurs in the area and the volume of the depression areas. Thus, by taking the highest surface infiltration rate (natural surface runoff coefficient), minimum precipitation intensity of the site (to identify areas that overflow with the minimum precipitation), and by taking the smallest depression areas highest risk areas can be identified.

Peak Runoff Rate

The peak runoff rate acquired by the Rational method of Q=CIA where A= the area of the catchment, C=runoff coefficient of the catchment, and I= intensity of rainfall (Bengtson, 2011).

- For the risk analysis, the calculation considers the area of each and every catchment acquired by Arch GIS, taking the runoff coefficient of 0.2 for natural surface area, 0.55 for semi urbanized area, 0.85 for urbanized surface area, and rainfall intensity of the dry, mid wet, wet season.
- For specific case area the calculation takes the selected site (the street total area), the intensity of rainfall considering the 33 years of metrological data, the IDF recurrence data, and runoff coefficient of the street surface character.

Peak Runoff Volume

The peak runoff volume is acquired by multiplying the pick runoff rate with the 1 hr time storm duration. The peak run of volume helps to identify the amount of runoff volume on different catchment characters with a certain duration of the rainfall. It helps to get the risk analysis factor by comparing the depression areas volume to the amount of runoff volume from their catchment area considering different seasonal factors.

2.2. Study area description

Akaki Kality is one of the ten districts/sub-cities/ of Addis Ababa. The sub-city is located in the southern part of the city at 20 km far from the city center (Emmanuel Development Association, 2015). The population is estimated 220,740 people (Census 2007), and it is one of the most crowded neighboring areas of the capital city. Most industries and factories are found in this sub-city so, it reclaimed as an industrial zone of the city.

The topography of this sub-city includes both flat and gentle slop areas.55 % of the land has a slope range of less than 4 % and areas considered as slopy with coverage of 30% of the city lays in the range of 4-7 % slop class (Mengesha,2017). The case area site woreda 07 has a total land of 780.34 ha experiencing less than 4 % slope range at most of the sites, with an average population density of 85.72 people /hectare (Addis Ababa sub-cities Atlas,2014). The infrastructure development in the site is not well planned and well developed. The road infrastructure consists of coble stone and gravel as a paving material and most of the streets are unpaved. The side drainages are not well planned and appropriately constructed which limits their drainage performance. Since the city's hydrological water flow and aquifer level increase to the south, the area has a large coverage of blue spots. These wet spot areas were analyzed to achieve the risk valuation.

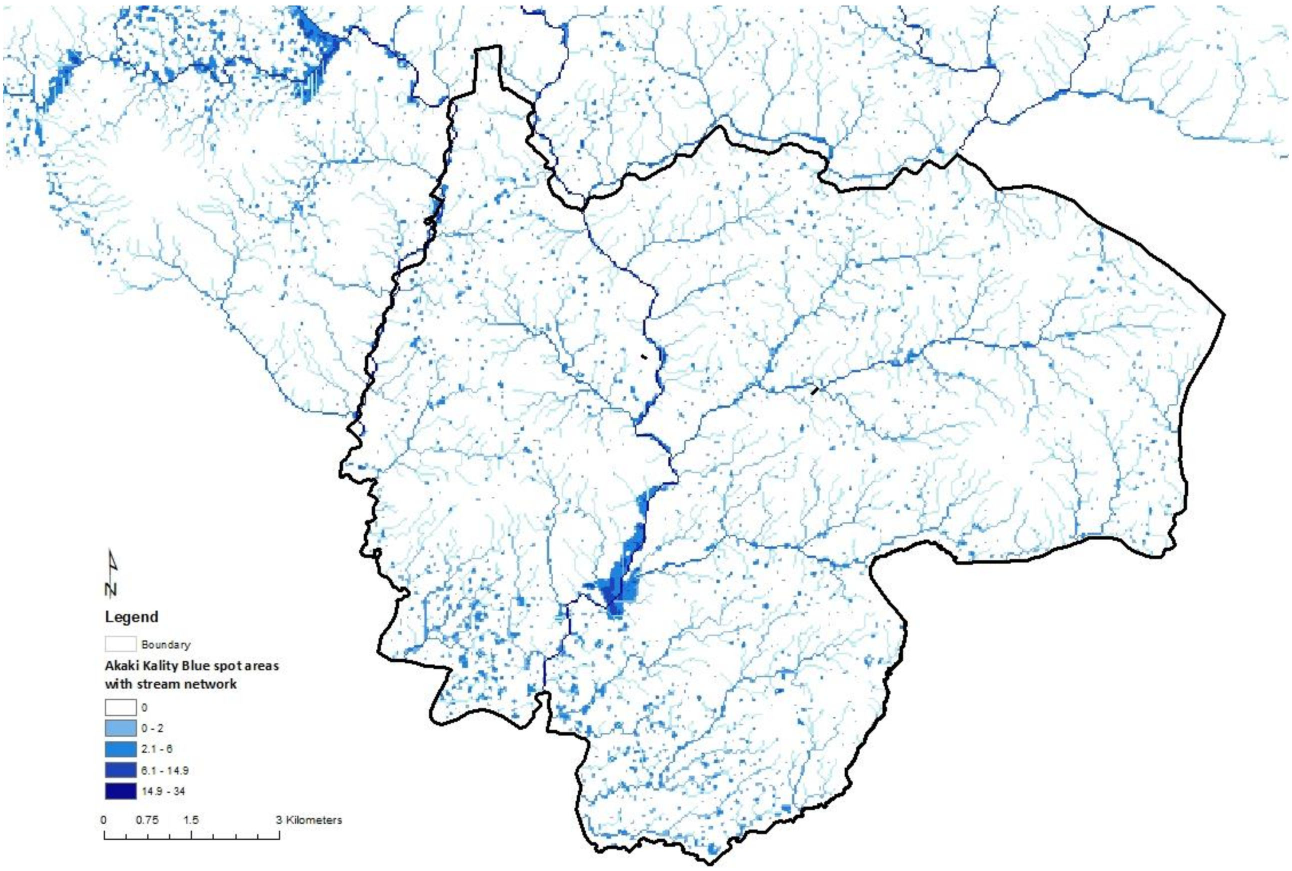

Figure 2: Akaki Kality Sub-city blue spot depression areas related to the stream network.

To analyze the Actual volume of blue spot, identify depression areas which are not connected to the stream network. The streamflow has the ability to drain the accommodated runoff which solves the possibility of overflow. The depressions that are on the sidestep of the natural drainage flow of the site cause a risk of overflow and waterlogging.

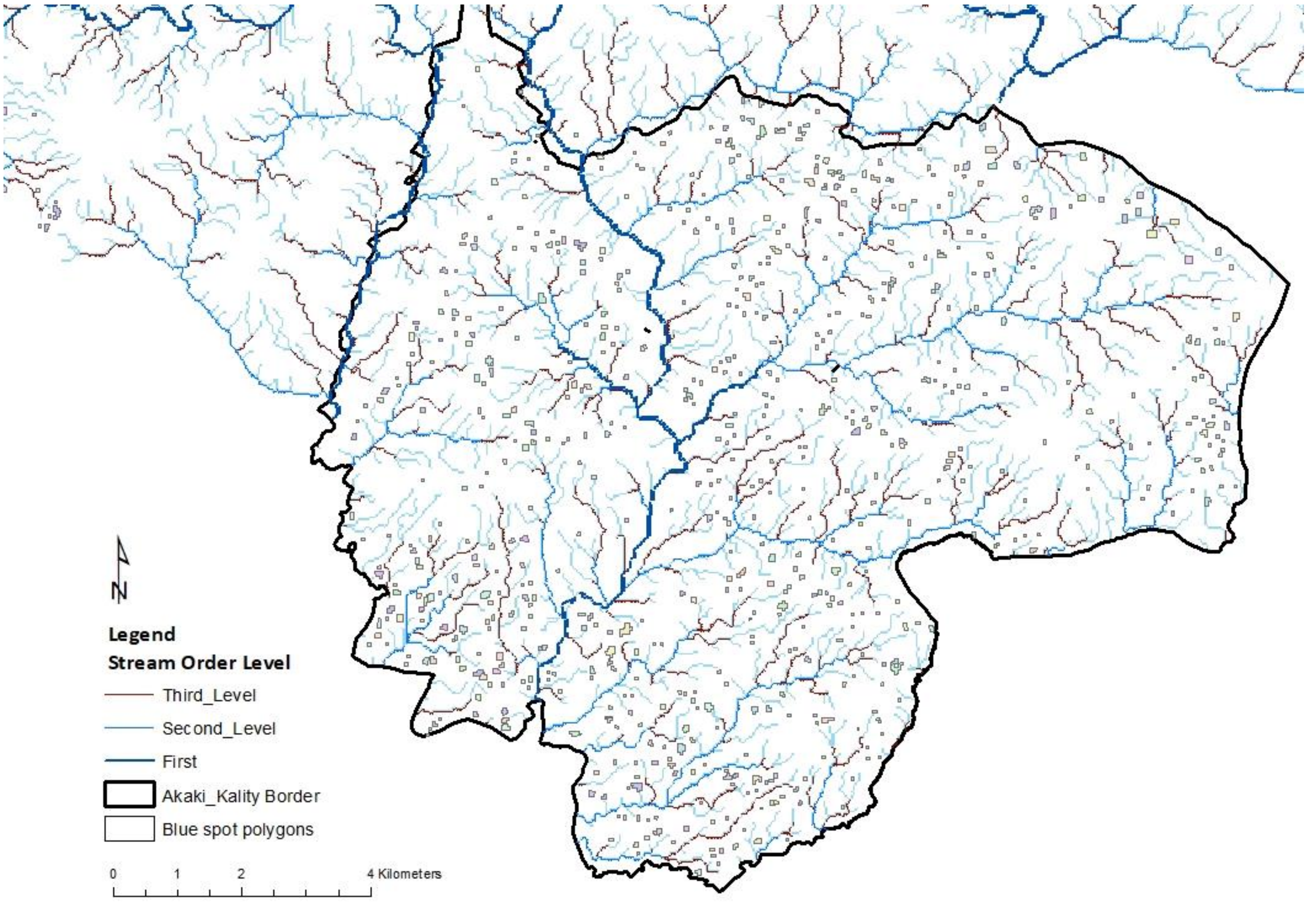

Figure 3: Akaki Kality Sub city Depression areas

The Actual volume of the blue spot and its holding capacity affected by the catchment area, surface runoff character, and rainfall intensity. Having the lowest volume of depression within the largest catchment area can cause flooding and a greater risk than a small catchment with a larger volume of depression. So, by taking the highest permeability scenario of the surface area and considering the lowest precipitation rate major risk areas of the depressions were identified. These depression areas are overflooded by the minimum precipitation even if having the highest infiltration rate can be indicated as high-risk areas. Increasing runoff volume on different catchment areas in different seasonal orientations lead to risk assessment based on the amount of precipitation need to fill the low-lying areas with smaller depression volume. Depression areas that are filled by the lowest precipitation considering their permeability and seasonal factors tend to have a high risk of overflow. Actual

Depression Volumes that are overflow by the minimum intensity of rainfall of 0.146mm/hr at dry season have the smallest actual volume rate to hold the runoff volume of their catchment area. With minimum precipitation, they overflow on the 0.2 runoff coefficient.

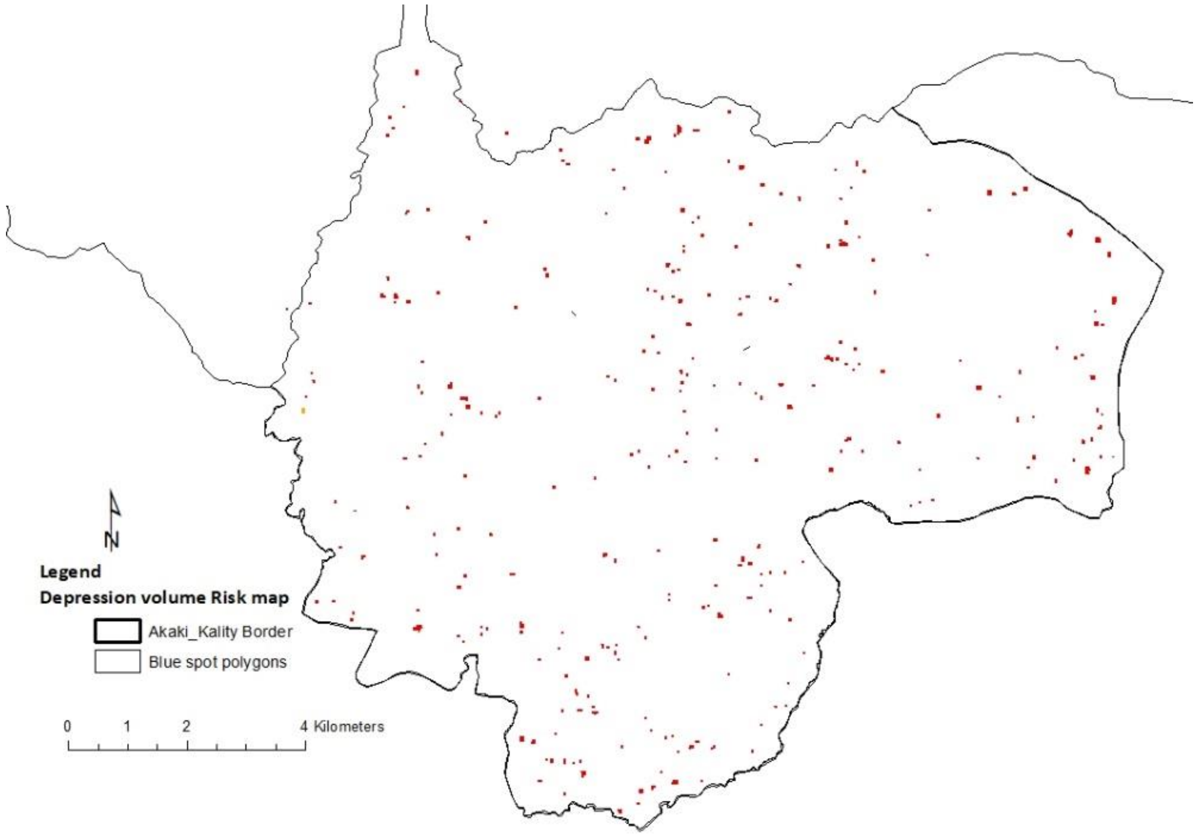

Figure 4: Risk map of Depression areas that overflow with the minimum precipitation Value.

The overflow from the depression areas does not have a natural drainage mechanism. This leads to the overflow to attune its way on the road surfaces of the areas. And risk points that are near to the road have a major impact on the infrastructure. Considering the peak runoff volume that their catchment area contributed to the actual depression capacity, the amount of overflow exerts and the scale of the impact caused by the overflow flooding on the infrastructure case area is selected in Akaki sub-city.

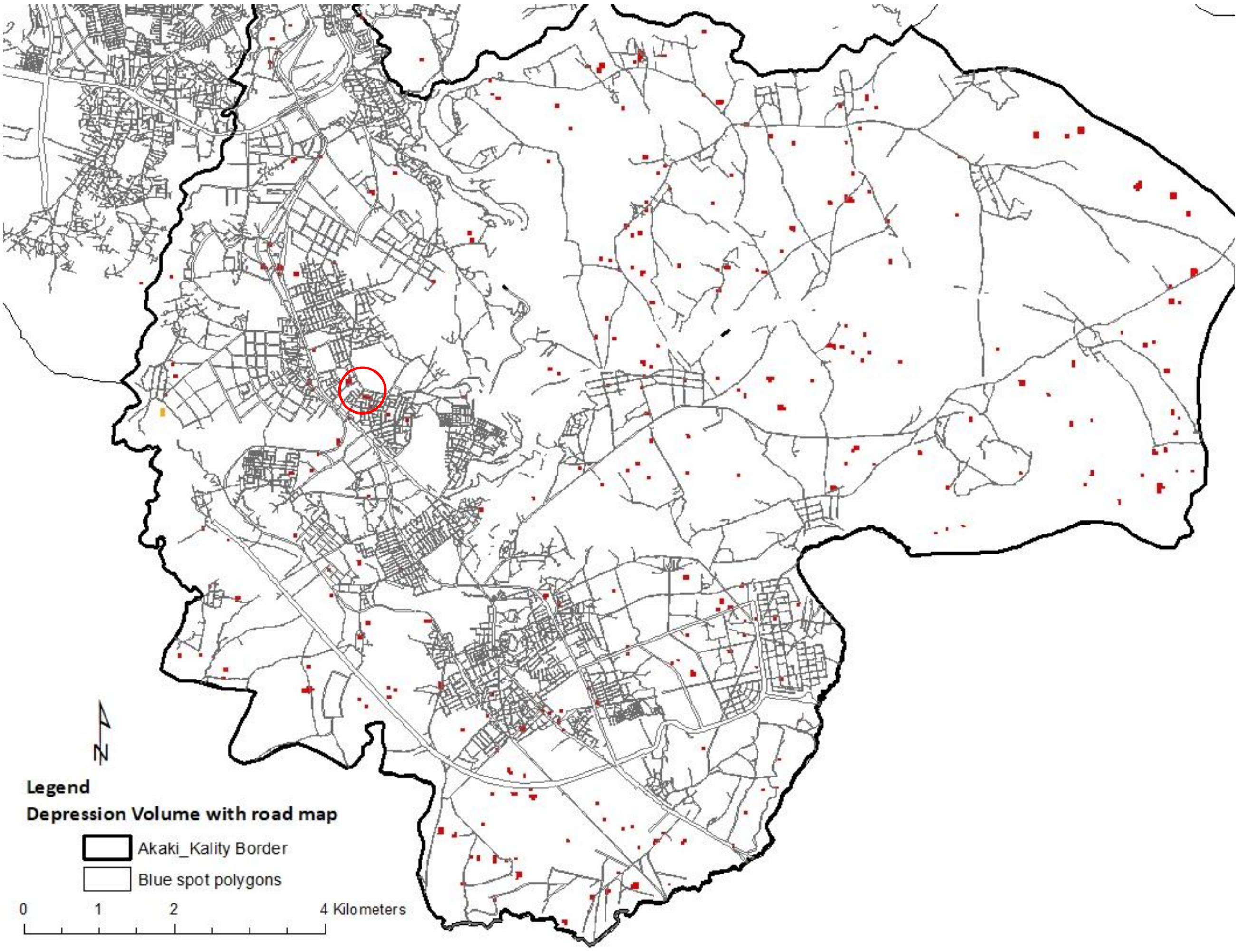

Figure 5: observing overflow depression areas with the road map of Akaki Kality Sub city and study site location

The road selected to be case area is located in the central part of Akaki Kality Sub-city worda 07. The area is located in a mixed-use residential settlement. The road is covered with local coble stone material with a width of 8 meters excluding local developed drainages ditches along each side having 1-meter width. Peak runoff occurs from the northern part of the site to the south attending the slope. The side adjacent roads (fig 6: left side) have major significance on adding a runoff volume to the catchment area. Due to un attendance of Surface runoff from these side roads there creates an impact on the main road. (fig 6, right side) surface area.

Figure 6: The Study site in Akaki Kality Sub city with cobblestone road features, damaged surface areas (right side) and adjacent road to the site contributing runoff (left side).(Source: photograph taken by the author on August 2019)

On the sides of the road, there are small vegetations that grow in the wet season but they don’t have any significance on infiltrating the water accumulation and overflow on the road. Total study area road length 101.4m with a total catchment area of 811.2 sq. m.Based on the risk analysis the blue spot on the area has an actual depression volume of 3 m^3. But the overall catchment has a minimum runoff volume of 4.75 m3 during the smallest precipitation on high infiltration surface that overflows the actual depression volume. Since the case area categorized as a mid-urbanized center by assuming the road placement and the overall catchment area of the depression lies at semi-permeable urban development the maximum runoff volume will be 71.819 m3 covering 16.16 ha of the total catchment runoff. With these rates Considering 0.08112 ha of the road area the minimum runoff volume will be 0.023 m^3 and the maximum runoff on the road will be 3.604 m3 assuming the road site categorized in the mid-urbanized area.

3.Result

3.1. Designing Sustainable stormwater management system (curb extension)

The design of sustainable curb extension helps to minimize the rate of runoff during high intensity of precipitation. These helps to control overflow of runoff volume from the depression area, provides a clear drainage, avoid waterlogging problem and it have an ability of retaining certain amount of water to manage the waterlogging intensity. The design also serves as a bump out to control the vehicular flow on the site. Since the design include green element, it improves the aesthetic value and boost livability of the neighborhood.

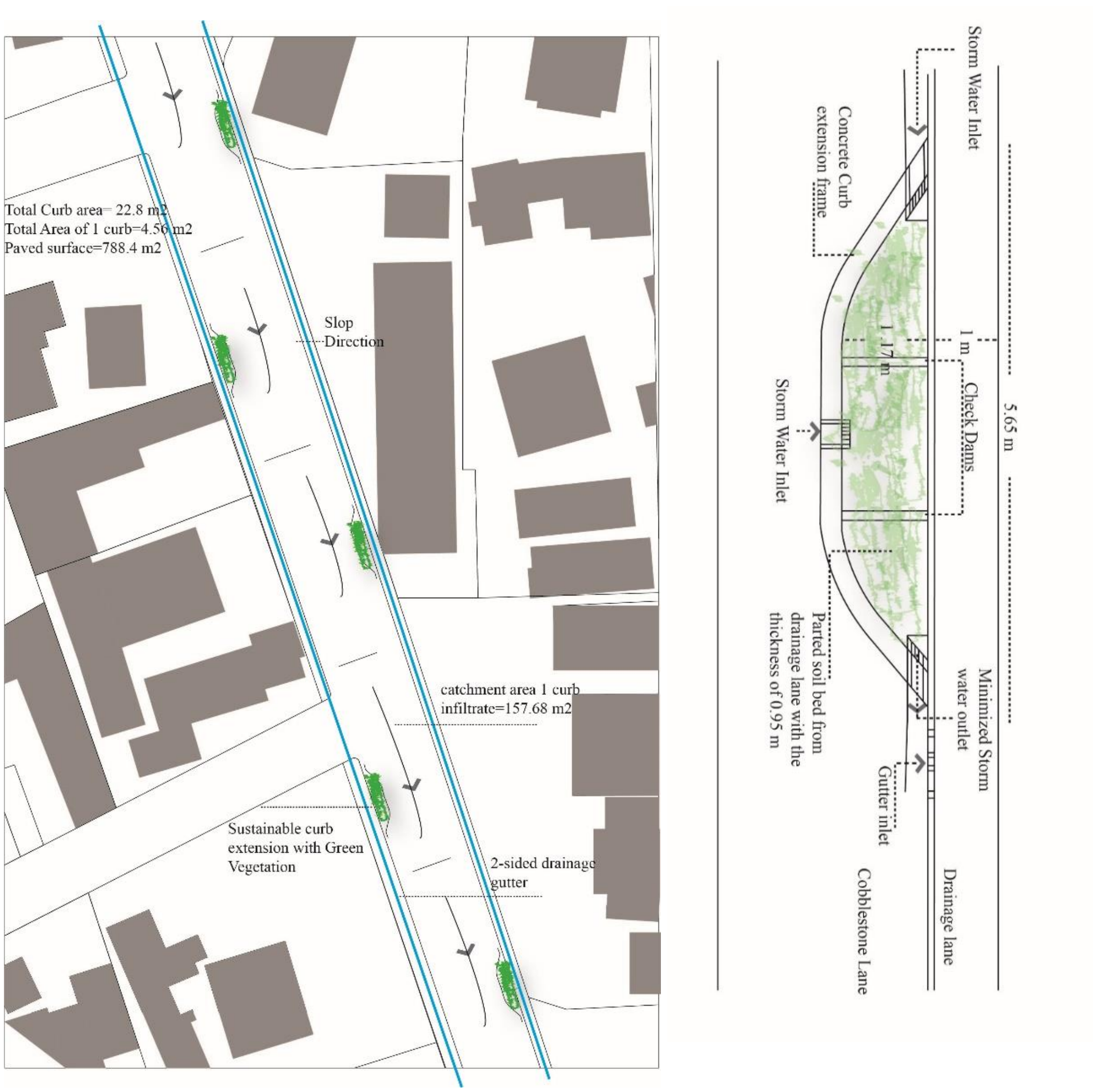

Figure 7: study area plan with curb extension, (left side), detailed plan layout (right side)of the designed curb extension.

The curb extension lies on the existing total surface area of the road as a bump-out with an outward distance of 1.17m from the corner of the road with a length of 5.65 m. It has a drainage gutter lain along the road length in which the treated and minimize stormwater flows towards the catchment basin. Drainage lain with 1 m width also serve as a sidewalk by covering the top surface. The curb extension has 2 inlet pads, one at the corner of the curb the other one at the front that collects the total catchment runoff volume for a single curb intake. To release the outflow water from the curb extension, there is an outlet pan that is connected to the existing conventional drainage lain. To stabilize the slope difference in curb extension, there are check dams with a width of 1.17m. For accepting the functionality of the curb extension, it needs to facilitate the highest intensity of runoff volumes that the site gain. In this case, 4.588m^3 runoff volume from the site,17.17 m^3,20.605 $m^{3,}$ and 22.89m^3 volumes from IDF curve of 2,5 and10 years respectively taken as the highest intensity runoff volume of Addis Ababa as inflow volume to the site.

Table 1 : The final Design runoff outcome comparison with the Peak runoff rates of the site.

	Volume inflow per hr.	Volume outflow	Total curb area runoff intake	Individual curb runoff intake	Depth needed to accumulate inflow volume	Overflow from the mezzanine considering the highest depth(1.01 m)
Runoff volume on the site	4.58 m^3	0.082 m^3	4.469 m^3	0.8938 m3	0.19 m	-
2-year recurrence runoff volume	17.17 m^3	0.082m^3	17.088 m^3	3.417 m^3	0.74 m	-
5-year recurrence runoff volume	20.60 m^3	0.082m^3	20.523 m^3	4.104 m^3	0.90 m	-
10-year recurrence runoff volume	22.895m3	0.082 m^3	22.813m^3	4.562 m3	1.01 m	0.082 m3

To control the overflow and waterlogging intensity 5 curb extensions installation are needed with an area of 4.56 m2 covering 811.2 m2 of the total catchment area of the road. The volume outflow calculated taking 1×10^{-6} m/s infiltration capacity of the soil in 1hr storm duration, which gives 0.08208 m3 for both daily and the maximum10 years' durational intensity runoffs. The size of magazine for the five curb extensions calculated based on water balance from inflow and outflow stormwater. Since the curb extension developed to avoid and control the highest runoff rate on the site, it majorly considers the relapse interval of 2,5 and 10-year IDF data as a design input. Taking the highest runoff volume that needs to be handled by individual curb capacity with the area of the curb 4.56 m^2, the depth is 1.01 m below the ground to retain the runoff volume covering 157.68 m^2 catchment area to drain individually.

The designed curb extensions on the street have an intake capacity of 22.813 m^3 runoff volume from the highest peak runoff rate of the site 22.895 m^3, giving the area of 811.2 m^2 and leaving 0.082 m^3 overflow to the surface. So, considering the depth and the overall area the curb takes, the volumetric capacity of the design element can handle the maximum rate of runoff during 10 years event of precipitation.

3.2. Evaluating the performance of the system

The designed curb include ponding area (30 cm depth), mulch area (5 cm depth), sand (50 cm depth) ,gravel (16 cm) and vegetation cover. Considering the infiltration rate and the void ratio of the elements the designed curb has the ability to hold a significant amount of water that will drain to the ground with a certain period of time. These processes will minimize the highest waterlogging and overflow effect occur during the maximum precipitation intensity.

Considering the highest precipitation interval 22.895 m^3 with the curb intake value of 22.813 m^3 the curb has 1.01 m depth. These depths include the elevation of the ponding area that has the ability to retain 6.84 m^3 of water, the mulch that helps to avoid dirt and segregate unwanted substances to enter and have the ability to retain 0.19 m3 of water, and considering the hydraulic property of sand and gravel they have the holding capacity of 2.28 m3 and 1.276 m3 of stormwater respectively. Also adding the plantation 0.27 in/day (0.00285 m/hr.) transpiration rate, it has the ability to intake 3.75 m^3 of stormwater. The designed curb extension retains a total of 14.336m^3 volume of water with the intake of 5 curbs and 2.79m3 volume of water retain by a single curb extension.

Having the retaining capacity on the design curb elements, the system responds in different ways throughout different intensities of rainfall. Considering the maximum runoff volume of the site during the wet season and taking the highest precipitation intensity with 2,5- and 10-years recurrence rate, the stormwater that will drain from the curb towards the drainage facilities vary.

Table 2: The designed Sustainable curb extension efficiency rate considering maximum runoff volumes occur on the site.

Sustainable curb extension efficiency rate	Max runoff volume on the site	Volume outflow from the total curb area	Volume inflow into the curb.(from min_ Max) intake capacity of the curb	Retaining capacity of the curb	Efficiency with %	Stormwater that will drain from the curb towards the drainage facilities
during wet season.	4.58 m3	0 – considering 1.01-meter depth	4.469 m^3(5 curb elements)	14.336 m3		Non (stormwater will retain and infiltrate to the ground.)
			0.893 m^3 (individual)	2.79 m3		
In 2 years, recurrence time.	17.17 m3	0 – considering 1.01-meter depth	17.08 m3(5 curb elements)	14.336 m3	83.9 %	2.752 m3
			3.417 m3 (individual)	2.79 m3		0.62 m3
In 5 years, recurrence time.	20.60 m3	0 – considering 1.01-meter depth	20.52 m3(5 curb elements)	14.336 m3	69.86%	6.187 m3
			4.104 m3 (individual)	2.79 m3		1.314 m3
In 10 years, recurrence time.	22.895 m3	0.082 m3	22.81 m3(5 curb elements)	14.336 m3	62.8 %	8.477 m3
			4.562 m3 (individual)	2.79 m3		1.772 m3

The designed curb extension has a good efficiency performance that at the maximum rainfall intensity of 10 years recurrence interval it retains 62% of the runoff volume. The efficiency of the curb increases with the decrease of runoff volume whereas the retention ability has a constant value.

4.Discussion

Based on the topographical character of the city the lowest region with the minimum slop level is impacted by stormwater runoff overflow and waterlogging. Where all depressions are identified, acquiring their actual volume helps to identify their water holding capacity. If these volumes are larger than $10m^3$ and close to a road, they are considered as threats (Hansson et al,2010). But in the analysis, some of the depression areas are less than $10m^3$ but have the ability of holding the run-off volume that exerts by their catchment, which caused them to overflow. Depression areas which area overflow by the smallest precipitation rate have a higher risk of creating flooding, stormwater runoff, and water saturation (Nielsen et al, 2011). In Akaki Kality there are depression areas that overflow by the lowest precipitation intensity of 0.146mm/hr. These areas have an actual volume which is much less than to hold the runoff volume exerted by their catchment or the volume that is gained by the precipitation intensity on the site. The second level is a calculation of rain sensitivity for each individual depression found by assuming no drainage from depressions and assuming impermeability of the catchment in different runoff coefficients (surface character).In this way, a risk map can be drawn showing the amount of precipitation needed to fill low-lying areas (Hansson et al,2010).

The design of sustainable curb extension has a major significance in controlling the stormwater runoff that occurs on the site. When designing curb extension, the site surface character (infiltration rate), total area of the site, rainfall intensity of the site, and the slop of the site taken into consideration (Wise, 2008). Since the designed curb is on the local street of Akaki kality area it has a coble stone layer having a 0.7 runoff coefficient within 811.2m2 as a total area of case site.

Considering the principles on designing the curb extension, the "Code for Design of Urban Outdoor Drainage", implemented in China, requires: "The design of drainage pipe network must meet the standard of 3 - 5 years rain event". The urban outdoor drainage design specification standard can only withstand rain of 27 - 33 mm/h or 100 mm/24 hours. Faced by sudden heavy rains, such a huge amount of rainfall exceeds the design standard for drainage pipelines, so it is too late to discharge, easily making waterlogging in the city (Wang, 2018). In the design based on the calculated runoff volume that occurred on the site and the Monthly rainfall intensity of Addis Ababa city based on Addis Ababa Bole observatory center from IDF curve data the design consider 2, 5, and 10 years of storm duration recurrence interval .the design taking the site rainfall intensity of 8.016 mm/hr of the wet season and 30 mm/hr and 36 mm/hr of 2 and 5 years respectively .even if the 5 years recurrence interval precipitation rate exceeds the standard above the design can manage it with a through infiltration, retention and evapotranspiration techniques with the help of the sizing of the curb element. But considering the maximum 10 years recurrence interval the design has a small amount of overflow but the excess stormwater runoff is managed to be subdued to the side drainage facility.

In the design process, site analysis is needed for mapping, measuring street dimensions to estimate space available for retrofit treatment areas (Fox, 2015). The case site has a total area of 811.2m2 subtracting the total curb's area 22.8 m^2 which leaves $788.4m^2$ of untouched coble stone area. The curb uses 3% of the total area for infiltration purposes. Stormwater Management Manual (SWMM) of the City of Portland specifies 6% or less for surface infiltration surface should be used considering the "Simplified Approach" in sizing the curb (Gallagher,2009). The designed curb extension acquires the standard extent considering the total used area for the infiltration purpose with a depth of 1.01 m and with a total area of 4.56 m2 that helps to attain the maximum runoff.

To know the performance and efficiency of curb extension design it is critical to quantify the benefit of the facilities incorporated and considered in the curb design (Gallagher, 2009). A minimum 60% reduction in peak flow, and would provide protection for a majority of low land areas regardless of the infiltration rate is needed (Gallagher, 2009). Considering the design curb extension choosing the maximum intensity of rainfall, the peak runoff reduced from 22.895 m3 to 0.082 m3. Taking 22.81 m3 which is 95% of the peak runoff volume is managed by the designed curb extension. And for flow volume reduction even with very low infiltration rates the facility would retain 20% of the total runoff volume and provide a measurable benefit to CSO control (Gallagher, 2009). Infiltration, retention, and evapotranspiration used as a hydrological performing element to decrease not only the flow volume of the peak runoff better to attain the waterlogging problem. Considering the void ratio of the layer elements in the designed curb, it has the ability to retain the maximum intensity of rainfall by 62% of its inflow volume.

Generally, the idea of a combination of “discharge and storage” is one of the important guiding ideologies for urban waterlogging management. Especially in some cities where urban drainage systems have been basically established and large-scale renovation is not available, the construction of urban discharge and storage system is one of the most important measures to deal with excessive rainfall (Wang, 2018). Designing with the retention ability that will minimize the waterlogging problem and maintaining these requirements of the curb either in the design level or on the application level of the ground, it will effectively reduce the anticipated runoff volume to the minimum and it decreases the waterlogging problem on the site. In addition, the benefit of bringing more *green* into streets by probing its potential as a sustainable strategy helps to achieve livable and healthy communities in urban cities (Im,2019).

5.Conclusive summery

The application of green infrastructure helps to manage stormwater and to create healthier urban environments. At the scale of a city county or neighborhood these sustainable stormwater management techniques is more effective and can be applied throughout the time by creating sustainable management of stormwater using a natural performance design. Since the timely increase of urbanization, a high rate of imperviousness and stormwater runoff going to be common. Roads and their drainage facilities are the major impacted urban structures due to these runoff volumes and the water accumulation on the surface. The study has tried to solve the problems of waterlogging and storm runoff on the site considering the catchment character of the area. The first step was wet spot analysis conducted with respect to flooding and overflow areas. Blue spot areas of the city and sub-catchment identified. These areas were analyzed based on their actual volume and the peak runoff rate. The smaller volume depressions have a higher risk of overflow. Depending on the severity of possible conflicts between the blue spot and the street, the level of investigation can be expanded to analyze rain sensitivity of individual blue spots peak runoff rate and peak runoff volume. The blue spot(depression) area that has the risk of overflow and has a high waterlog effect with the minimum precipitation selected as a case area site.

The designed sustainable stormwater management system helps to minimize the overflow that occurs in the site and it has a tendency of minimizing the level of saturation caused by the overflow through retention, infiltrations, and evapotranspiration. The curb extension was designed in consideration of the maximum runoff volume on the site during the wet season and the storm duration recurrence interval of the monthly rainfall intensity of the city.

The design has good efficiency of retaining the maximum runoff volume that entered the curb element. These abilities are acquired by the infiltration and porosity character of curb elements that are incorporated in the design. The designed curb extension system with 62% retaining capacity at the maximum runoff volume, it considered as an effective sustainable stormwater management system. Besides these with the incorporation of trees and other green elements on the top of the system, it can provide more environmental benefits while creating an attractive and safer environment. Eventually, the city should incorporate a system as a design and planning strategy for future drainage and green infrastructure development for achieving nationwide green economic development policy.

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