Climate Adaptive Design and Reliability Analysis of Drinking Water Distribution Networks for Sustainable Urban Water Management: A Case Study of Haroa

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submitted by

SHRAMANA GHOSH

Class Roll No: 002130302016

Under the guidance of

(Prof.) DR. ASIS MAZUMDAR
Professor & Director
School of Water Resources Engineering
Jadavpur University

DR. GOURAB BANERJEE
Assistant Professor
School of Water Resources Engineering
Jadavpur University

School of Water Resources Engineering

M.E. (Water Resources & Hydraulic Engineering) course affiliated to Faculty Council of Engineering & Technology

Jadavpur University

Kolkata 700032, India

2024

M.E. (Water Resources & Hydraulic Engg.) Course Affiliated to

Faculty Council of Engineering & Technology

Jadavpur University

Kolkata, India

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I hereby declare that this thesis contains literature survey and original research work by the undersigned candidate, as part of my Master of Engineering in Water Resources & Hydraulic Engineering in the Faculty Council of Interdisciplinary Studies, Law & Management, Jadavpur University during academic session 2023-24.

All information in this document have been obtained and presented in accordance with academic rules and ethical conduct.

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Name	:	Shramana Ghosh
Exam Roll Number	:	M6WRP24014
Thesis Title	:	Climate Adaptive Design and Reliability Analysis of Drinking Water Distribution Networks for Sustainable Urban Water Management: A Case Study of Haroa
Signature with Date	:	

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This is to certify that the thesis entitled *"Climate Adaptive Design and Reliability Analysis of Drinking Water Distribution Networks for Sustainable Urban Water Management: A Case Study of Haroa"* is a Bonafede work carried out by Ms. Shramana Ghosh under my supervision and guidance for partial fulfillment of the requirement for the Post Graduate Degree of Master of Engineering in Water Resources & Hydraulic Engineering during the academic session 2023-2024.

THESIS ADVISOR

Prof. (Dr.) Asis Mazumdar
Professor & Director
School of Water Resources Engineering
Jadavpur University

THESIS ADVISOR

Dr. Gourab Banerjee
Assistant Professor
School of Water Resources Engineering
Jadavpur University

Prof. (Dr.) Asis Mazumdar
Director
School of Water Resources Engineering
Jadavpur University

DEAN
Faculty Council of Interdisciplinary Studies, Law & Management
Jadavpur University

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Committee of Final Examination for
the evaluation of the thesis.

** Only in case the thesis is approved.

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Date:
Place: Jadavpur University

SHRAMANA GHOSH
(Exam Roll No: M6WRP24014)

Abstract

Designing an adaptive water distribution network capable of supplying water on-demand in response to seasonal and climatic variations is critical for ensuring efficient water management. A low carbon footprint pipe network is superior as it ensures minimal carbon emission. This thesis presents the methodology and considerations for developing such a network, focusing on the case study of Haroa. The design process involves analyzing historical data to discern patterns in water demand influenced by seasonal factors like temperature, precipitation, and population fluctuations. Using hydraulic modeling software WaterGEMS, an attempt has been made to simulate the network's performance under varying scenarios to optimize its configuration. Key components such as storage reservoirs, pumps, and valves are strategically positioned to manage fluctuations in demand and maintain consistent water pressure and flow rates. Furthermore, advanced control and monitoring systems enable real-time adjustments based on current demand patterns and weather forecasts, enhancing the network's responsiveness and resilience. This study compares the performance of a WaterGEMS-designed water distribution network (WDN) using pipes made of different materials: HDPE, DI, and PVC. Parameters such as head loss, residual pressure, and carbon emissions were evaluated. The results show that HDPE pipes exhibit minimum head loss (3.974 m/km) and residual pressure (15.13 m H_2O) characteristics, while PVC pipes have lower carbon emission values (451.9 kg/kWh) despite higher head loss (4.264 m/km) and similar residual pressure (15.26 m H_2O). This optimization study suggests that HDPE pipes, despite their higher carbon emissions compared to PVC pipes, are superior considering overall performance parameters. Additionally, criticality analysis reveals certain valve segments with a 100% demand shortfall, indicating areas of non-reliability. The major findings highlight the advantages of HDPE pipes in terms of hydraulic performance and resilience, though improvements are needed to address carbon emissions. The study recommends incorporating advanced materials and technologies to balance performance and environmental impact, ensuring sustainable urban water management under varying climatic conditions.

Keywords : Climate Adaptive, Reliability, WDN, Pipe Material, Head loss, Residual Pressure, Carbon Emission

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Chapter 1

1 Introduction

1.1 General Background

With the increasing impacts of climate change on water distribution systems, it has become imperative to develop climate adaptive designs for drinking water distribution networks. This involves incorporating resilient and reliable features to ensure the continuous and safe supply of drinking water to communities. The use of advanced software such as WaterGEMS allows for the analysis and optimization of these networks to enhance their performance and reliability under changing environmental conditions. In this paper, we will discuss the application of climate adaptive design principles and reliability analysis using WaterGEMS to address the challenges associated with drinking water distribution networks in the face of climate change. Cassottanaet al. [1] worked on the enhancement of the resilience of the WDS by methodical analysis of the system considering design and economic parameters. The economic analysis monetizes the three metrics and compares two resilience strategies involving the installation of remotely controlled shutoff valves. Dave et al. [2] worked on the robustness of a WDS. They worked on the design of a WDS which is ecologically robust. They have considered two bio-inspired networks, selected from an optimization based on the ecosystem metric robustness. Kadhim et al. [3] did a hydraulic analysis of WDS in their work. They did a simulation-based study on the data acquired from a water scarce region on the Earth, Baghdad. They considered pressures and speeds during the average daily demand per person of 350 litres / day and during the maximum operational design capacities of the compact Units, the results showed that the pressures within the acceptable limits and the flow velocity are not excessive in some pipes due to the low average daily demand. Hajibabaeiet al. [4] worked on the design and renovation of the WDS considering uncertainties. They applied life cycle assessment (LCA) to water distribution networks (WDNs) and observed that it usually requires considerable reliable data, and neglecting specific parts could significantly affect the reliability of results. Shuang et al. [5] Performance and Reliability Analysis of Water Distribution Systems under Cascading Failures and the Identification of Crucial Pipes. They observed when the tolerance parameter is less than the threshold, the time period with the highest system reliability does not meet the minimum value of demand multiplier. The results indicate that the system reliability should be evaluated with the properties of WDS and the characteristics of cascading failures, so as to improve its ability to resist disasters. Patil et al. [6] worked on Analysis & design of water distribution network of urban area by WaterGEMS software. In this paper they have designed a specific water distribution network for urban areas considering all total demands, by demand method. According to them water distribution network is analysed firstly and we found out that many of lines were out of age and need to design new network among the study area. By using hardy cross method and by doing manual calculations we studied flow in loops of our network. Li et al. [7] reviewed the researches performed on WDS. They said that, the future studies may focus on (1) impact of climate change on water distribution systems (2) research on the resilience of urban water supply infrastructure (3) more accurate leak detection and more effective leakage control management (4) energy efficiency improvement and energy recovery in water distribution systems. Roy et al. [8] did research on Hydraulic analysis of a proposed Drinking water distribution network using WaterGEMS and GIS. The objective of their paper is to design safe drinking water networks through gravity cum pumping and hydraulic analysis of pipe networks using the WaterGEMS software for virtual-time realization of pressure head and average daily flows through the house connections and stand-posts. Hydraulic simulation has been carried out for a continuous supply of 24 hours daily to achieve the desired results with suggestive conclusions for practical implementations. Lee et al. [9] reviewed Quantitative Measure of Sustainability for Water Distribution Systems. The two primary recommendations made based upon reviews were to: (1) consider balancing usage (cost) and gain (benefit), rather than impacts; (2) consider indirect (cascading/consequential) interactions. Overall, existing measures of sustainability and sustainable development practices in WDSs must be advanced to accommodate a focus on restorative systems, as well as to maximize benefits and enable multidisciplinary and broader analyses. Shuang et al. [10] reviewed the Quantitative Resilience Methods in Water Distribution Networks. This study reviews contemporary approaches for quantifying the resilience of WDNs. 1508 journal

articles published from 1950 to 2018 are identified under systematic review guidelines. 137 references that focus on the quantitative resilience methods of WDN are classified as surrogate measures, simulation methods, network theory approaches, and fault detection and isolation approaches. This study identifies the resilience capability of the WDNs and describes the related terms of absorptive, restorative, and adaptive capabilities. It also discusses the metrics, research progresses, and limitations associated with each method. Finally, this study indicates the challenges associated with the quantification of WDNs that should be overcome for achieving improved resilience assessments in the future. Srisant et al. [11] reviewed the Advances in assessing the reliability of water distribution networks. The bibliometric analysis identified trends and gaps by focusing on articles output, citation network of articles, co- authorship and collaboration analysis, co-citation, and clustering analysis. In addition, coupling keywords analysis with thematic maps analysis helped identify basic, niche, emerging, and declining research themes in the field of WDN reliability. Zou et al [12] published their work on Quantitative assessment of adaptive measures on optimal water resources allocation by using reliability, resilience, vulnerability indicators. They have mentioned that Water resources allocation is facing great challenge, since hydrological series have shown non-stationarity with high uncertainty due to climate change and human activities. Adaptive measures are suggested to respond to the challenge. They showed that water saving study reduces vulnerability of the system and increases the reliability. Gonzalez et al [13] mentioned in their paper that Data analysis suggests that monitoring the water quality in distribution systems is important for their proper management.

Sadiq et al [14] wrote that The PVC pipes in the network contained about 1 % of lead and water passing through these pipes contained relatively higher lead concentrations. Leaching of lead from the PVC appears to be responsible for lead elevation in these water samples. Iron concentrations in the water samples from the galvanized pipes were higher than those collected from non-galvanized pipes. The results of this study show that distribution network material can modify water quality during transportation to the consumers. Tamminen et al [15] have found that the performance of the water age was dependent mainly on the tank usage, and the performance of contamination by organic material depended on the coefficient that defines the decay rate of the organic material in the bulk phase.

Through this study, we aim to develop a comprehensive understanding of the impacts of climate change on drinking water distribution networks and the effectiveness of adaptive strategies in mitigating these impacts. By integrating climate adaptive design principles and reliability analysis using WaterGEMS, we can enhance the resilience and performance of drinking water distribution networks in the face of climate change, ensuring the continued provision of safe and reliable drinking water to communities. In conclusion, this study aims to integrate empirical research on water supply, demand, and climate change adaptation into the analysis of drinking water distribution networks.

According to a study on the greenhouse gas footprint of common WDS elements, pumping energy accounts for 81% of GHG emissions in the drinking water distribution system [16]. By considering the life-cycle assessment of the drinking water distribution system, we can accurately estimate the carbon footprints of pipes at each phase, from manufacturing and installation to operation and maintenance [17]. This comprehensive analysis will provide us with valuable insights into the environmental impacts of the drinking water distribution system and guide decision-makers in developing eco-friendly processes and technologies to mitigate these impacts [18]. Overall, understanding and addressing the carbon footprints of pipes in the drinking water distribution system is crucial for sustainable water management and climate change mitigation [19]. In conclusion, the carbon footprints of pipes in the drinking water distribution system play a significant role in assessing the overall environmental impact and implementing strategies to reduce greenhouse gas emissions [20].

The reliability of a WDN could be defined as the ability of a system to provide a desired flow rate at desired pressure head on a probabilistic scale. Bao et al. [21] used Kentucky Hydraulic Simulation Model (KYPIPE) as to analyse the reliability of a system. Ostfeld [22] used lumped supply-lumped demand approach to estimate the WDN reliability. Atkinson et al. [23] commented that WDS solutions with high entropy have increased mechanical reliability, yet are expensive and have poor hydraulic operation and water quality. In contrast, high resilience index networks are relatively cheaper and present reasonable hydraulic operational performance, yet

have limited improvement in mechanical reliability. Gheisi et al. [24] have reviewed a host of works on WDN reliability and they have mentioned several pros and cons of a few in their literature. Wagner et al. [25] used simulation studies on nodes by giving them a certain amount of sully and observing their performance for a several passes. Right now AI enabled systems are analysing reliability of a water resource system by addressing the water management system itself [26].

1.1.1 Gap between Demand and Supply of Drinking Water in India

Access to clean and safe drinking water is a basic human necessity, yet in India, millions of people still lack reliable access to this essential resource. The country faces a significant gap between the demand for drinking water and its supply, leading to widespread water scarcity and associated socio-economic challenges. The figure 1.1 is a bar chart which represents the gap between the demand and supply scenario in India/

Causes of the Gap: The disparity between demand and supply of drinking water in India can be attributed to various factors. Rapid population growth, urbanization, and industrialization have placed immense pressure on existing water resources, leading to increased demand [27]. Inefficient water management practices, such as leakages in distribution networks and contamination of water sources, further exacerbate the problem [28]. Climate change-induced variability in rainfall patterns and depletion of groundwater reserves also contribute to water scarcity [29].

Impacts of the Gap: The consequences of the gap between demand and supply of drinking water are profound and wide-ranging. In rural areas, water scarcity affects agricultural productivity, livelihoods, and health outcomes, particularly among women and children [30]. In urban areas, inadequate access to clean water leads to waterborne diseases, economic losses, and social unrest [31].

Solutions to Bridge the Gap: Addressing the gap between demand and supply of drinking water requires a multifaceted approach. Investments in water infrastructure, such as piped water supply systems and decentralized treatment plants, are crucial for improving access to clean water [32]. Promoting water conservation measures, including rainwater harvesting and efficient irrigation practices, can help optimize water use and mitigate scarcity [33]. Strengthening governance structures, enhancing community participation, and leveraging technology for water management are also essential for ensuring sustainable water supply [34]. By addressing the root causes of water scarcity, implementing sustainable solutions, and fostering collaboration among stakeholders, the country can overcome this challenge and build a resilient water future. However, concerted efforts, adequate investments, and effective policies are essential to translate aspirations into action and make clean water accessible to all.

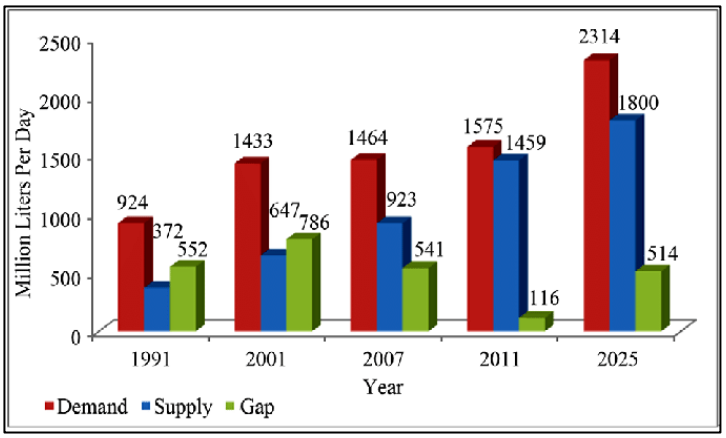


Figure 1.1 : Distribution Characteristics for The Gap Between the Demand & Supply in India

(Source : Bharathi, G. N., & Reddy, V. B. (2015). Demand and supply gap in water supply in Bangalore city [Image]. Retrieved from https://www.researchgate.net/figure/Demand-and-supply-gap-in-water-supply-in-Bangalore-city_fig2_274749780 *Consulted on 7th February, 2024)*

1.1.2 Carbon dioxide Emission

Alsadi et al. [35] suggested that the underground WDN works are the most recent large-scale works going in the USA. It is also one of the potential sources of Greenhouse Gas (GHG) emission. In the past, the open-cut pipeline installation method, involving the buried pipe excavation, was the only solution for replacing and renewing the pipeline. This procedure requires excavation to be performed very efficiently and accurately due to the existence of other utilities, including water pipes, cables, electrical power, gas pipes, and other obstacles adjacent to the wastewater pipe, which make the work time-consuming and difficult. This method, however, adversely impacts the day-to-day life and activities of people and businesses around the pipeline renewal project. These adverse impacts include breaking the road pavement, road closures, traffic delays, loss of access to businesses and homes, and unwanted noise and air pollution. Since the 1980s, various trenchless methods have been available that significantly reduce or eliminate the adverse problem. These methods involve replacing or installing a new pipe or renewing an existing failed pipe with minimal excavation and little or no surface and subsurface disruption. The GHG emission could be divided into four phases for this entire process viz, Fabrication phase, installation phase, operational phase and the disposal phase.

The fabrication phase includes all the energy consumption until the factory gate (material extraction, material production, and pipe fabrication), which is named the embodied energy. Based on Alsadi's study 2020, the weight of the resin in the CIPP pipe is almost two-thirds of the total weight of the CIPP lining, which means a small energy saving in producing the resin will help save energy in the fabrication phase of CIPP.

The installation stage's major construction activities are transporting pipes and equipment to a job site, excavation, loading, backfilling, compaction, and repaving. The installation phase is divided into three categories: transport pipe and equipment to jobsite, pipeline installation, and backfill and repaving. Asphalt pavement is more inexpensive compared to concrete pavement, but the asphalt has higher carbon emissions

The operation phase can be classified into three categories when accounting for the CO_2emissions: pumping energy, pipe cleaning, and pipe repair. For a pressure pipeline, wastewater needs to be pumped to a certain pressure and flow rate using pumps, which involve energy consumption and CO_2 emissions.

The pipeline requires repair and maintenance over the pipeline's life service. Therefore, in the same pipe diameter: a smaller wall thickness results in a smaller pump size, which will reduce the CO_2emissions during the operation phase. For a 91 cm (36 in) pipe diameter with a 30 m (100 ft) long section under 690 kPa (100 psi) pressure, PVC pipe emits the least carbon compared to HDPE, and that is due to the smaller wall thickness of the PVC pipe for the same diameters.

1.2 The Study Area

In this case study, a hydraulic zone (named HZ 11) of Haroa, Rajarhat, North 24 parganas of West Bengal has been taken. The total area and population as per 2011 counting are 34990.65 Ha and 7222 respectively. The population density has been evaluated as 16.88 people/Ha.

it is located at the eastern bank of river Ganges and bordered by the two mentioned districts. The nearest water treatment plant is 33.75 km from Haroa. The nearest railway station, Sealdah is 12 km away from this plant and the airport at Dumdum, Kolkata is 13 km away. The entire town and its surrounding areas are located on flat plains with alluvial soil. The general slope of the town is from North to South.

The location of the study area is shown in the figure 1.2.

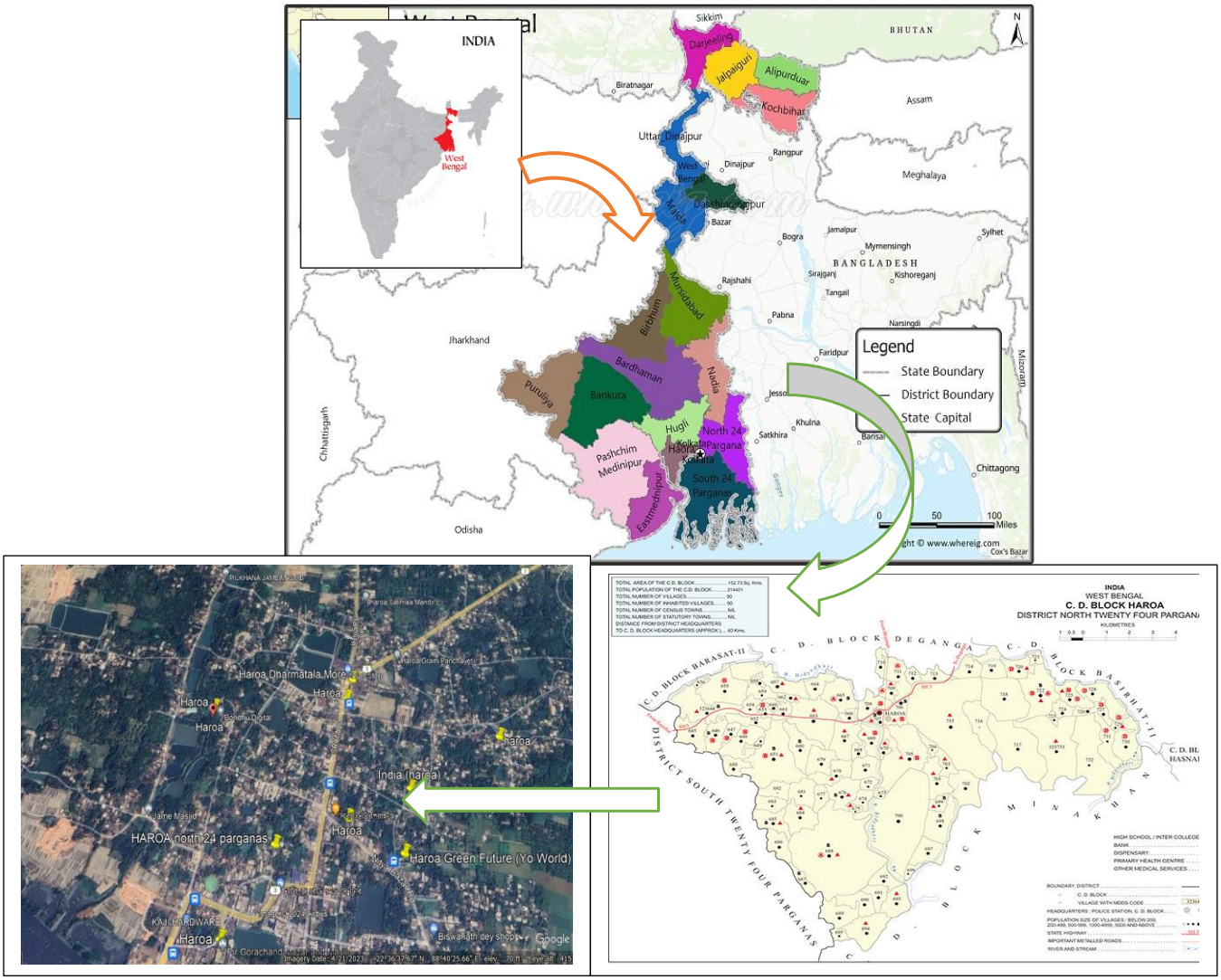


Figure 1.2 : Tangible Road Map of The Study Area

1.3 Research Gap

Despite the significant advancements in water distribution system (WDS) design, current approaches often rely on deterministic models that do not adequately account for the uncertainties associated with climate change and urbanization. These models fail to provide robust solutions capable of adapting to fluctuating water volumes at the source and varying water demands. There is a pressing need for simulation-based methodologies that incorporate probabilistic analyses, such as Monte Carlo simulations, to enhance the reliability and climate resilience of WDS, especially in urban areas like Haroa, where water scarcity and supply shortages are critical issues.

1.3 Objective of The Study

The primary objective of this research is to develop a climate-adaptive and reliable water distribution network for sustainable urban water management using WaterGEMS software. This study aims to optimize the water distribution network in Haroa, evaluate the suitability and sensitivity of different pipe materials in terms of climate resilience, and minimize the carbon footprint of the chosen materials. By incorporating probabilistic analysis and real-world conditions into the design process, this research seeks to ensure the robustness of the WDS under various climatic scenarios and urbanization pressures.

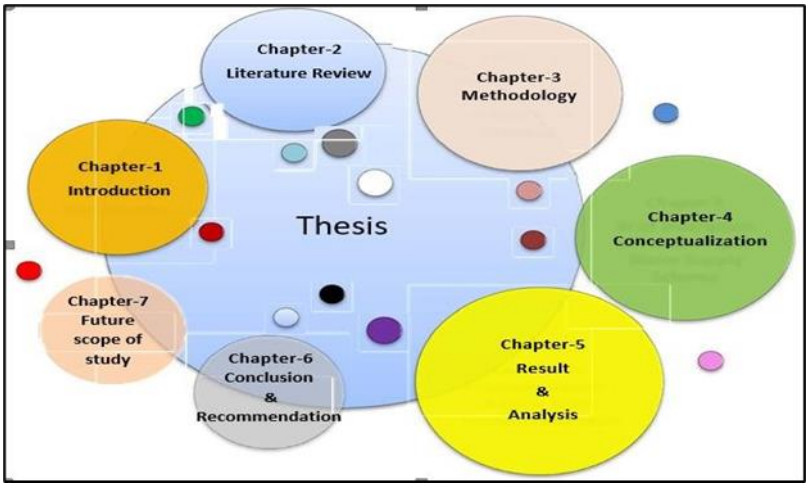
1.4 Proposed Outcome of The Study

The following are the research outputs:

- To integrate and develop an optimized water distribution network in the study area.
- To choose a pipe material to deduce the carbon footprint.
- To maintain a network for climate resilience.

1.5 Outline of The Thesis

The thesis consists of seven chapters. The references are given at the end of the thesis.



Chapter 1 : Introduction
Chapter 2 : Literature Review
Chapter 3 : Methodology
Chapter 4 : Conceptualization
Chapter 5 : Result & Analysis
Chapter 6 : Conclusion
Chapter 7 : Future Scope of Study

Chapter 2

2 Literature Review

A literature review is an overview of previously published works on a specific topic. It can be a full scholarly paper or a section of a larger work, such as a book or article. The purpose of a literature review is to provide a comprehensive image of the existing knowledge on the topic for both the researcher and the audience. It helps ensure that the research question is properly framed and that the appropriate theoretical framework and methodology are chosen. A literature review situates the current study within the relevant body of literature and provides context for the reader, typically preceding the methodology and results sections.
Producing a literature review is a common task for graduate and post-graduate students as part of their thesis, dissertation, or journal articles. It is also a standard component of research proposals or prospectuses. As a type of review article, a literature review presents the current knowledge, including substantive findings and theoretical and methodological contributions to a particular topic. These reviews are secondary sources and do not report new experimental work. Literature reviews are essential in nearly every academic field and are commonly found in academic journals, distinct from book reviews.

Cassottana B et al. (2023) explored an innovative approach to designing water distribution systems that are both resilient and economically viable. The study demonstrated the vulnerabilities of traditional water distribution systems to various hazards, such as natural disasters, climate change, aging infrastructure, and operational failures, can provide insights into the need for resilient design approaches. It also focused on the economic viability of water infrastructure design, as it influences project feasibility, funding allocation, and long-term sustainability by exploring cost-benefit analysis methodologies, life-cycle costing approaches, and economic evaluation techniques commonly used in the water sector to assess the economic performance of infrastructure projects.

Dave T et al. (2020) presented an innovative approach to designing water distribution networks that draw inspiration from ecological principles to enhance robustness. This paper explored the concept of ecologically-inspired design principles in the context of water infrastructure, emphasizing the importance of mimicking natural systems and processes to improve resilience and sustainability and demonstrated the application of ecological concepts, such as biodiversity, self-organization, adaptability, and feedback mechanisms, in engineering design can provide insights into innovative approaches for water distribution network design. It proposed the integration of nature-based solutions (NBS) into water distribution network design to enhance robustness and ecological sustainability. The study also examined the factors that contribute to the robustness of water systems, such as redundancy, flexibility, modularity, and diversity, can inform the development of ecologically-inspired design strategies.

Kadhim NR et al. (2021) presented a study on the hydraulic analysis and modeling of a water distribution network in the AL-Karada area. The study demonstrates the use of hydraulic modeling software such as WATERCAD, EPANET, and SWMM in assessing network hydraulics, pressure distribution, flow rates, and water quality parameters can be included. This paper utilized Geographic Information Systems (GIS) for spatial data analysis and visualization in water distribution network modeling for planning, including data collection, network digitization, spatial analysis, and decision support for infrastructure management.

Hajibabaei M et al. (2020) addressed the environmental implications of construction and renovation activities in water distribution networks, with a focus on uncertainty analysis. The study demonstrated the environmental footprint of infrastructure materials, energy consumption, greenhouse gas emissions, water quality degradation, and habitat disruption can be included. The paper employs Life Cycle Assessment (LCA) methodologies to quantify the environmental impacts of water distribution network construction and renovation and incorporated uncertainty analysis techniques to account for variability and uncertainty in environmental impact assessments

of water distribution network projects. So, solve the problem it is required some planning such as regulatory requirements, sustainability goals, stakeholder preferences, and cost-effectiveness should be addressed, along with strategies for integrating environmental considerations into project planning and management.

Shuang Q et al. (2014) investigates the performance and reliability of water distribution systems (WDS) under cascading failures, with a focus on identifying crucial pipes. The paper demonstrated the causes and consequences of cascading failures, including pipe bursts, leaks, pump failures, and pressure fluctuations, can be included. This paper conducted performance and reliability analysis of water distribution systems to assess their robustness and resilience against cascading failures and identified crucial pipes in water distribution systems that are most critical for maintaining system functionality and minimizing the impacts of cascading failures. it examples of successful projects that have implemented resilience-enhancing measures and mitigated the impacts of cascading failures can be included to highlight their benefits and lessons learned.

Li Y et al. (2021) investigated a comprehensive overview of the research landscape related to water distribution systems. This paper traced the historical development of research on water distribution systems, starting from early studies to recent advancements. That included milestones in engineering, technology, and management practices related to water distribution and identified the main research areas and topics covered in studies related to water distribution systems. This may include network optimization, hydraulic modeling, water quality management, leakage detection, asset management, and resilience analysis. The methodology involves numerical modeling, simulation techniques, data analytics, optimization algorithms, and field experimentation. The use of smart sensors, Internet of Things (IoT) devices, remote sensing technologies, and advanced data analytics for system monitoring and control are suggested in this paper.

Roy PK et al. (2015) presented a study on the development and hydraulic analysis of a proposed drinking water distribution network and their importance in ensuring access to safe and reliable drinking water, and the challenges associated with their design, operation, and management. The importance of Geographic Information Systems (GIS) in water infrastructure planning, including data collection, spatial analysis, network design, asset management, and decision support systems is discussed here. The software tools such as WaterGEMS for simulating hydraulic behavior, pressure distribution, flow rates, and water quality parameters was applied here. This integrated approach allows for spatially explicit analysis and visualization of network characteristics, facilitating informed decision-making. The case studies which can demonstrate the effectiveness of the integrated approach in addressing real-world challenges and improving system performance was discussed here. This may include considerations related to data accuracy, model calibration, computational complexity, and stakeholder engagement.

Lee S et al. (2020) presented a thorough examination of quantitative measures of sustainability applied to water distribution systems. Here, the concept of sustainability in the context of water distribution systems is discussed. This includes defining sustainability and its dimensions (e.g., environmental, social, economic), as well as identifying key indicators used to assess sustainability. The paper explored the various quantitative measures and indicators used to assess the sustainability of water distribution systems. This may include metrics related to water quality, water quantity, energy consumption, greenhouse gas emissions, infrastructure resilience, economic viability, and social equity. The methodologies and tools employed to conduct sustainability assessments of water distribution systems involves life cycle assessment (LCA), multi-criteria decision analysis (MCDA), cost-benefit analysis (CBA), environmental impact assessment (EIA), and other quantitative modeling approaches. The paper highlighted the studies that have integrated sustainability principles into the design, operation, and management of water distribution systems. This may include approaches for optimizing network layout, minimizing water losses, enhancing energy efficiency, promoting water reuse, and improving social inclusivity. This work shows the limitations associated with quantifying sustainability in water distribution systems. This could include issues related to data availability, uncertainty in modeling, conflicting objectives, and trade-offs between sustainability dimensions.

Shuang Q et al. (2019) presented a comprehensive review of quantitative methods for assessing resilience in water distribution networks (WDNs). The paper defined resilience in the context of WDNs, emphasizing the ability of a system to withstand and recover from disturbances while maintaining essential functions. The exploration of the various quantitative metrics and indicators used to assess resilience in WDNs is done in this paper. This may include measures of network connectivity, robustness, redundancy, recovery time, reliability, and adaptability. The study discussed the methodologies and analytical techniques employed to quantitatively assess resilience in WDNs. This involves mathematical modeling, network simulation, optimization algorithms, and statistical analysis. The paper provides case studies and practical applications where quantitative resilience methods have been applied to real-world WDNs. The comparison and contrast different quantitative resilience assessment methods in terms of their strengths, limitations, and applicability to different types of WDNs and operational scenarios is shown here.

Sirsant S et al. (2023) offered a detailed examination of the advancements in assessing the reliability of water distribution networks (WDNs). This aper defined reliability in the context of WDNs, emphasizing the ability of the system to consistently deliver adequate water supply under normal operating conditions and during emergencies. They conducted a bibliometric analysis to identify trends, patterns, and the evolution of research in assessing the reliability of WDNs. This analysis includes the identification of key authors, institutions, countries, and publication outlets, as well as the frequency of keywords and citation networks. This study explored the quantitative methods and techniques used to assess the reliability of WDNs. This may include probabilistic modeling, failure analysis, risk assessment, resilience analysis, and optimization algorithms. The technology and tools involve the use of sensor networks, remote monitoring systems, geographic information systems (GIS), hydraulic modeling software, and data analytics platforms. The paper examined the integration of reliability assessment with asset management and planning processes in WDNs. Explore how reliability metrics can inform decision-making related to infrastructure investment, maintenance prioritization, and risk mitigation strategies. This study provided insights into future research directions and emerging trends in the field of reliability assessment for WDNs. This included areas such as resilience-based design, real-time monitoring, predictive maintenance, and community-level risk assessment.

Zou H et al. (2020) presents a quantitative assessment framework for optimal water resources allocation considering reliability, resilience, and vulnerability indicators. The paper discusses the importance of effective water resources allocation and management in ensuring sustainable use of water resources, meeting competing demands, and addressing water scarcity challenges. The study defines the concepts of reliability, resilience, and vulnerability in the context of water resources systems. And how these indicators contribute to assessing the performance and robustness of water allocation strategies. It explores the quantitative methods and approaches used to assess reliability, resilience, and vulnerability in water resources systems which includes probabilistic modeling, scenario analysis, optimization algorithms, and sensitivity analysis. The integration of adaptive measures into the assessment framework for optimal water resources allocation which involves strategies for managing uncertainty, variability, and changing hydrological conditions through flexible infrastructure design, adaptive management practices, and decision support systems. The paper represents case studies or applications where the proposed assessment framework has been applied to real-world water resources allocation problems. The benefit includes considerations related to data availability, model complexity, stakeholder engagement, and institutional barriers. The research findings can inform decision-making processes related to water governance, infrastructure investment, risk management, and climate adaptation.

Gonzalez S et al. (2013) offers a comprehensive review of the presence of metals in drinking water distribution networks resulting from leaching of pipe materials. Here, the composition of commonly used pipe materials in drinking water distribution networks, such as iron, copper, lead, zinc, and plastics is discussed and the mechanisms through which metals can leach into the water, including corrosion, dissolution, and chemical reactions with water constituents is described. The factors that influence the extent and rate of metal leaching from pipe materials which include water quality parameters (e.g., pH, temperature, hardness), hydraulic

conditions (e.g., flow velocity, residence time), pipe age, and surface treatment is described in this paper. The paper also explores the potential health impacts associated with the presence of metals in drinking water, including acute and chronic toxicity, carcinogenicity, and bioaccumulation. They suggested to review regulatory standards and guidelines established by organizations such as the World Health Organization (WHO) and the Environmental Protection Agency (EPA) to limit metal concentrations in drinking water by grab sampling, continuous monitoring, laboratory analysis (e.g., atomic absorption spectrometry, inductively coupled plasma mass spectrometry), and computational modeling. They proposed mitigation strategies and treatment technologies employed to minimize metal leaching from pipe materials and reduce metal concentrations in drinking water. This could include corrosion control measures, pH adjustment, water conditioning, and the use of corrosion-resistant materials or coatings. The paper provides examples of case studies that have documented the presence of metals in drinking water distribution networks and evaluated their potential sources and impacts.

Sadiq M et al. (1997) investigates the influence of distribution network pipe material on the quality of drinking water. The composition and characteristics of commonly used pipe materials in distribution networks, such as iron, copper, galvanized steel, polyvinyl chloride (PVC), and asbestos-cement is discussed here by highlighting the potential for these materials to interact with water and influence its quality. The mechanisms of leaching and corrosion that occur between the pipe material and drinking water is described by the factors such as water chemistry, pH, temperature, and hydraulic conditions can affect the rate and extent of material release into the water. The paper shows the potential health implications of changes in water quality resulting from interactions with distribution network pipe material and suggests the review of relevant regulatory standards and guidelines established by organizations such as the Environmental Protection Agency (EPA) or the World Health Organization (WHO) to ensure the safety of drinking water.

Tamminen S et al. (2008) focuses on analyzing water quality performance in water supply systems with different pipe materials. The characteristics of various pipe materials commonly used in water supply systems, such as iron, steel, copper, PVC, and polyethylene is discussed here. Factors such as pipe age, material composition, surface roughness, and hydraulic conditions can affect water quality through processes such as corrosion, scaling, biofilm formation, and material leaching is shown here. The water quality parameters such as pH, turbidity, color, odor, taste, dissolved oxygen, disinfection by-products, metals, ions, and microbial contamination is discussed in the study. Water quality is analyzed by grab sampling, continuous monitoring, laboratory analysis (e.g., spectroscopy, chromatography), and computational modeling (e.g., water quality simulation). A comparison is done by findings related to differences in water quality parameters, spatial variability, temporal trends, and the influence of operational factors.

Alsadi AA et al. (2022) explores the optimization of carbon emissions reduction throughout the life cycle of force main pipe materials commonly used in water infrastructure. The paper discusses the methodology of life cycle assessment (LCA) used to evaluate the environmental impacts associated with different pipe materials over their entire life cycle, including raw material extraction, manufacturing, transportation, installation, operation, maintenance, and end-of-life disposal or recycling. Also, how carbon emissions contribute to climate change and the importance of reducing emissions from water system operations is discussed here. The properties, performance, and environmental considerations of commonly used materials for force main pipes, such as ductile iron, steel, polyvinyl chloride (PVC), high-density polyethylene (HDPE), and fiberglass-reinforced plastic (FRP) is discussed here. For reducing carbon emissions throughout the life cycle of force main pipe materials by material substitution, energy-efficient manufacturing processes, renewable energy sources, transportation optimization, operational improvements, and end-of-life recycling or reuse is proposed in this paper.

Alsadi A focuses on the evaluation of carbon footprint throughout the life cycle of four different pipe materials. The study aims to assess the environmental impacts associated with these materials and provide insights into their sustainability performance. Here, the methodology of life cycle assessment (LCA) is used to evaluate the carbon footprint of the selected pipe materials by highlighting the stages of the life cycle considered, including raw material extraction, manufacturing, transportation, installation, use, maintenance, and disposal. In this study, the four pipe materials selected for evaluation and their common applications in various infrastructure projects. This includes materials such as ductile iron, steel, polyvinyl chloride (PVC), high-density polyethylene (HDPE), or others. The carbon footprint associated with each stage of the life cycle for the selected pipe materials is quantified here and how carbon emissions are calculated, including direct emissions from manufacturing processes, indirect emissions from energy consumption, and embodied emissions from material production is discussed. A comparative analysis of the carbon footprint of the four different pipe materials is given for comparison and contrast their environmental impacts across various life cycle stages, considering factors such as energy intensity, resource consumption, emissions intensity, and waste generation.

Boulos et al. (2010) presented into the topic of the assessment of carbon footprints in water supply and distribution systems in the face of climate change and growing environmental concerns, examining methodologies and findings related to quantifying the carbon footprint of water infrastructure. They highlight the diverse methodologies employed to assess the carbon footprint of water supply and distribution systems. These include life cycle assessment (LCA), carbon accounting frameworks, and carbon intensity indicators. LCA, in particular, allows for a comprehensive analysis of carbon emissions associated with various stages of water infrastructure, from raw material extraction to end-of-life disposal. Other studies corroborate the effectiveness of LCA in capturing the environmental impacts of water systems. The study emphasizes the role of energy-intensive processes, such as pumping and treatment, in contributing to carbon emissions. The paper provides case studies and empirical findings from water utilities to illustrate the carbon footprint variability across different systems. Their analysis reveals considerable differences in carbon intensity among utilities, highlighting the importance of contextual factors and system characteristics. As there are several challenges persist, including data availability, methodological uncertainties, and system complexity, they call for standardized methodologies and data protocols to improve comparability and reliability of carbon footprint assessments. Furthermore, they highlight opportunities for reducing carbon emissions through technology upgrades, energy efficiency measures, and renewable energy integration.

Govindarajan et al. (2009) explored into the combined use of material flow analysis (MFA) and life cycle assessment (LCA) for analyzing wastewater pipeline networks. This study shows us that Material Flow Analysis (MFA) and Life Cycle Assessment (LCA) are two complementary methodologies used to evaluate resource flows and environmental impacts associated with infrastructure systems. MFA focuses on quantifying material flows within a system, including inputs, outputs, and stock accumulation, while LCA assesses the environmental impacts of a product or process throughout its entire life cycle, from extraction of raw materials to disposal. The integration of MFA and LCA allows for a comprehensive analysis of both material and environmental aspects of wastewater pipeline networks. They propose a methodological framework for combining MFA and LCA to analyze wastewater pipeline networks. Their approach involves mapping material flows through the pipeline network using MFA and assessing the environmental impacts associated with material use, energy consumption, and emissions using LCA. This integrated analysis enables researchers and practitioners to identify hotspots, quantify resource use and emissions, and evaluate the environmental performance of wastewater infrastructure. The study provides case studies and empirical findings from wastewater pipeline networks to illustrate the application of combined MFA-LCA methodology. Their analysis reveals significant resource inputs, energy consumption, and emissions associated with pipeline construction, operation, and maintenance. By identifying key drivers of environmental impacts, such as material use and energy consumption, the study offers insights into potential strategies for mitigating the environmental footprint of wastewater infrastructure. While the combined use of MFA and LCA offers valuable insights into the environmental impacts of wastewater pipeline networks, several challenges exist, including data availability,

methodological uncertainties, and system complexity. They acknowledge these challenges and call for standardized protocols and guidelines to improve the consistency and reliability of MFA-LCA assessments. Furthermore, they highlight opportunities for integrating sustainability criteria into decision-making processes, promoting resource efficiency and environmental stewardship in wastewater management.

Hendrickson et al. (2014) presented a perspective on the cost-effectiveness of greenhouse gas (GHG) reduction solutions in water distribution systems. Water distribution systems are significant contributors to GHG emissions due to energy-intensive operations, such as pumping, treatment, and distribution. They identify key challenges in assessing and mitigating GHG emissions from water infrastructure, including the variability of energy sources, system complexity, and competing sustainability objectives. Their study underscores the need for cost-effective strategies to reduce GHG emissions while ensuring reliable water supply and affordability. They review methodological approaches for evaluating the cost-effectiveness of GHG reduction solutions in water distribution systems. These approaches include life cycle assessment (LCA), economic analysis, and multi-criteria decision-making. LCA enables researchers to quantify the environmental impacts of water infrastructure, while economic analysis assesses the costs and benefits of GHG mitigation measures. Multi-criteria decision-making frameworks integrate environmental, economic, and social criteria to evaluate the overall sustainability of mitigation options. This presents case studies and empirical findings from water utilities to illustrate the cost-effectiveness of GHG reduction solutions. Their analysis highlights the variability in GHG emissions intensity among utilities and the importance of contextual factors, such as energy prices, technology availability, and regulatory frameworks. By identifying cost-effective mitigation measures, such as energy efficiency improvements and renewable energy integration, the study offers insights into strategies for achieving GHG reduction targets in water distribution systems. While cost-effectiveness analysis provides valuable insights into GHG mitigation strategies, several challenges exist, including data availability, uncertainty in cost estimates, and long-term planning considerations. They acknowledge these challenges and emphasize the importance of robust analytical frameworks and stakeholder engagement in decision-making processes. Furthermore, they highlight opportunities for leveraging co-benefits, such as energy savings and water conservation, to enhance the cost-effectiveness of GHG reduction solutions.

Piratla et al. (2012) focused on estimating CO_2 emissions from the life cycle of a potable water pipeline project. employ a life cycle assessment (LCA) methodology to quantify CO_2 emissions throughout the life cycle of a potable water pipeline project. LCA allows for the comprehensive analysis of environmental impacts associated with various stages of the project, including raw material extraction, manufacturing, transportation, installation, operation, and end-of-life disposal. By considering emissions from cradle to grave, LCA provides a holistic view of the project's carbon footprint. The study identifies key factors influencing CO2 emissions from potable water pipeline projects. These factors include material selection, construction methods, transportation distances, energy consumption, and maintenance practices. Their analysis highlights the importance of optimizing design and construction processes, selecting low-carbon materials, and minimizing energy use to reduce CO2 emissions over the project's life cycle. The paper presents a case study of a potable water pipeline project to illustrate the application of LCA methodology in estimating CO2 emissions. Their analysis quantifies emissions associated with various project components, such as pipe materials, construction equipment, and transportation vehicles. By identifying hotspots and emission sources, the study offers insights into potential mitigation strategies, such as using recycled materials, optimizing transportation routes, and implementing energy-efficient construction practices. While LCA provides valuable insights into the environmental impacts of potable water pipeline projects, several challenges exist, including data availability, uncertainty in emission factors, and system boundaries. They acknowledge these challenges and emphasize the need for standardized protocols and data sources to improve the accuracy and consistency of carbon footprint assessments. Furthermore, they highlight opportunities for integrating sustainability criteria into project planning and decision-making processes, promoting resource efficiency and environmental stewardship in water infrastructure projects.

Chapter 3

3 Methodology

This article will describe how the climate adaptive design has been made and the output has been simulated using WaterGEMS. The following flow chart (figure 3.1) represents the research method for feeding the input variables to the system.

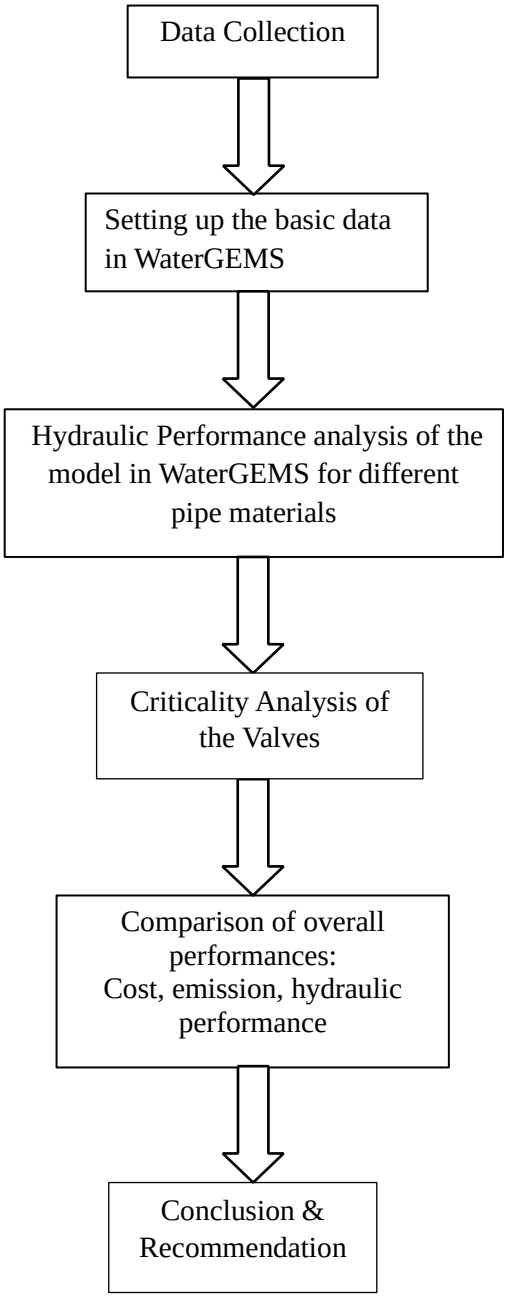


Figure 3.1 : Research Methodology

3.1 Brief Description of the Project

Water distribution networks play a critical role in ensuring the reliable and efficient supply of clean water to communities. One crucial aspect of designing and maintaining these networks is the selection of appropriate pipe materials. Choosing the right pipe material for a water distribution network is essential as it can significantly impact the performance and sustainability of the system. There are several factors to consider when evaluating different pipe materials for water distribution networks. These factors include head loss, residual pressure, cost, and carbon emissions. Understanding how each of these factors varies across different pipe materials can help in making informed decisions when designing and maintaining water distribution networks. In this essay, we will delve into the comparison of various pipe materials based on these important parameters, and discuss their implications for the performance and sustainability of water distribution systems.

- **Head Loss:**

  Head loss is a critical factor in the selection of pipe materials for water distribution networks. Different pipe materials exhibit varying levels of roughness, which directly impacts the head loss experienced as water flows through the pipes. For example, traditional materials like cast iron and concrete have higher roughness coefficients compared to newer materials like PVC and HDPE. This results in higher head losses and increased energy requirements for pumping water through the network. Therefore, careful consideration of head loss characteristics is crucial in optimizing the hydraulic efficiency of water distribution systems.

- **Residual Pressure:**

  Residual pressure, or the pressure remaining in the network during periods of low demand, is another important consideration when evaluating pipe materials. The choice of material affects the ability of the network to maintain adequate residual pressure, especially in areas with varying topography. While some materials may offer lower friction losses and better maintenance of residual pressure, others may be prone to deformation over time, impacting the overall system performance.

- **Cost and Carbon Emission:**

  In addition to hydraulic and performance considerations, cost and carbon emissions are integral aspects of material selection. While traditional materials like ductile iron may have higher upfront costs, their longevity and lower carbon footprint over their lifecycle can make them a more sustainable choice compared to materials like steel or copper. Evaluating the holistic cost and environmental impact of pipe materials is essential for ensuring the long-term sustainability of water distribution networks.

  By examining these factors, we can gain a comprehensive understanding of the implications of different pipe materials on the performance and sustainability of water distribution systems. This analysis can serve as a valuable guide for decision-makers involved in the design, construction, and maintenance of water distribution networks. In this work, proposal for a smart solution for water distribution network for the Indian scenario has been made.

3.2 Design Philosophy

The design philosophy which shall be the basis for the analysis of the water distribution network is described below. The study has been done based on the approved network (by concerned authority).

The design philosophy of using different pipe materials in water distribution networks plays a crucial role in ensuring efficient and sustainable water supply systems. By carefully selecting and utilizing the right pipe materials, engineers can optimize various factors such as head loss, residual pressure, cost, and carbon emissions. One of the key considerations in choosing pipe materials is their impact on head loss. Head loss refers to the reduction in pressure that occurs as water flows through a pipe. Material selection for water

distribution networks also greatly influences residual pressure, cost, and carbon emissions. Residual pressure is essential for maintaining adequate water flow and ensuring that all consumers receive reliable water supply. Different pipe materials have varying roughness coefficients and frictional characteristics that directly impact residual pressure. Additionally, the cost of the pipe materials and installation, as well as their environmental footprint in terms of carbon emissions, are significant considerations in the design philosophy.

In the following sections, a comprehensive comparison of various pipe materials such as PVC, ductile iron and HDPE will be presented, analyzing their performance in terms of head loss, residual pressure, cost, and carbon emissions. This comparative analysis will shed light on the advantages and limitations of each material, providing valuable insights for engineering decision-making in water distribution network design.

3.3 Design Procedure

3.3.1 Step: 1 – Data Collection

The AutoCAD drawing and necessary data which was required for the modelling of the distribution network was collected from an individual consultant. This network is approved by concerned authority for distributing drinking water at a hydraulic zone of Haroa.

Step: 2 – WaterGEMS Model Creation

3.3.2.a Overview and Modelling Capabilities of WaterGEMS Software

WaterGEMS stands for Water Geographic Engineering Modelling System that analyses, designs, and optimizes water distribution systems. It provides powerful tools and capabilities to model, simulate, and manage various aspects of water infrastructure.

a) Hydraulic Analysis

b) Perform a steady-state analysis for a snapshot view of the system, or perform an extended-period simulation to see how the system behaves over time.

c) Use any common friction method: Hazen-Williams, Darcy-Weisbach, or Manning's methods.

d) Take advantage of scenario management to see how your system reacts to different demand and physical conditions, including fire and emergency usage.

e) Control pressure and flow completely by using flexible valve configurations. You can automatically control pipe, valve, and pump status based on changes in system pressure (or based on the time of day). Control pumps, pipes, and valves based on any pressure junction or tank in the distribution system.

f) Perform automated fire flow analysis for any set of elements and zones in the network.

g) Calibrate your model manually, or use the Darwin Calibrator.

h) Generate capital and energy-cost estimates.

i) Compute system head curves.

j) Water Quality Analysis

k) Track the growth or decay of substances (such as chlorine) as they travel through the distribution network.

l) Determine the age of water anywhere in the network.

m) Identify source trends throughout the system.

An initial steady-state model of the required network can be created within WaterGEMS directly, using the advanced WaterGEMS Modeller interface, or import one from existing steady-state model created using other software.

WaterGEMS is efficient for laying out a water-transmission pipeline. It is easy to prepare a schematic model and WaterGEMS takes care of the link-node connectivity and element labels by assigning them automatically. For a schematic model only pipe lengths must be entered manually to complete the layout and also other additional data may required for some hydraulic elements prior to run.

- **Modelling Capabilities**

a) Steady-State/Extended Period Simulation

b) Global Demand and Roughness Adjustments

c) Check Data and Validate

d) Calculate Network

e) Flow Emitters

f) Parallel VSPs

g) Fire Flow Analysis

h) Water Quality Analysis

i) Calculation Options

j) Patterns

k) Controls

l) Active Topology

Detailed analysis and governing equations are discussed in the next chapter.

3.3.2.b Data Input in WaterGEMS Software

While creating a schematic drawing, pipe lengths are entered manually generally, except in the case of scaled and geo-referenced drawing, pipe lengths are automatically calculated from the position of the pipe bends and start and stop nodes on the drawing pane. The labels are also assigned automatically to pipes and nodes. There are several elements to be considered while creating a model such as Tanks, Pipes, Junctions, Hydrants, Tanks, Reservoirs, Pumps, Valves etc. The input parameters of some elements are discussed below:

- **Tanks:** Tanks are a type of Storage Node. A Storage Node is a special type of node where a free water surface exists, and the hydraulic head is the elevation of the water surface above some datum (usually sea level). The water surface elevation of a tank will change as water flows into or out of it during an extended period simulation. The primary input properties are (shown in figure 3.2):
  - Bottom elevation (where water level is zero)
  - Diameter (or shape, if non-cylindrical)
  - Initial, minimum and maximum water levels.

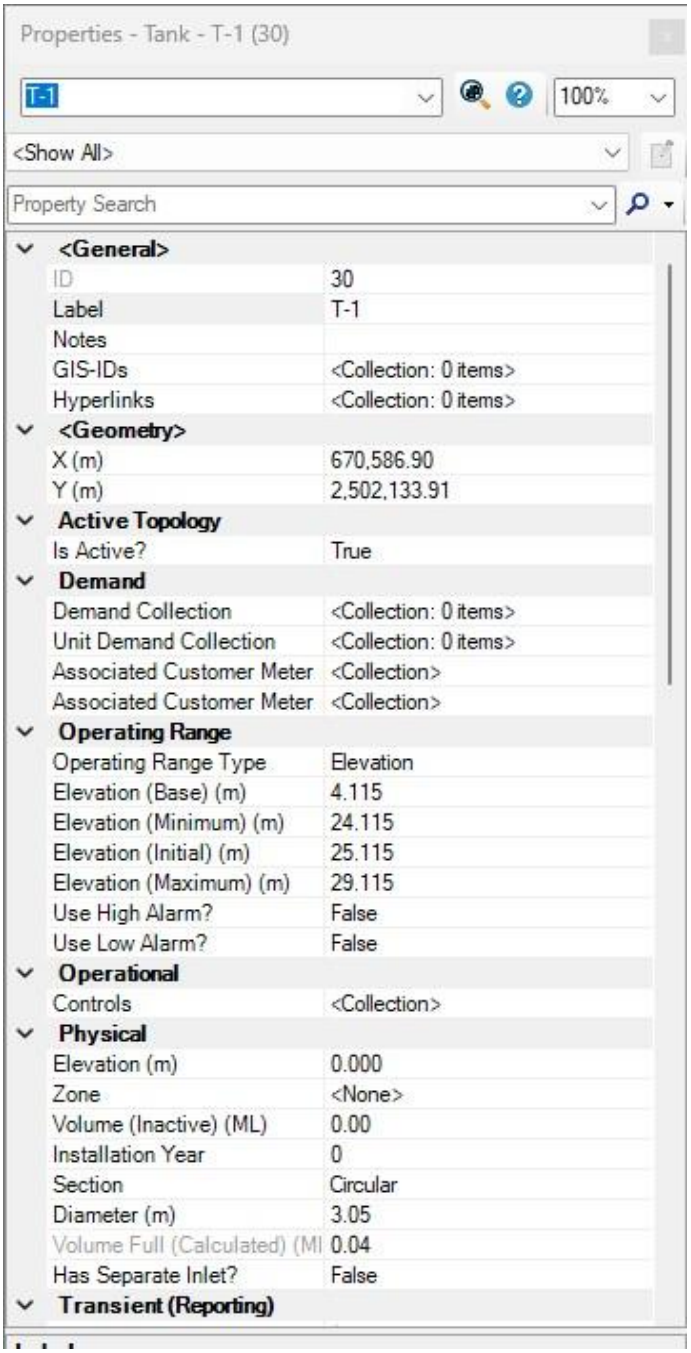


Figure 3.2 : Tank Input Fields

- **Pipes:** Pipes are link elements that connect junction nodes, pumps, valves, tanks, and reservoirs. Each pipe element must terminate in two end node elements. WaterGEMS assumes that all pipes are full at all times and flow direction is from the higher end of hydraulic head (internal energy per weight of water) to that at lower head. Figure 3.3 shows the input properties for pipes, which are:

  - Start and end nodes
  - Diameter
  - Length
  - Roughness co-efficient
  - Status (open, closed or contains a check valve)
  - The status parameter allows pipes to implicitly contain shutoff (gate) valves and check (non-return) valves (which allow flow in only one direction).

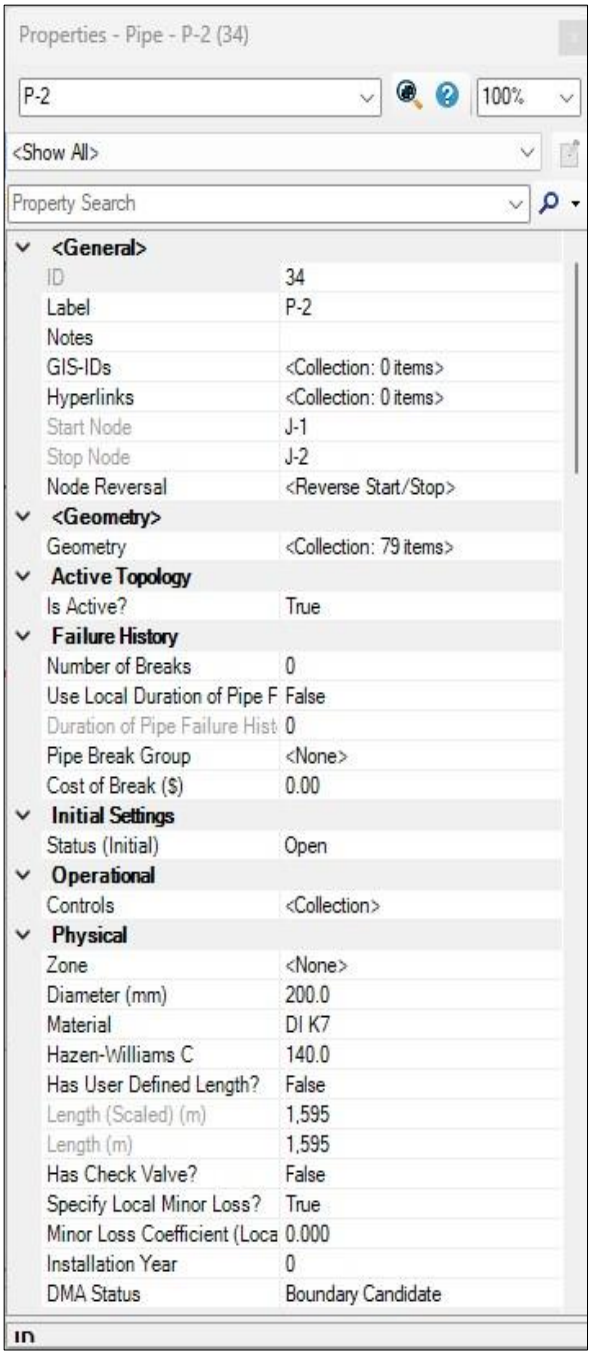


Figure 3.3 : Pipe Input Fields

- **Junctions:** Junctions are non-storage nodes where water can leave the network to satisfy consumer demands or enter the network as an inflow. Junctions are also where chemical constituents can enter the network. The basic input data (figure 3.4) required for junctions are:

  - Elevation above some reference (usually RL)
  - Water Demand (rate of withdrawal from the network)

  Junctions can also:

  - Have their demand vary with time
  - Have multiple categories of demands indicating that water is entering the network
  - Have negative demands indicating that water is entering the network
  - Be water quality sources where constituents enter the network
  - Contain emitters (or sprinklers) which make the outflow rate depend on the pressure.

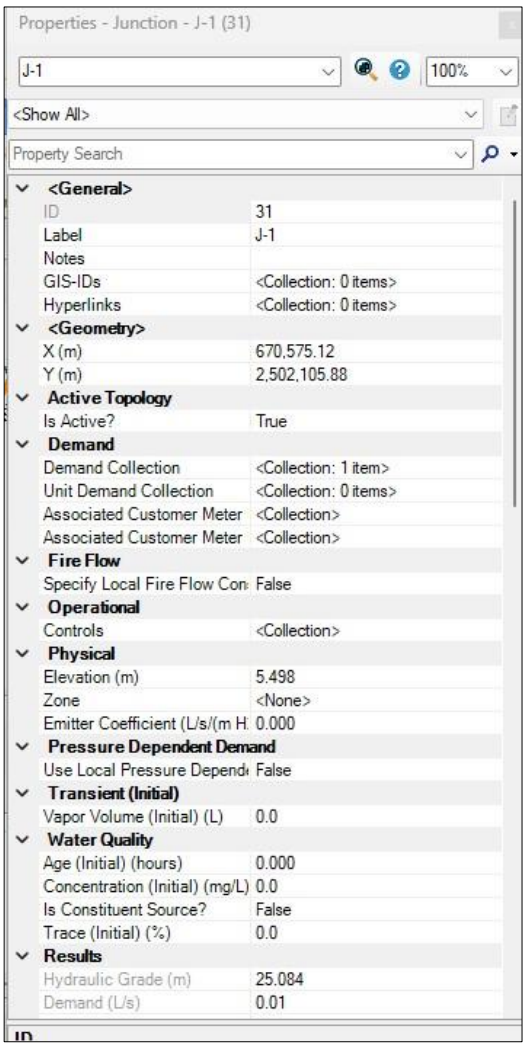


Figure 3.4 : Junction Input Fields

The discussions related to actual data used in the model are in the next chapter.

3.3.3 Step: 3 – Hydraulic Simulations & Optimization

After finishing the basemap and annotating all the modelling elements with necessary input data, the model has been computed using WaterGEMS V8i to optimize the distribution system for hydraulic analysis in steady state condition. An extended period simulation can also be done to see how the system behaves over time using any common friction equation like Hazen-William's, Darcy-Weisbach or Manning's.

We can also use scenario management to see how the system works to different demand and physical conditions, including fire and emergency usage.

Also, the pressure and flow can be completely controlled by using flexible valve configurations.

The design criteria has been applied to pipe connections to make DMA delineations to optimize the different parameters like unit head loss, velocity and residual pressure. Figure 3.5 gives us the calculation summary.

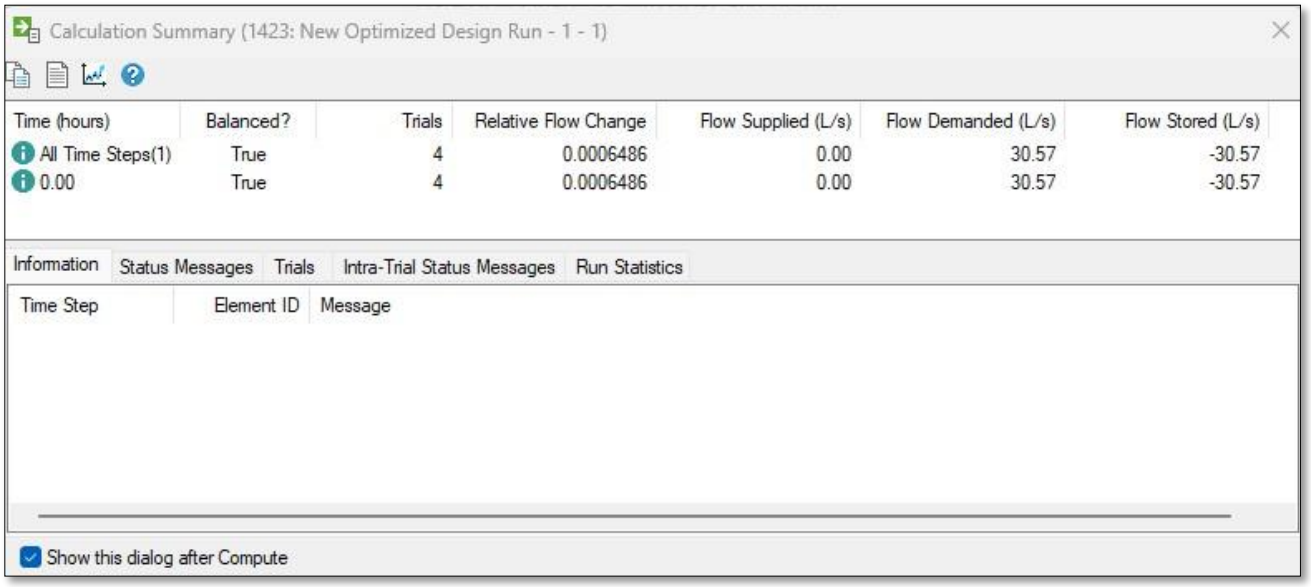


Figure 3.5 : Calculation Summary

3.3.4 Step 4 : Criticality Analysis

Criticality analysis is done by using the valves presented in the network. The demand amount of the nodes in the network sometimes is not met by the valve segments. This optimization is done by criticality analysis. Figure 3.6 shows the analysis table.

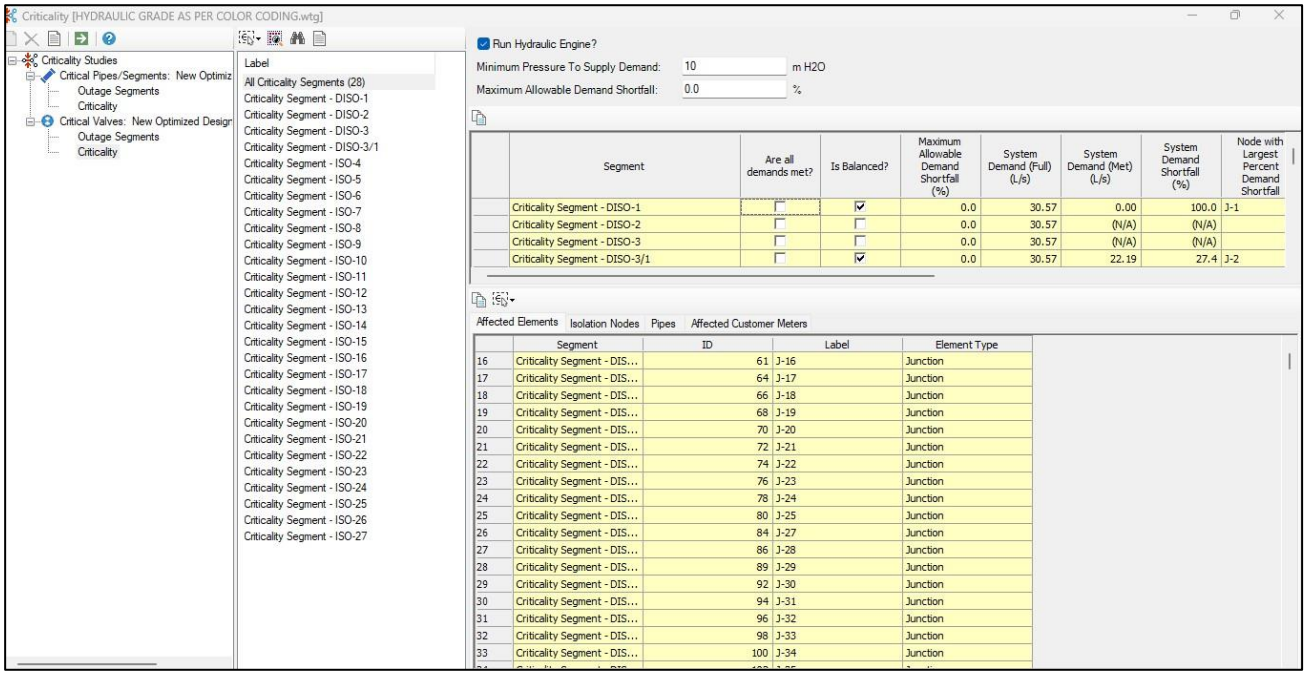


Figure 3.6 : Criticality Analysis

Chapter 4

4 Conceptualization

4.1 Evolution of Distribution Network Analysis

Drinking water distribution network (DWDN) analysis has evolved significantly over millennia, driven by human ingenuity, technological advancements, and scientific understanding. This essay traces the evolution of DWDN analysis from ancient civilizations to modern times, highlighting key milestones, methodologies, and contributions documented in scholarly journals.

Ancient Civilizations: Ancient civilizations, such as Mesopotamia, Egypt, and Rome, developed sophisticated water distribution systems to supply water to urban centers and agricultural fields. Archaeological evidence and historical texts, including Vitruvius' "De Architectura,"[36] provide insights into the design and operation of ancient aqueducts, pipelines, and reservoirs. These early hydraulic engineering feats laid the foundation for future developments in water distribution network analysis.

Renaissance and Early Modern Era: During the Renaissance and early modern era, advancements in mathematics, engineering, and hydrodynamics contributed to the development of hydraulic principles and empirical methods for analyzing water distribution networks. Leonardo da Vinci's sketches and writings on fluid mechanics and flow patterns in water systems exemplify the era's scientific inquiries into hydraulic phenomena.[37]

19th Century: The 19th century witnessed significant progress in water distribution network analysis, marked by the introduction of hydraulic formulas and empirical laws for calculating pipe flow, pressure losses, and network optimization. Notable contributions include Darcy's law for groundwater flow and Hazen-Williams equation for pipe flow, which provided practical tools for engineers to design and operate water distribution systems.[38]

20th Century: The 20th century saw the emergence of computer-based models and numerical methods for simulating water distribution networks. Landmark developments include the introduction of the Hardy-Cross method for iterative pipe flow analysis and the creation of EPANET software for hydraulic modeling of DWDNs. These technological innovations revolutionized network analysis, enabling engineers to conduct detailed simulations, optimize system performance, and assess water quality.[39]

21st Century: In the 21st century, advancements in sensor technologies, data analytics, and computational tools have transformed DWDN analysis. Real-time monitoring systems, remote sensing technologies, and machine learning algorithms enable water utilities to collect and analyze vast amounts of data on network operation, water quality, and asset condition. These innovations enhance decision-making, improve system resilience, and optimize resource allocation in water distribution networks [40]. Table 4.1 represents the software used in the modern days.

The evolution of drinking water distribution network analysis from ancient times to the present day reflects a journey of human innovation, scientific discovery, and technological progress. Through interdisciplinary collaboration and scholarly inquiry, researchers and engineers continue to advance the field, addressing contemporary challenges and striving to ensure the reliable delivery of safe drinking water to communities worldwide. From ancient aqueducts to modern sensor networks, the evolution of DWDN analysis underscores the importance of leveraging scientific knowledge and technological innovation to address the complex challenges of water management in the 21st century.

4.1.1 Evolution of Hydraulic Modelling

The evolution of hydraulic modeling for water distribution systems has undergone significant transformations over the decades. Initially, manual engineering calculations were relied upon for small-pipe systems until the 1960s. The Hardy-Cross method was commonly used for single-loop systems, but its practicality diminished for more complex systems with multiple loops. Attempts were made to simulate water distribution systems using electronic circuitry in the 1950s, but these physical models were cumbersome and expensive.

The advent of digital computer models in the 1960s marked a major advancement. Models developed in the FORTRAN programming language became accessible to engineers, offering increased efficiency and accuracy. Throughout the 1970s and 1980s, modeling software with extended period simulation and water quality analysis capabilities emerged. Graphical user interfaces were incorporated, enhancing system visualization and output display. These software packages were marketed as comprehensive solutions, containing various modular components.

In 1993 Lew Rossman, an environmental engineer at the USEPA's national research center in Cincinnati Ohio, developed EPANET, a freely available open-source program for both hydraulic and water quality modeling in water distribution systems. First released in 1993. The computational engine was written in C as well as a Microsoft Windows user interface written in Visual Basic. It used Todini's Global Gradient Algorithm as its hydraulic solver and the Discrete Volume Element Method [39] for its water quality solver. In 2000 EPANET 2.0 was released with many enhancements made to its C engine and a rewritten user interface in Delphi that allowed users to graphically edit their pipe network directly. Software packages were designed to integrate seamlessly with other standard software, such as AutoCAD and ArcView, facilitating data exchange and enhancing editing and drawing functions.

In 1996, Haestad Methods, a commercial company for water related software development adopted the hydraulic engine of EPANET with the release of WaterCAD which also provided a user-interface with AutoCAD. later release a companion product in

WaterGEMS which provided an interface with ESRI software like ArcGIS. In 2004, Haestad was acquired by Bentley System, Inc.

Currently, advancements in technology, including real-time instrumentation, faster computers, and high network bandwidth, have revolutionized water modeling software applications. The availability of vast amounts of data from multiple sources has expanded modeling capabilities to newer areas. Water leakage detection and management tools have been developed to reduce nonrevenue water, while pump scheduling optimization tools aid in energy management. These advancements underscore the ongoing evolution of hydraulic modeling, enabling more efficient and sustainable water distribution system management.[41]

Table 4.1: Summary of Common Water Distribution Modeling Software Programs

Software Program	Hydraulic Balancing Method	Head Loss Methods	Developer
EPANET	Gradient	Hazen-Williams, Darcy-Weisbach, or Manning	Environmental Protection Agency
lnfoWater, lnfoWater Pro, IWLive Pro, H20 Net	Gradient	Hazen-Williams, Darcy-Weisbach, or Manning	lnnovyze
MIKE+, MIKE OPERATIONS	Gradient	Hazen-Williams, Darcy-Weisbach, or Manning	DHI
Pipe Flow Expert	Linear Theory, Newton-Raphson, Newton-Raphson variant	Darcy-Weisbach	Daxesoft Ltd
WaterGEMS, WaterCAD, WaterOPS, WaterSight	Gradient	Hazen-Williams, Darcy-Weisbach, or Manning	Bentley Systems

4.1.2 Evolution of Pipe Material

Table 4.2 : Timeline of Evolution of Pipe Network

Pipe Material	Years of Evolution of Material
Clay Pipe	4000 BCE
Stone & Terracotta Pipe	3200-1100 BCE
Copper Alloys Pipe	2000 to 500 BC
Wooden Pipe	1800s
Fibre Pipes	1800s – mid 1900s
Cast Iron Pipes	1917 s – mid 2000s
Concrete Pipes	1942s
Ductile Iron Pipe	1950s
PVC	Late 1960s
HDPE, CIPP	1960s

Table 4.2 gives the evolution of pipe network with the changes of time over the year. [45]

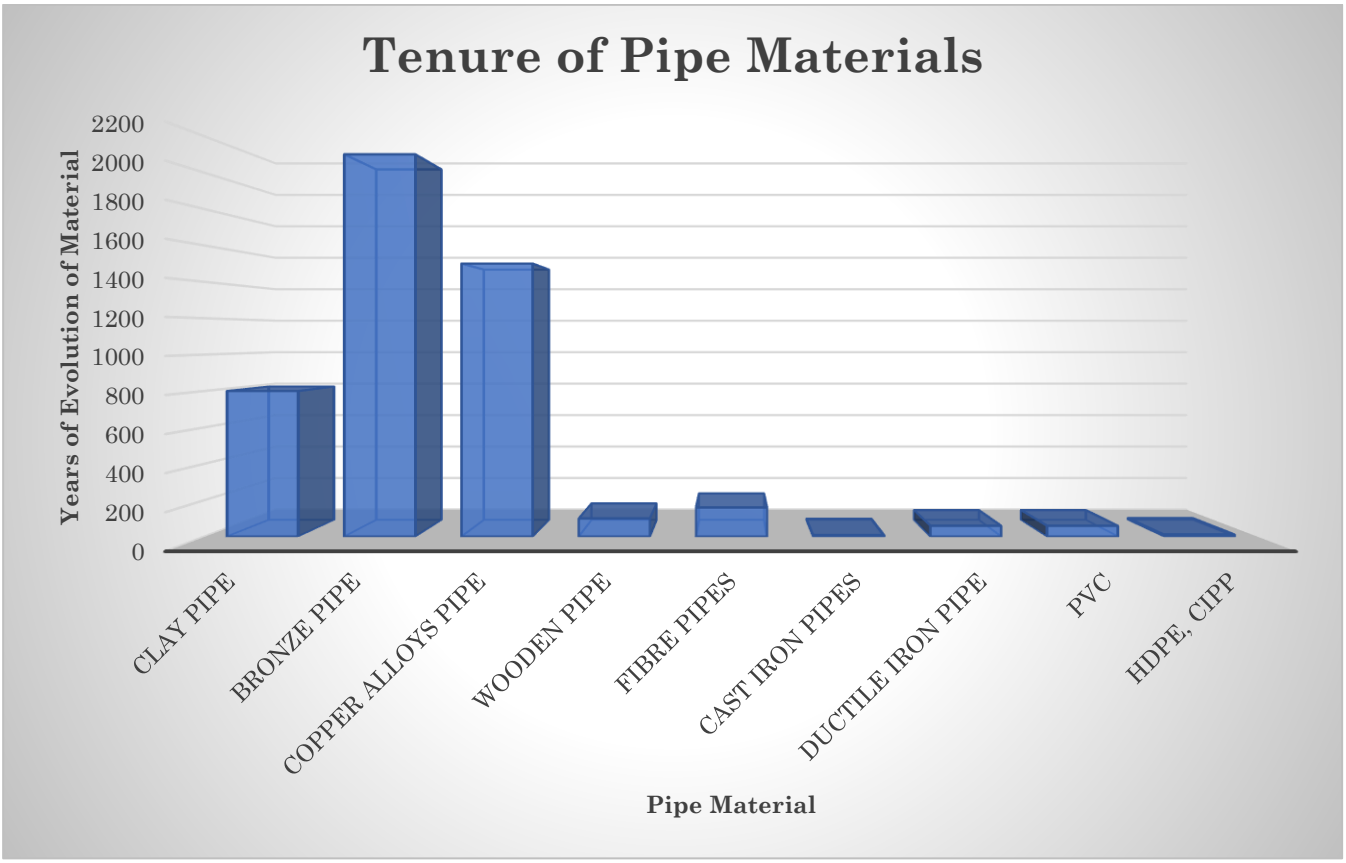


Figure 4.1: Tenure of Pipe Materials

(Source : Dutron Group. (2024). History of Concrete Pipes. Retrieved from https://www.dutronindia.com/elementor-3552/s, consulted on 15th March, 2024)

Figure 4.1 shows a bar chart representation of using year of different pipe materials.

4.2 Theory of Distribution Network Analysis

A DWDN contains a heavy deal of pipe networks. In order to design a pipe network successfully, like all design procedure, one must find the sources of the failures and losses of the system. If one is able to assess how much loss could be there in the DWDN, the designer would be able to evaluate the required pump input. The losses would also directly reflect the characteristics of the pipe materials, and the designer could assess which one need to be used.

- **Losses in a Pipe Flow:**

In a pipe flow there are two types of losses which are measured in terms of the net available head (energy per unit weight) of the fluid. These losses are:

- Major loss (Head loss due to friction)
- Minor losses

Head loss due to friction is called the major loss as it accounts for the major portion of the total loss of head in a flow through pipe. The following figure 4.2 would describe how frictional loss does take place in a pipe flow.

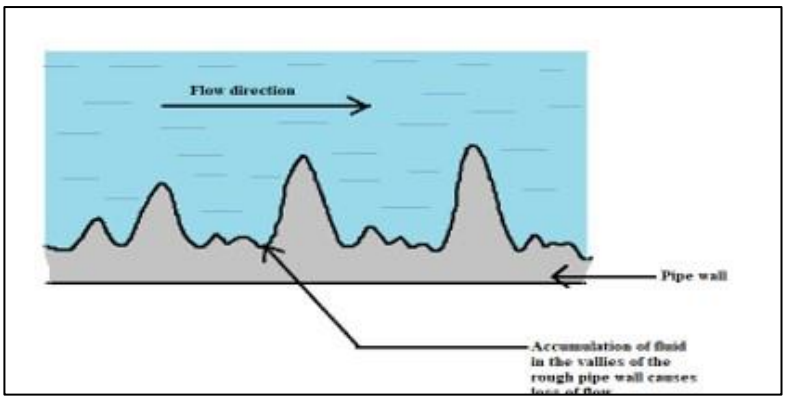


Figure 4.2 : Source of Flow Friction

In the Fig. 4.3 the source of pipe friction is shown. This theory is based on Nikkurade's experiment. The pipe wall which may appear to the observer as a smooth one but in reality, it has asperities as shown in the fig. in the form of peaks and vallies. This is commonly known as the surface roughness. When a fluid (incompressible in this case) is flowing through the pipe, part of it gets accumulated within the vallies, obstructed by high peaks. In order to maintain the flow rate which has been lost due to such accumulations, the fluid needs to spend more energy, which appears as the loss of head. The loss energy due to the pipe roughness is called the loss due to the friction.

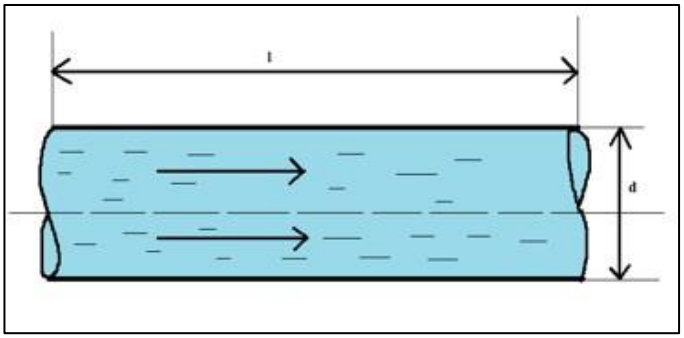


Figure 4.3 : Sample Pipe Dimensions

For a pipe of length 'l' and diameter (inner), 'd' the head loss due to friction is given by, the Darcy-Weisbach's equation, which is –

$$h_f = \frac{4flv^2}{2g \times d} \qquad \text{..... eq. (4.1)}$$

There exists another well-known equation for determining head lost due to friction, in pipes, called the Chazy's equation. However, Chazy's equation in combination with Manning's equation is largely suitable for the open channel flow analysis.

- **Coefficient of Friction:**

The coefficient of friction between the pipe and the fluid is very much dependent on the flow velocity. Actually, it is a function of a dimensionless parameter called the Reynolds' number (Re).

Reynolds' Number (Re): It is the ratio of inertial force of a flowing fluid to the viscous force exists within the fluid.

Mathematically it is represented by,

$$Re_x = \frac{\rho v x}{\mu} \qquad \text{..... eq. (4.2)}$$

Here 'x' is the characteristics length of the flow field. For a circular pipe, it is the diameter, 'd' of the pipe. $\mu$is the coefficient of viscosity or dynamic viscosity of the fluid.

For, 0 < Re < 2000, the flow is regarded as a laminar flow,

2000 < Re < 4000, the flow is said to be transitional one,

4000 < Re <~ 10^5, the flow is called the turbulent flow.

For, laminar flow,

$$f = \frac{16}{Re} \qquad \text{..... eq. (4.3)}$$

For, turbulent flow,

$$f = \frac{0.0791}{Re^{\frac{1}{4}}} \qquad \text{..... eq. (4.4)}$$

- **Pipe arrangements**

- **In nodes**

In DWDN there are nodes, where a set of pipes carry the flow to and a set of pipes from which a set of pipes carry the flow from. All these pipes are connected in parallel. In each node, the vector sum of all discharge is zero as, there is no storage of fluid in the nodes, but the sum of discharge of all the incoming fluid lines, equal the same of outgoing lines, as represented in the figure 4.4.

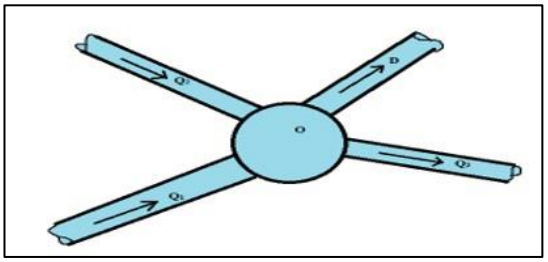


Figure 4.4 : Node Analysis

In the above arrangement, two pipes with flow rates Q_1 and, Q_2 are carrying fluid to the node O. There is a demand line D which accounts for the demand of the water from that node and another pipe taking away the remaining fluid of flow rate Q_3.

Thus, $$Q_1 + Q_2 = D + Q_3$$

$$\Rightarrow D = Q_1 + Q_2 - Q_3 \quad \text{..... eq. (4.5)}$$

Using the above expression the required demand discharge could be determined.

- **Series pipes:**

There might be cases where two or more pipes of different lengths and diameters are connected head to tail or better to say in series. The fluid simply flows through all these pipes in sequence and in this case the total head loss is the sum of individual head losses incurred individual pipes as shown in figure 4.5.

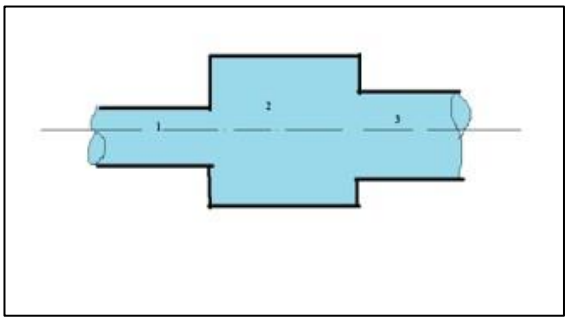


Figure 4.5 : Arrangement of Pipes in Series

In the aforesaid figure 4.6 there are three pipes marked as '1', '2' and, '3'. Let us say frictional head losses in the pipes are h_{f1}, h_{f2}, and, h_{f3} respectively. Thus, the total head loss in the pipe would be –

$$h_f = h_{f_1} + h_{f_2} + h_{f_3} \quad \text{..... eq. (4.6)}$$

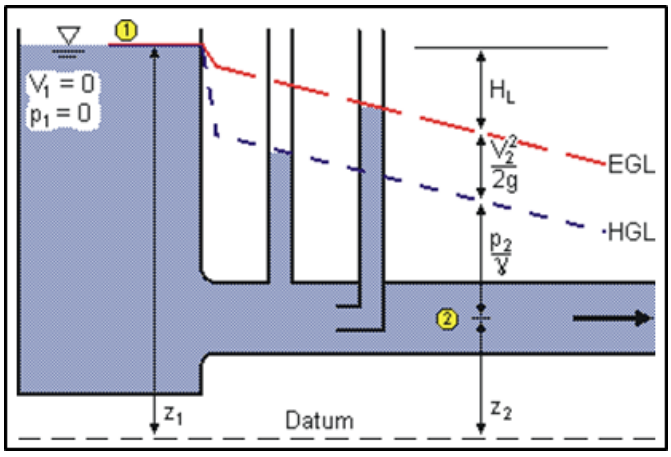


Figure 4.6 : Energy Gradient Line & Hydraulic Gradient Line

Assume, that the flow direction in the pipe is from junction (1) to (2) and its value is the pressure and elevation head and the mean velocity at (1) are p_1, z_1 and V_1 respectively, the total pressure, elevation head and mean velocity at (2) are p_2, z_2 and V_2 respectively, the total friction and fitting head losses from (1) and (2) are h_L, the pump's head is h_p, all heads in are in m for this system:

$$\frac{p_1}{\gamma} + z_1 + \frac{{V_1}^2}{2g} + h_p = \frac{p_2}{\gamma} + z_2 + \frac{{V_2}^2}{2g} + h_L \quad \text{..... eq. (4.7)}$$

❖ **Head loss Calculation:**

The hydraulic head loss by water flowing in pipe due to friction with the pipe walls can be computed using one of the three different formulas:

- Hazen-Williams Formula
- Darcy-Weisbach Formula
- Chazy-Manning Formula

The Hazen-Williams formula is the most commonly used headloss formula in the US. It cannot be used for liquids other than water and was originally developed for turbulent flow only. The Darcy-Weisbach formula is the most theoretically correct. It applies over all flow regimes and to all liquids. The Chezy-Manning formula is more commonly used for open channel flow. Each formula uses the following equation to compute headloss between the start and end node of the pipe:

$$h_L = AqB \quad \ldots\ldots\ldots\ldots \quad \text{eq. (4.8)}$$

where, h_L = head loss (length), q = flow rate (volume/time), A = resistance coefficient and B = flow exponent

Table 4.3 : Co-efficient in Different Equation

Formula	Resistance Coefficient (A)	Flow Exponent (B)
Hazen-Williams	$469.855\ C^{-1.852}\ d^{-4.871}\ L^{1.852}$	1.852
Darcy-Weisbach	$2.9197\ f(\in, d, q)\ d^{-5}\ L^{2}$	2
Chezy-Manning	$799\ l\ n^{2}\ d^{-5.33}\ L^{2}$	2

Notes: The symbols used in table 4.3 is referred below:

C = Hazen-Williams roughness coefficient

v = Darcy-Weisbach roughness coefficient (c)

f = friction factor (dependent on e, d and q)

n = Manning roughness coefficient

d = pipe diameter (m)

L = pipe length (m)

q = flow rate (m^3/s)

Table 4.4 : Co-efficient in Different Pipe Materials

Material	Hazen-William's C (unit less)	Darcy-Weisbach $\in$ ($m \times 10^{-3}$)	Manning's n (unit less)
Cast Iron	130 – 140	0.259	0.012 – 0.015
Concrete or Concrete Lined	120 – 140	0.3 - 3.0	0.012 – 0.017
Galvanized Iron	120	0.152	0.015 – 0.017
Plastic	140 – 150	0.002	0.011 – 0.017
Steel	140 – 150	0.046	0.015 -0.017
Vitrified Clay	110		0.013 – 0.015

The friction co-efficient of different pipe materials is shown in table 4.4.

❖ **Minor Losses:**

It has been observed that the head loss due to minor losses are all proportional to the kinetic head of the flow. Minor head losses (also called local losses) are caused by added turbulence that occurs at bends and fittings. The importance of including such losses depends on the layout of the network and the degree of accuracy required. They can be accounted for by assigning the pipe a minor loss coefficient.

Thus, one can empirically say that,

$$h_{minor\ loss} = k\frac{v^2}{2g} \ldots\ldots\ldots\ldots \text{ eq. (4.9)}$$

Where, k = minor loss coefficient, v = flow velocity (length/time) and g = acceleration due to gravity (length/time^2).

The value of the proportionality constant 'k' is different for different cases. These values are given in the following table:

Table 4.5 : Values of Loss Co-efficient

Sl. No.	Values of k for-	Values
1	Enlargement	1
2	Contraction	0.375
3	Obstruction	0.375
4	Entrance	1
5	Exit	0.5
6	Fitting	Different for different fittings
7	Bending	Different for different bend angles

The value of loss co-efficient is different in the various pipe condition which is shown in table 4.5.

Table 4.6 : Minor Loss Co-efficient

Fitting	Loss Co-efficient
Globe valve, fully open	10
Angle valve, fully open	5
Swing Check valve, fully open	2.5
Gate valve, fully open	0.2
Short-radius elbow	0.9
Medium-radius elbow	0.8
45-degree elbow	0.4
Closed return bend	2.2
Standard tee – flow through run	0.6
Standard tee – flow through branch	1.8
Square entrance	0.5
Exit	1

Table 4.6 shows the loss co-efficient for various fittings like valves, tees and bends.

4.3 Climate Resilience

Climate resilience refers to the capacity of individuals, communities, ecosystems, and systems to anticipate, prepare for, respond to, and recover from the impacts of climate change. It encompasses a range of adaptive strategies and measures aimed at building resilience to the adverse effects of climate variability and change, while also seizing opportunities for sustainable development.

A. Adaptation: Climate resilience involves implementing measures to adapt to changing climatic conditions and reduce vulnerability to climate-related risks. This may include enhancing infrastructure resilience, diversifying livelihoods, improving water management practices, and strengthening natural ecosystems to withstand climate impacts such as extreme weather events, sea-level rise, and shifting precipitation patterns.

B. Risk Reduction: Climate resilience entails reducing the underlying drivers of climate risk and enhancing preparedness for potential climate-related hazards. This involves identifying and addressing vulnerabilities, improving early warning systems, developing risk-informed land-use planning and building codes, and implementing measures to reduce exposure to climate-related disasters.

C. Capacity Building: Climate resilience requires building the capacity of individuals, communities, institutions, and governments to understand, respond to, and manage climate risks effectively. This includes enhancing knowledge and awareness of climate change impacts, promoting adaptive behavior and practices, fostering community engagement and participation, and strengthening governance mechanisms for climate resilience planning and implementation.

D. Integration: Climate resilience involves integrating climate considerations into decision-making processes across sectors and scales. This includes mainstreaming climate adaptation and resilience into development planning, policies, and investments, as well as promoting cross-sectoral collaboration and coordination to address interconnected climate and development challenges.

E. Flexibility and Innovation: Climate resilience requires fostering flexibility, innovation, and learning to adapt to evolving climate conditions and uncertainties. This involves embracing adaptive management approaches, experimenting with new technologies and practices, fostering social innovation and knowledge exchange, and leveraging traditional knowledge and indigenous practices for climate adaptation.

4.3.1 Application of Climate Resilience in Water Distribution System

Applying climate resilience in water distribution systems involves implementing a range of strategies and measures to enhance the system's ability to cope with and adapt to climate change impacts.

A. Risk Assessment and Vulnerability Analysis:

- Conduct a comprehensive risk assessment and vulnerability analysis to identify climate-related risks and vulnerabilities within the water distribution system.
- Assess potential impacts of climate change such as changes in precipitation patterns, increased frequency of extreme weather events, rising temperatures, and sea-level rise on water availability, water quality, infrastructure, and operations.

B. Infrastructure Resilience:

- Enhance the resilience of water infrastructure by designing, retrofitting, and upgrading distribution networks to withstand climate-related hazards such as floods, storms, droughts, and heatwaves.
- Implement nature-based solutions such as green infrastructure, rainwater harvesting, and permeable pavements to enhance water retention, reduce runoff, and mitigate urban heat island effects.

C. Water Supply Diversification:

- Diversify water sources and supply sources to reduce reliance on single water sources vulnerable to climate variability and change.
- Explore alternative water sources such as recycled water, desalinated water, groundwater recharge, and decentralized water systems to enhance water security and resilience.

D. Demand Management and Conservation:

- Promote water conservation measures and demand management strategies to reduce water consumption, optimize water use efficiency, and minimize stress on water resources.
- Implement water-efficient technologies, policies, and practices such as water-efficient fixtures, leak detection, metering, and pricing mechanisms to encourage responsible water use behavior.

E. Adaptive Management and Planning:

- Adopt adaptive management approaches and flexible planning processes to account for uncertainty and variability associated with climate change.
- Incorporate climate projections, scenarios, and risk assessments into long-term water resource planning, infrastructure design, and operational decision-making processes.

F. Community Engagement and Stakeholder Collaboration:

- Engage stakeholders, including water utilities, government agencies, communities, businesses, and NGOs, in climate resilience planning, decision-making, and implementation.
- Foster collaboration, partnerships, and knowledge-sharing platforms to exchange best practices, lessons learned, and innovative solutions for climate-resilient water management.

G. Capacity Building and Awareness Raising:

- Build capacity among water professionals, policymakers, and community members to understand, assess, and address climate-related risks and vulnerabilities in water distribution systems.
- Raise awareness about the importance of climate resilience, water conservation, and sustainable water management practices through education, outreach, and public awareness campaigns.

4.3 Theory of Reliability

Water distribution network reliability is the ability of the system to supply the required demand with sufficient pressure at normal and abnormal conditions.

The following definitions are adopted in the study:

- **Hydraulic reliability**, which describes the performance of the system to satisfy the required water demand.
- **Component reliability** is defined as the probability that a component has no failure during its life time.
- **Mechanical reliability**, which measures the effect of component failure on the system performance, mechanical reliability depends on both hydraulic reliability and component reliability.
- **Network/System reliability**, is the minimum mechanical reliability of all system components. For example, a single supply pipeline would have zero hydraulic reliability but 98% mechanical reliability if its probability of failure is 2%. If there are many cases of failure, then the network reliability is defined as the minimum mechanical reliability.

❖ **Applications of Reliability Theory:** Reliability theory finds applications across diverse fields and disciplines, including:

A. Engineering: In engineering, reliability theory is used to design and optimize systems, such as mechanical, electrical, and software systems, to ensure they meet performance requirements and safety standards.

B. Economics: In economics, reliability theory is applied to assess the reliability of financial systems, investment portfolios, and supply chains. It helps decision-makers evaluate risk, allocate resources efficiently, and optimize asset management strategies.

C. Healthcare: In healthcare, reliability theory is employed to improve patient safety, enhance the reliability of medical devices and equipment, and optimize healthcare delivery processes, such as scheduling, triage, and patient flow.

D. Psychology and Sociology: In psychology and sociology, reliability theory is utilized to assess the consistency and validity of measurement instruments, such as psychological tests and surveys. It helps researchers ensure the reliability of data and make meaningful interpretations of study findings.

❖ **Implications of Reliability Theory:** Reliability theory has several implications for practice and policy, including:

A. Risk Management: Reliability analysis helps organizations identify and mitigate risks associated with system failures, thereby improving safety, minimizing downtime, and protecting assets.

B. Quality Assurance: Reliability principles are integral to quality assurance processes, such as Six Sigma and Total Quality Management, which aim to optimize processes, reduce defects, and enhance customer satisfaction.

C. Regulatory Compliance: Regulatory agencies often require industries to adhere to reliability standards and guidelines to ensure the safety and reliability of products and services.

D. Sustainability: By optimizing the reliability of systems and processes, organizations can minimize resource consumption, reduce waste, and promote sustainability initiatives.

The theory of reliability is a multifaceted concept with broad-ranging applications and implications across various disciplines. By understanding the key concepts, applications, and implications of reliability theory, practitioners and policymakers can make informed decisions to enhance the performance, safety, and sustainability of systems and processes in their respective domains.

4.3.1 Application of Reliability in Water Distribution Network

Reliability theory finds significant application in the design, operation, and maintenance of water distribution networks.

A. **Design Phase:**

- **Component Selection:** Reliability theory helps in selecting robust materials and components for water distribution networks. Materials with high durability, resistance to corrosion, and minimal susceptibility to leaks are preferred to enhance the reliability of the network.
- **Redundancy Planning:** Reliability analysis guides the incorporation of redundancy into the network design. This involves installing backup components such as duplicate pipes, valves, and pumps to ensure uninterrupted water supply, even in the event of component failure or maintenance activities.

B. **Operation and Maintenance:**

- **Predictive Maintenance:** Reliability principles are applied to develop predictive maintenance schedules for water distribution networks. Predictive maintenance techniques, such as condition monitoring and performance forecasting, help identify potential failures before they occur, allowing for timely intervention and preventive measures.
- **Asset Management:** Reliability analysis aids in optimizing asset management strategies for water distribution networks. By assessing the probability of component failure and evaluating the consequences of failure, maintenance resources can be allocated more efficiently to critical infrastructure, minimizing downtime and maximizing system reliability.
- **Emergency Response Planning:** Reliability theory informs emergency response planning for water distribution networks. Contingency plans are developed to address unforeseen events such as pipe bursts, equipment failures, or natural disasters, ensuring prompt and effective responses to maintain water supply continuity.

C. **Performance Evaluation:**

- **Reliability Assessment:** Reliability analysis is used to assess the overall reliability of water distribution networks. Key performance indicators such as system reliability, availability, and resilience are evaluated to measure the network's ability to meet demand under normal operating conditions and during adverse events.
- **Failure Analysis:** Reliability theory facilitates failure analysis of water distribution networks. By analyzing historical failure data and identifying common failure modes, root causes of failures can be addressed through targeted interventions such as infrastructure upgrades, maintenance improvements, or policy changes.

D. **Risk Management:**

- **Risk Assessment:** Reliability principles are employed to assess risks associated with water distribution networks. Risk analysis identifies potential hazards, vulnerabilities, and consequences of system failures, enabling proactive risk mitigation measures to be implemented to minimize the likelihood and impact of adverse events.
- **Resilience Planning:** Reliability theory guides resilience planning for water distribution networks. Resilience strategies focus on enhancing the network's ability to withstand and recover from disruptions, such as improving redundancy, diversifying water sources, and integrating advanced monitoring and control systems.

4.4 Relationship between Climate Resilience, Reliability and Sustainability

- Climate resilience enhances the reliability and sustainability of water distribution networks by ensuring their ability to adapt to changing climate conditions and withstand climate-related risks.
- Reliability contributes to climate resilience by providing a stable and dependable water supply even under adverse conditions, thereby increasing the system's capacity to cope with climate variability and extremes.
- Sustainability considerations inform both climate resilience and reliability efforts, guiding the implementation of environmentally sound practices, resource-efficient technologies, and socially equitable policies to promote long-term system viability and resilience.

4.4 Application in WaterGEMS

WaterGEMS software, developed by Bentley Systems, is a powerful tool used for the analysis, design, and optimization of water distribution networks. It offers a wide range of features and capabilities that facilitate various applications in the management of water distribution systems.

It gives the choice between performing a steady-state analysis of the system or performing an extended-period simulation over any time period.

In steady state analysis, WaterGEMS computes the heads and flows for every pipe in the system. WaterGEMS automatically determines the friction factor, prior to the beginning of the transient calculations, based on the following information:

- WaterGEMS uses the friction co-efficient specified in the Pipe Physical Properties (Hazen-Williams, used in the study), if a pipe has zero flow at the initial steady state.
- Whereas, if a pipe has non zero flow at the initial steady state, WaterGEMS automatically calculates using Darcy-Weisbach friction co-efficient, based on the heads at each end of the pipe, length of pipe, diameter of the pipe and the flow in pipe.

4.5 Hydraulic Design in The Study Area

4.5.1 Criteria of the Design : Adherence to the CPHEEO Manual

The key design parameters are considered in accordance with the CPHEEO manual.

- **Design Population:**

As per Manual on Water Supply and Treatment Systems published by CPHEEO, the population projection for the North 24 Parganas District and South 24 Parganas District has been calculated using various methods such as Geometric Projection, Arithmetic Progression, and Incremental Increase Method. The most appropriate method, considering the actual situation, has been accepted for each district.

The design population for each district has been calculated based on the decadal growth rate from the census report of 2011, subject to a maximum increase of 20% and a minimum increase of 10% per decade. Specifically, the decadal growth rate for the North 24 Parganas District is 12.86%, and for the South 24 Parganas District, it is 8.05%. These growth rates have been taken into account for the scheme.

The design clear water demand from the Water Treatment Plant (WTP), as well as the design of the clear water rising main network, distribution network, Ground-Level Reservoir (GLR), and Overhead Reservoir (OHR), have been based on the projected design population (table 4.7) for the year 2046. This ensures that the water supply infrastructure is appropriately sized and designed to meet the future water demand of the growing population in both districts.

By utilizing population projection methods and considering the decadal growth rates, the water supply scheme can effectively plan for the future needs of the North 24 Parganas and South 24 Parganas Districts, ensuring reliable and sustainable water supply to meet the demands of the expanding population.

Table 4.7 : Design Population Calculation

Zones	Population (Census)	Design Population
	2011	2046
Detail Zoning of Haroa Block		
Zone - XI	7222	10473

- **Design Demand Calculation:**

It's commendable that the Public Health Engineering Department (PHED) of West Bengal has decided to provide 100% household connections through Piped Water Supply Schemes (PWSS) in rural areas, aligning with the latest guidelines of the National Rural Drinking Water Programme (NRDWP). This initiative reflects a commitment to ensuring access to safe and reliable drinking water for every rural household in the state.

The decision to adopt a per capita supply rate of 70 liters per capita per day (Lpcd), as recommended by the Central Public Health and Environmental Engineering Organisation (CPHEEO) manual and incorporated into the PHED guidelines, is crucial for ensuring that households receive an adequate and sustainable water supply. The calculation of water demand is shown in table 4.8.

Table 4.8 : Water Demand Calculation

Design Population	Demand (MLD)	Demand (lps)	Demand with Peak Factor (3) (lps)
Yr. 2046			
10473	0.815	9.43	28.29

- **Supply Hours:**

24 hours supply at steady state.

- **Minimum Residual Head:**

Minimum residual head is maintained as 17 - 21 as per clause 12.4.2 of the CPHEEO manual.

- **Minimum Velocity:**

Minimum velocity is maintained as 0.6 m/sec as per clause 6.6 of the CPHEEO Manual. However, where inevitable due to minimum pipe diameter criteria or other hydraulic constraints, lower velocities up to 0.3 m/s may be adopted with adequate provision for scouring.

- **Minimum Pipe Diameter:**

Table 4.9 : Types of Pipelines Used

DI K7		HDPE		uPVC	
Nominal Diameter (mm)	**Length (m)**	**Nominal Diameter (mm)**	**Length (m)**	**Nominal Diameter (mm)**	**Length (m)**
80	18,348	63	11,318	90	10,654
100	3,632	75	5,062	110	10,958
150	1,533	90	1,968	125	1,086
200	2724	110	3,632	140	404
250	31	140	1,533	200	3,146
		200	2,724	225	19
		250	31		

Table 4.6 shows the diameter which was taken as per respective IS Codes and the lengths required in the network.

- **Max. Unit Head Loss:**

  The maximum unit head loss is considered as 10 m/km as per the clause no. 6.6 of the CPHEEO manual.

- **Head Loss Analysis:**

  For head loss analysis Hazen Williams formula is considered.

- **Coefficient of Roughness:**

  The Hazen William's co-efficient "C" is taken as 140 for DI pipes and 145 for both HDPE and PVC as per the table 6.2 of 6.5.1.4 of the CPHEEO manual.

4.5.2 Nodal Demand Allocation

The consumption of water is indeed a pivotal factor influencing the hydraulic dynamics within water distribution systems. When modeling these dynamics, ensuring an accurate representation of system demands is as crucial as precisely modeling the physical components of the system.

To fully harness the potential of a water distribution model as a tool for master planning and decision support, it's essential to accurately allocate demands while also anticipating future demands. This involves regularly collecting relevant data and translating it into model loading data to reflect changes in network conditions over time. However, manually loading a model can be challenging and time-consuming, which is why automated techniques have been developed to assist modelers in this task.

One common approach to automating demand allocation is through spatial allocation, leveraging the spatial analysis capabilities of Geographic Information Systems (GIS). This approach utilizes geocoded meter data, demand density information, and coverage polygon intersections to distribute demands across the network accurately.

LoadBuilder is a tool that harnesses the spatial analysis abilities of GIS software to automate the demand allocation process. It streamlines tasks related to demand allocation and projection by enhancing every step of the loading process. From gathering and analyzing data from various sources and formats to employing different allocation strategies, LoadBuilder simplifies and enhances the demand allocation process.

The following are the types of allocation strategies that can be applied using LoadBuilder:

- Allocation
- Billing Meter Aggregation
- Distribution
- Projection

Allocation process is used in the study here. The process described, utilizes the spatial analysis capabilities of Geographic Information Systems (GIS) to assign geocoded customer meters to the nearest demand node or pipe within a water distribution network. Geocoded data contains coordinate information, such as x-y coordinates, which represent the physical location of the meters.

Assigning metered demands to nodes is a point-to-point demand allocation technique, where known point demands (customer meters) are directly assigned to network demand points (demand nodes). Similarly, assigning metered demands to pipes also follows a point-to-point assignment technique, but with an additional step involved. In the case of the Nearest Pipe meter assignment strategy, demands at a meter are initially assigned to the nearest pipe. Subsequently, the demand is distributed from the pipe to the nodes at the ends of

the pipe, utilizing a distribution strategy.

This approach simplifies the allocation process and requires minimal data input since service polygons are not necessary. The figure 4.7 below illustrates the simplicity of the meter assignment technique:

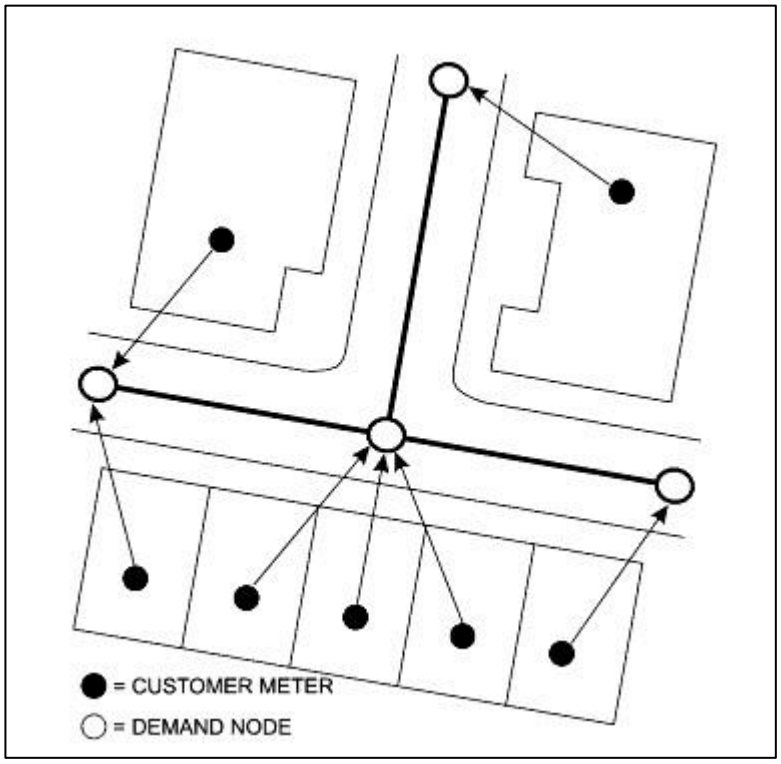


Figure 4.7 : Simplified Illustration of Meter Assignment Technique

(*Source: https://docs.bentley.com/LiveContent/web/Bentley%20WaterGEMS%20SS6-v1/en/GUID-9BC5F83952CC4C71ACE414899E1356B2.html , Consulted on 5th April, 2024)*

Overall, utilizing GIS spatial analysis capabilities for meter assignment ensures efficient allocation of demands within a water distribution network, enabling accurate representation of consumption patterns and facilitating informed decision-making in network management and planning.

4.5.3 Concept of DMA Delineation

After allocating the demand, the network is divided in District Metered Areas (DMA) considering the flow requirements for each such area.

A DMA is a sub-zone within an Operational Zone (OZ) of a water distribution network, capable of being hydraulically isolated and monitored using water meters. Bulk flow meters are installed at DMA entry points, and all user connections are properly metered to record consumption. Dividing the network into smaller DMAs enables better management of flow, pressure, and Non-Revenue Water (NRW).

The primary purpose of DMAs is to identify and prioritize leak identification and repair programs by computing NRW values. Additionally, DMAs facilitate the rational distribution of water according to demand with consistent pressure.

The design of DMAs involves several criteria and considerations:

- Size of DMA: Determined by the number of connections and the need for hydraulic isolation.
- Boundary valves: Required to isolate the DMA for maintenance or emergencies.
- Flow meters: Installed to measure inflows and outflows, especially in cascading DMAs.

- Ground level variations: Influence pressure variations within the DMA.
- Topographic features: Used as boundaries for DMAs.
- Maximum water demand, population, and grievances: Considered for DMA selection.

Ideally, each OZ served by an overhead tank should comprise a single DMA. However, in cases of wide supply zones or irregular topography, multiple DMAs may be necessary within the same OZ. DMAs are also designed within OZs to address high-pressure issues, with Pressure Reducing Valves (PRVs) sometimes employed to regulate pressure.

- Clustering: Allocating nodes of the network to form DMAs.
- Vectorization: Identifying pipes where isolation valves and flow meters need to be installed.
- Performance evaluation: Assessing the partitioned network in terms of pressure and available demand.

By adhering to these design principles and criteria, water authorities can effectively implement DMAs to optimize system performance, reduce water losses, and ensure reliable water supply to consumers.

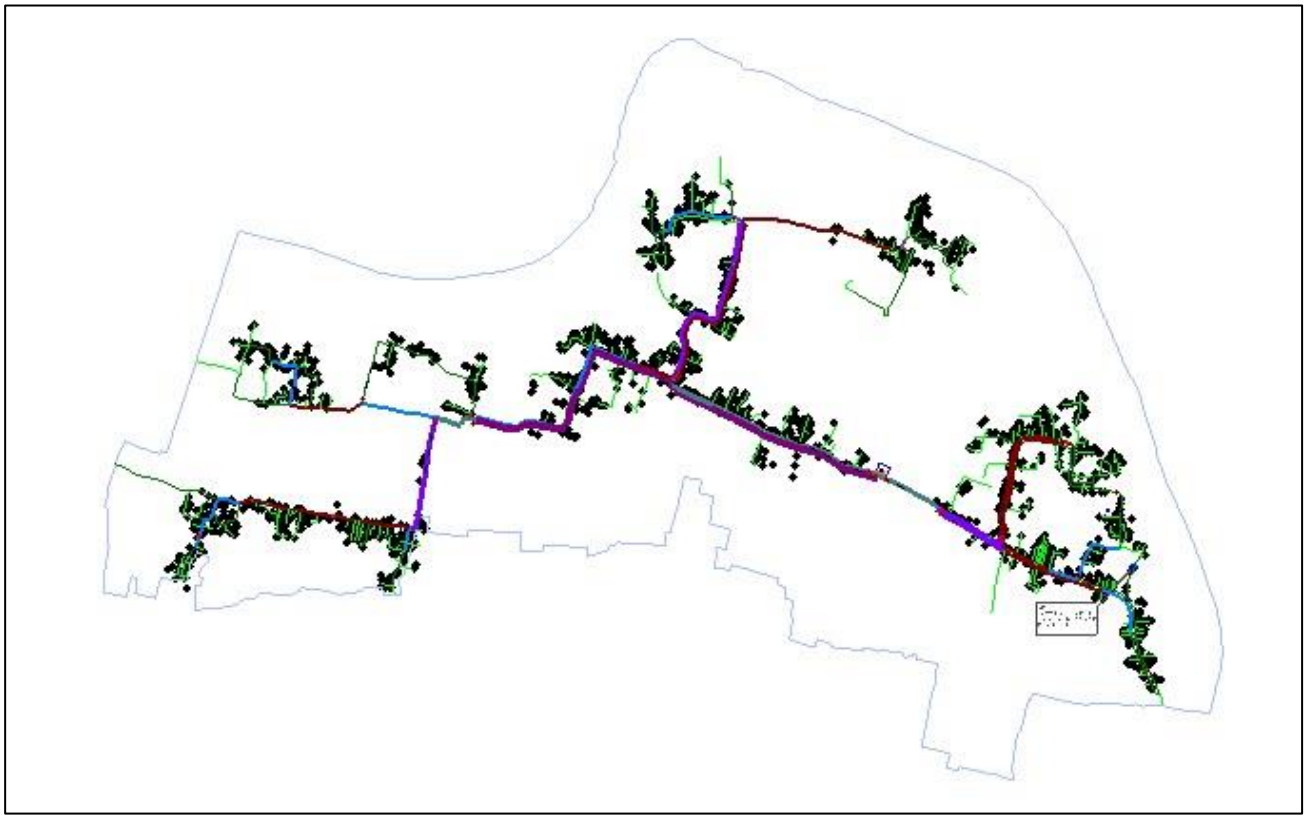


Figure 4.8 : Delineation of DMA

DMA of the utilized distribution zone in the study is shown in the figure 4.8.

4.5.4 Valves

To control, isolate and drain pipe sections for test, installation & maintenance purpose a number of appurtenances or auxiliaries are generally installed in the line adhered to clause no. 11.23 of the CPHEEO Manual.

Flow Control Valve, is designed to maintain a constant pre-set maximum flow regardless of fluctuating demand or varying system pressure. Flow limiting is required at the outlets from main systems to consumers like secondary systems (main line to hydrant line; hydrant line to distribution line), reservoirs, etc.

Butterfly Valve, a valve consisting of a rotating circular plate or a pair of hinged semicircular plates, attached to a transverse spindle and mounted inside a pipe in order to regulate or prevent flow. These valves are used where space is limited and can be used for throttling or regulating flow as well as in the full open and fully closed position. The pressure loss through a butterfly valve is small in comparison with the gate valve

Globe Valve, is an instrument used to stop and/or control the flow of fluids in a pipeline. It works by halting the flow of a fluid through a pipe. The name globe comes about due to the valve's cylindrical shape. There are usually two halves of the body within the globe valve that are separated by an internal baffle

Chapter 5

5 Result and Discussion

The chapter below report and discuss the results obtained from the study. After collecting and computing data of the distribution network of the study area, the parameters like pressure, flow, unit head loss and velocity of the network using different pipe materials have been computed by WaterGEMS V8i.

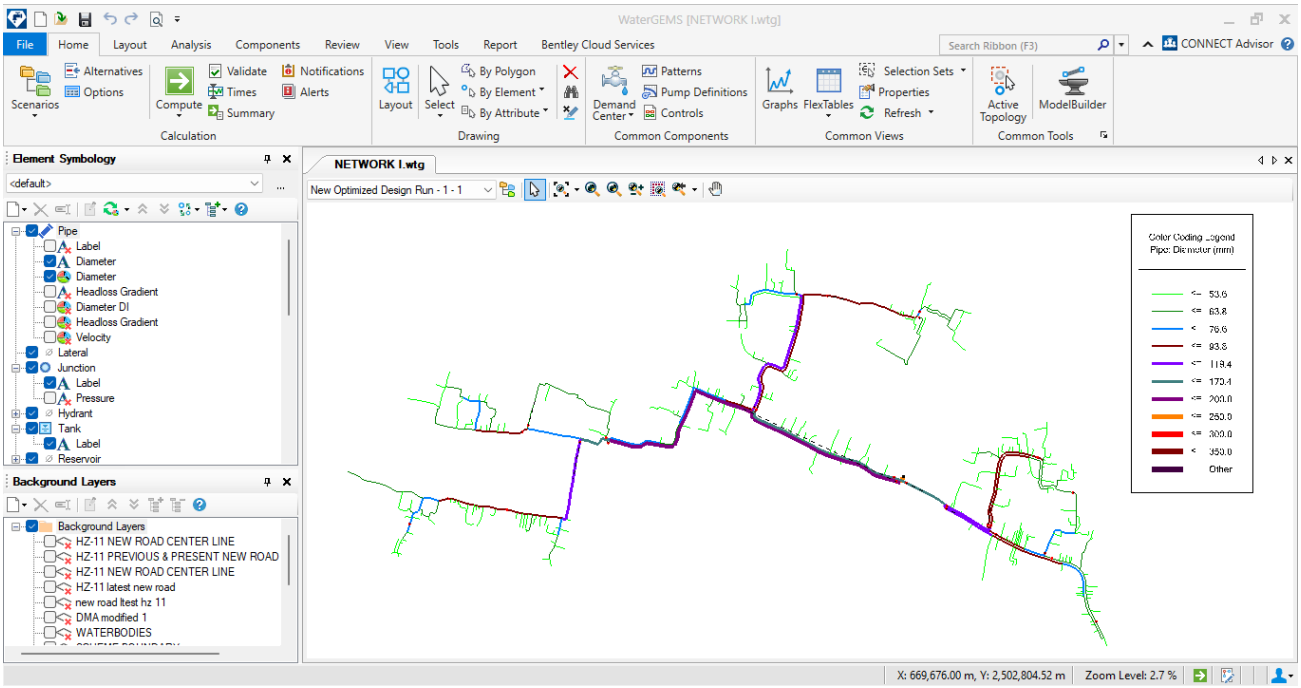


Figure 5.1 : Location of the Distribution Network in Project Area (Zone 11)

In this analysis, a network is taken as an example as shown in Figure 5.1, to run a comparison analysis using different pipe materials.

The existing network was a combination of DI K7 and HDPE. In the comparison, the whole network was designed with DI K7, HDPE and uPVC separately. The diameters were chosen as per IS codes.

Table 5.1 : Pipe Materials and their Corresponding Codes

Pipe Material	IS Code
Ductile Iron (DI)	IS 8329:2000
High Density Polyethylene (HDPE)	IS 4984:1995
uPVC (Unplasticized Polyvinyl Chloride)	IS 4985:2000

Table 5.1 represents the IS codes which are used to refer diameter, thickness and other characteristics of the pipe materials.

5.1 Chart for Minimum Residual Pressure of Different Pipe Materials

Table 5.2: Residual Pressure of the Existing Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
235	J-99	7.027	0.01	22.893	15.83
141	J-54	7.336	0.06	23.508	16.14
143	J-55	7.336	0.01	23.508	16.14
76	J-23	6.315	0.03	23.321	16.97
569	J-261	4.685	0.15	21.695	16.98
573	J-263	4.587	0.08	21.69	17.07
567	J-260	4.409	0.04	21.705	17.26
1517	J-461	4.409	0.13	21.708	17.26
571	J-262	4.353	0.04	21.694	17.31
549	J-251	4.49	0.02	21.877	17.35

Table 5.3: Residual Pressure of the DI Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
235	J-99	7.027	0.01	23.429	16.37
141	J-54	7.336	0.06	23.896	16.53
143	J-55	7.336	0.01	23.896	16.53
76	J-23	6.315	0.03	23.655	17.31
569	J-261	4.685	0.15	22.704	17.98
573	J-263	4.587	0.08	22.704	18.08
223	J-93	5.282	0.1	23.443	18.12
243	J-103	5.247	0.01	23.427	18.14
821	J-378	5.906	0.1	24.111	18.17
703	J-324	5.813	0	24.076	18.23

Table 5.4 : Residual Pressure of the HDPE Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
235	J-99	7.027	0.01	22.184	15.13
141	J-54	7.336	0.06	22.799	15.43
143	J-55	7.336	0.01	22.799	15.43
76	J-23	6.315	0.03	22.612	16.26
243	J-103	5.247	0.01	22.165	16.88
223	J-93	5.282	0.1	22.204	16.89
569	J-261	4.685	0.15	21.665	16.95
1594	J-476	5.136	0.06	22.165	16.99
229	J-96	5.156	0.09	22.193	17
573	J-263	4.587	0.08	21.66	17.04

Table 5.5 : Residual Pressure of the uPVC Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
235	J-99	7.027	0.01	22.316	15.26
141	J-54	7.336	0.06	22.668	15.3
143	J-55	7.336	0.01	22.668	15.3
223	J-93	5.282	0.1	22.32	17
243	J-103	5.247	0.01	22.315	17.03
229	J-96	5.156	0.09	22.317	17.13
1594	J-476	5.136	0.06	22.315	17.14
220	J-92	5.106	0.06	22.324	17.18
253	J-108	5.063	0.03	22.321	17.22
241	J-102	5.048	0.06	22.316	17.23

The tables 5.2, 5.3, 5.4 and 5.5 represents the minimum residual head at different nodes for different pipe materials for particular demands and hydraulic gradients. Here it shows that the minimum pressure has occurred at almost same nodes in DI and HDPE pipe network, than the PVC.

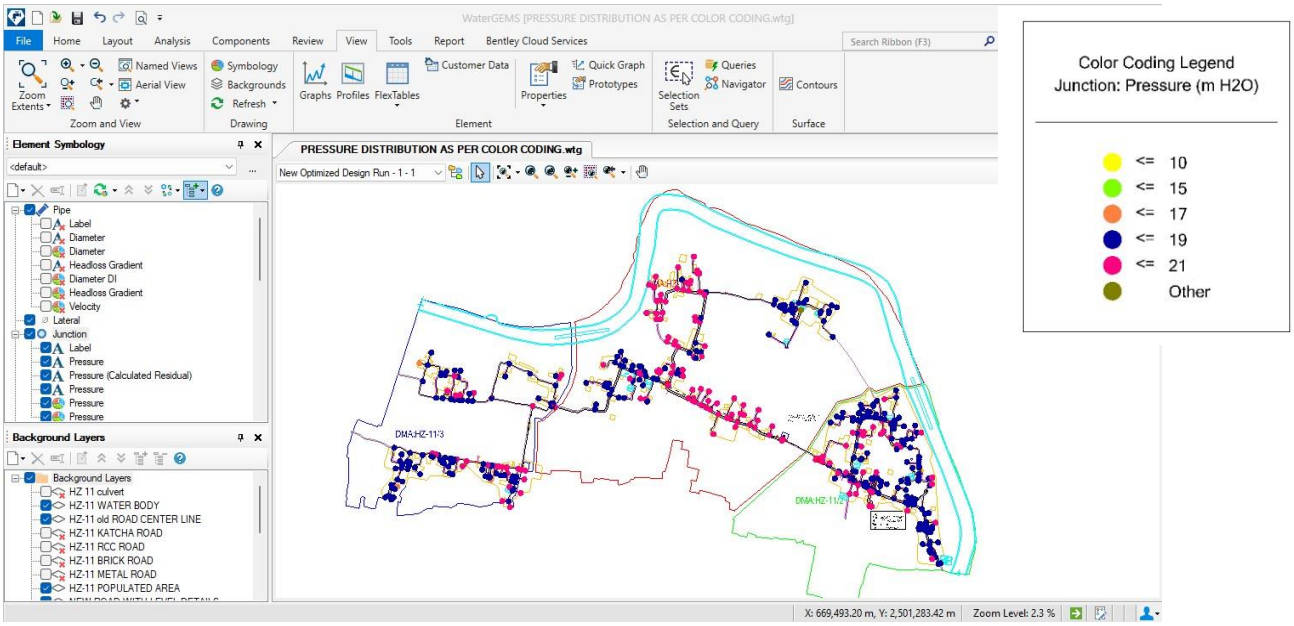


Figure 5.2 : Pressure Distribution for Existing Network

The color coding representation of pressure distribution of the entire network has been shown by figure 5.2. The range has been shown by inserting a legend which is between 10 m H_2O to 21 m H_2O. The greater than 21 m H_2O and less than 10 m H_2O value is represented by different color.

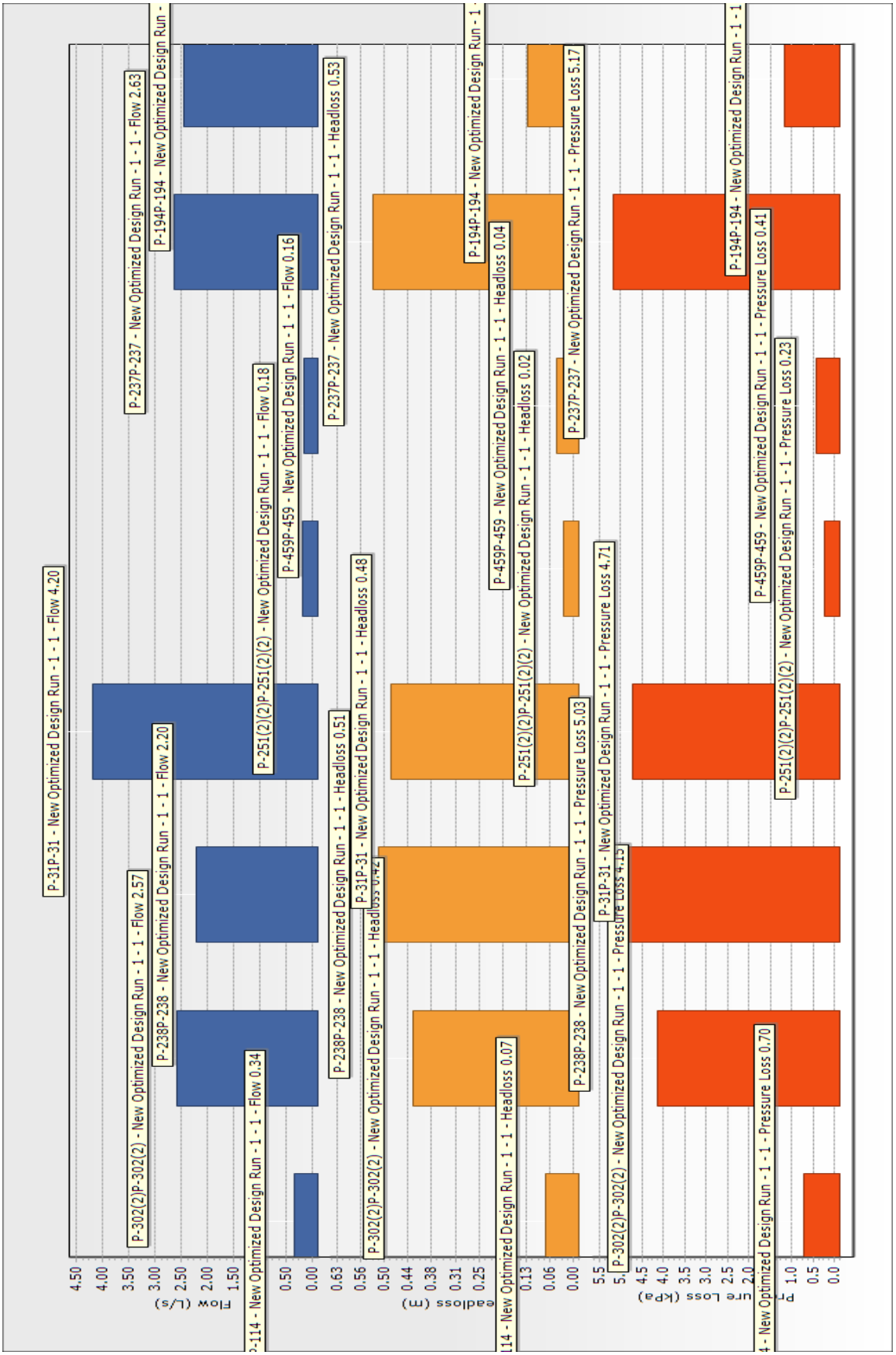


Figure 5.3 : Graph of Flow vs Headloss vs Pressure Loss

Figure 5.3 represents a graph between flow, head loss and pressure of a number of pipe segments in the network.

5.2 Maximum Head Loss Occurrence in Different Pipe Materials

Table 5.6 : Head Loss of Existing Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Headloss Gradient (m/km)
P-290(2)(2)(2)	27	J-467	J-294	119.4	HDPE	145	3.974
P-292	11	J-294	J-296	119.4	HDPE	145	3.92
P-294	41	J-296	J-298	119.4	HDPE	145	3.626
P-296	68	J-298	J-300	119.4	HDPE	145	3.552
P-298	38	J-300	J-302	119.4	HDPE	145	3.493
P-446(1)	41	J-302	J-451	119.4	HDPE	145	3.432
P-112(1)(1)	17	J-3	J-475	63.8	HDPE	145	3.427
P-224	81	J-159	J-227	93.8	HDPE	145	3.426
P-4(2)(1)	241	J-29	J-114	76.6	HDPE	145	3.113
P-230(1)	211	J-227	J-238	93.8	HDPE	145	2.91

Table 5.7 : Head Loss of DI Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Headloss Gradient (m/km)
P-1(1)	19	T-1	J-453	200	DIK7	140	4.496
P-224	81	J-159	J-227	100	DIK7	140	2.677
P-144	17	J-143	J-146	80	DIK7	140	2.366
P-230(1)	211	J-227	J-238	100	DIK7	140	2.273
P-141	22	J-141	J-143	80	DIK7	140	2.162
P-374	95	J-373	J-377	80	DIK7	140	2.073
P-49	67	J-32	J-47	100	DIK7	140	2.063
P-4(2)(1)	241	J-29	J-114	80	DIK7	140	2.026
P-139	12	J-136	J-141	80	DIK7	140	2.017
P-51	28	J-47	J-49	100	DIK7	140	1.932

Table 5.8 : Head Loss of HDPE Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Headloss Gradient (m/km)
P-290(2)(2)(2)	27	J-467	J-294	119.4	HDPE	145	3.974
P-292	11	J-294	J-296	119.4	HDPE	145	3.92
P-294	41	J-296	J-298	119.4	HDPE	145	3.626
P-296	68	J-298	J-300	119.4	HDPE	145	3.552
P-298	38	J-300	J-302	119.4	HDPE	145	3.493
P-446(1)	41	J-302	J-451	119.4	HDPE	145	3.432
P-112(1)(1)	17	J-3	J-475	63.8	HDPE	145	3.427
P-224	81	J-159	J-227	93.8	HDPE	145	3.426
P-4(2)(1)	241	J-29	J-114	76.6	HDPE	145	3.113
P-1(1)	19	T-1	J-453	213.2	HDPE	145	3.086

Table 5.9 : Head Loss of uPVC Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Headloss Gradient (m/km)
P-164	36	J-164	J-166	130.4	PVC	145	4.142
P-162	20	J-162	J-164	130.4	PVC	145	4.038
P-160	26	J-160	J-162	130.4	PVC	145	4.002
P-158	147	J-159	J-160	130.4	PVC	145	3.87
P-290(2)(2)(2)	27	J-467	J-294	119.4	PVC	145	3.594
P-292	11	J-294	J-296	119.4	PVC	145	3.543
P-1(1)	19	T-1	J-453	209.4	PVC	145	3.369
P-294	41	J-296	J-298	119.4	PVC	145	3.263
P-296	68	J-298	J-300	119.4	PVC	145	3.193
P-298	38	J-300	J-302	119.4	PVC	145	3.136

The above tables 5.6, 5.7, 5.8 and 5.9 give the values of head loss at different nodes of the network for different pipe materials. The head loss of the pipes changes with the change of the material of the pipe. It can be seen that head loss is much less in HDPE pipes than uPVC pipe network.

The detailed output results of WaterGEMS for Junctions and Pipes are given as Appendix 1 and Appendix 2 respectively.

Table 5.10 : Comparison Chart of Various Parameters for Different Pipe Materials in a Particular Network

PIPE MATERIAL	**HEADLOSS GRADIENT (m/km)**	**RESIDUAL PRESSURE (m H_2O)**	**COST**	**CARBON EMISSION [42][43]**
	MAX	**MIN**		**(kg/kWh)**
HDPE & DI (Existing)	3.974	15.83	₹ 27,339,749.17	457.7
DI	4.496	16.37	₹ 41,553,900.52	681.1
HDPE	3.974	15.13	₹ 26,281,782.96	453.7
PVC	4.264	15.26	₹ 21,827,407.09	451.9

The table 5.10 helps to choose the proper material of pipe for climate resilience,

Note: The rate of pipe materials is taken from “Schedule of Rates For Civil Works”, July 2019 and for DI pipes the rate is taken from a schedule published in June 2022 published by PHED, Gov of WB and a necessary escalation is done for present time.

5.3 Criticality Analysis of Valves in the Existing Network

Table 5.11 : Criticality Analysis of Valves in Existing Pipe Network

Segment	System Demand (Full) (L/s)	System Demand (Met) (L/s)	System Demand Shortfall (%)	Node with Largest Percent Demand Shortfall	Demand Shortfall at Worst Node (%)	Node with Largest Flow Shortfall	Flow Demanded at Worst Node (L/s)	Flow Supplied at Worst Node (L/s)
Criticality Segment - ISO-27	30.57	29.07	4.9	J-85	100	J-106	0.15	0
Criticality Segment - ISO-7	30.57	28.49	6.8	J-291	100	J-377	0.14	0
Criticality Segment - ISO-23	30.57	28.37	7.2	J-242	100	J-242	0.29	0
Criticality Segment - ISO-24	30.57	28.37	7.2	J-242	100	J-242	0.29	0
Criticality Segment - ISO-19	30.57	28.32	7.4	J-270	100	J-284	0.18	0
Criticality Segment - ISO-20	30.57	28.27	7.5	J-291	100	J-337	0.16	0
Criticality Segment - ISO-8	30.57	28.26	7.6	J-353	100	J-415	0.15	0
Criticality Segment - ISO-11	30.57	28.19	7.8	J-65	100	J-106	0.15	0
Criticality Segment - ISO-25	30.57	27.79	9.1	J-304	100	J-304	0.21	0
Criticality Segment - ISO-5	30.57	27.5	10	J-189	100	J-478	0.25	0
Criticality Segment - ISO-15	30.57	27.39	10.4	J-269	100	J-424	0.26	0
Criticality Segment - ISO-4	30.57	26.91	12	J-227	100	J-241	0.43	0
Criticality Segment - ISO-18	30.57	26.88	12.1	J-270	100	J-304	0.21	0
Criticality Segment - ISO-26	30.57	26.37	13.7	J-30	100	J-30	0.25	0
Criticality Segment - ISO-6	30.57	23.46	23.3	J-270	100	J-304	0.21	0
Criticality Segment - ISO-9	30.57	22.35	26.9	J-3	100	J-29	0.46	0

Segment	System Demand (Full) (L/s)	System Demand (Met) (L/s)	System Demand Shortfall (%)	Node with Largest Percent Demand Shortfall	Demand Shortfall at Worst Node (%)	Node with Largest Flow Shortfall	Flow Demanded at Worst Node (L/s)	Flow Supplied at Worst Node (L/s)
Criticality Segment - ISO-10	30.57	22.35	26.9	J-3	100	J-29	0.46	0
Criticality Segment - ISO-21	30.57	22.35	26.9	J-3	100	J-29	0.46	0
Criticality Segment - ISO-22	30.57	22.35	26.9	J-3	100	J-29	0.46	0
Criticality Segment - DISO-3/1	30.57	22.19	27.4	J-2	100	J-29	0.46	0
Criticality Segment - ISO-16	30.57	20.02	34.5	J-269	100	J-424	0.26	0
Criticality Segment - ISO-17	30.57	20.02	34.5	J-269	100	J-424	0.26	0
Criticality Segment - ISO-12	30.57	19.16	37.3	J-119	100	J-241	0.43	0
Criticality Segment - ISO-13	30.57	19.16	37.3	J-119	100	J-241	0.43	0
Criticality Segment - ISO-14	30.57	19.16	37.3	J-119	100	J-241	0.43	0
Criticality Segment - DISO-1	30.57	0	100	J-1	100	J-29	0.46	0
Criticality Segment - DISO-2	30.57	0	100	J-1	100	J-29	0.46	0
Criticality Segment - DISO-3	30.57	0	100	J-1	100	J-29	0.46	0

From the above table 5.11, we can see the system demand and supply of the valve segments. The table defines the criticality of the segments which fails to reach the demand. The valves which is more critical in fulfilling the required demand at nodes are the less reliable source for water supply.

Chapter 6

6 Conclusion & Recommendation

In this study, the hydraulic analysis of the water distribution network in Zone 11 of Haroa Block has been carried out using WaterGEMS, a computer-based simulation software for water distribution network. Prelude to the analysis, a review of literature was carried out. The current conditions of water supply and distribution, carbon emission in the climate for the production, transportation and laying of distribution pipe network in the study has been studied to explore the real need to have a surface water-based climate adaptive distribution network in the study area. The results of all the analysis were supported by charts, screen-shots and pictures in adherence to the CPHEEO Manual.

A procedure for the creation of DMA in a water distribution system has been presented. The procedure has a GIS based modular structure and is mainly based on techniques derived from allocating the water demand to the nearest network nodes. After that the same network was analyzed for different type of pipe materials.
The results of the analysis shows that the network has less residual pressure and minimum head loss when it is designed with HDPE (residual pressure 15.13 m H_2O and headloss 3.974 m/km) rather than DI and uPVC. Although, the carbon emission percentage is slightly higher in HDPE (453.7 kg/kWh) pipe material than uPVC (451.9 kg/kWh).

With the use of this software one can indeed analyze the network at the desk and can foresee the most climate adaptive network which has the capability to handle the water demand from node to node in lower residual pressure and less head loss. Also, a particular pipe material can be chosen for well hydraulic functions and less carbon emission.

The reliability analysis is shown in this study by criticality analysis in WaterGEMS. This analysis helps us to choose the most reliable valve in the entire network which will help us for fulfilling the water demand in service area. It can be said that the valve segment which has the lowest demand shortfall (4.9%) is the most reliable segment in the distribution network. The critical valves which is not reaching the demand can be replaced or maintained which is easily identified by the software.

Chapter 7

7 Future Scope of Study and Limitations

7.1 Future Scope

- More systematic documentation is required for life cycle level GHG emission data for different pipe materials, with special emphasis on the transport level emission, including the GHG emission factor as an option for selection of pipe material.
- Adopting climate friendly pipe material for execution.
- Indian standards should make it compulsory for the pipe manufacturer to publish carbon footprint for their products.
- Under AMRUT-II, numerous regions are beings taken for development. There carbon emission factor for choosing pipe materials, should be factor.
- The criticality analysis can be optimized by using combination of different valves and pipe materials.

7.2 Limitations

- The carbon emission study was done on the basis of literature review. The industrial data was not incorporated here.
- The network was semi optimized as the residual pressure was above 12 m H_2O in the study. It was taken as otherwise below 12 m H_2O; the network was not running.
- The criticality analysis was only done by using a set of valves.

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Appendix – I

9 Junction Details

Table 9.1 : Junction Details of Existing Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
31	J-1	5.498	0.01	25.084	19.55
33	J-2	5.341	0.16	24.436	19.06
	J-3	5.62	0.1	24.42	18.76
37	J-4	4.64	0.12	23.469	18.79
39	J-5	4.23	0.03	23.469	19.2
41	J-6	4.616	0.06	23.443	18.79
43	J-7	4.798	0.14	23.414	18.58
45	J-8	4.42	0.02	23.443	18.98
47	J-9	4.445	0.15	23.358	18.88
49	J-10	4.832	0.02	23.358	18.49
51	J-11	4.623	0.05	23.405	18.74
53	J-12	3.969	0.02	23.405	19.4
55	J-13	4.57	0.05	23.393	18.79
57	J-14	4.145	0.01	23.393	19.21
59	J-15	4.599	0.12	23.384	18.75
61	J-16	4.25	0.15	23.357	19.07
64	J-17	4.605	0.02	23.356	18.71
66	J-18	4.467	0.06	23.344	18.84
68	J-19	5.049	0.01	23.344	18.26
70	J-20	4.605	0.09	23.339	18.7
72	J-21	4.313	0.09	23.339	18.99
74	J-22	4.449	0.21	23.322	18.83
76	J-23	6.315	0.03	23.321	16.97
78	J-24	4.666	0.05	23.321	18.62
80	J-25	4.826	0.17	23.322	18.46
82	J-26	4.714	(N/A)	(N/A)	(N/A)
84	J-27	4.969	0.1	23.353	18.35
86	J-28	4.134	0.05	23.351	19.18
89	J-29	4.855	0.45	24.348	19.45
92	J-30	4.523	0.25	23.867	19.3
94	J-31	4.183	0.01	23.867	19.64
96	J-32	4.747	0.08	23.845	19.06
98	J-33	5.025	0.09	23.83	18.77
100	J-34	5.296	0.01	23.83	18.5
102	J-35	4.4	0.03	23.83	19.39
104	J-36	5.184	0.06	23.824	18.6
106	J-37	5.095	0.04	23.816	18.68
108	J-38	4.318	0.01	23.816	19.46

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
110	J-39	5.169	0.08	23.814	18.61
112	J-40	4.097	0.03	23.814	19.68
114	J-41	4.996	0.09	23.811	18.78
117	J-42	3.936	0.02	23.811	19.84
119	J-43	4.524	0.02	23.811	19.25
121	J-44	5.445	0.07	23.822	18.34
123	J-45	4.995	0.01	23.821	18.79
125	J-46	4.664	0.04	23.821	19.12
127	J-47	3.94	0.09	23.668	19.69
129	J-48	4.744	0.03	23.668	18.89
131	J-49	4.194	0.06	23.598	19.37
133	J-50	4.789	0.03	23.598	18.77
135	J-51	4.37	0.05	23.552	19.14
137	J-52	4.653	0.03	23.552	18.86
139	J-53	4.375	0.07	23.51	19.1
141	J-54	7.336	0.06	23.508	16.14
143	J-55	7.336	0.01	23.508	16.14
145	J-56	4.798	0.01	23.508	18.67
147	J-57	4.458	0.06	23.472	18.98
149	J-58	4.973	0.04	23.471	18.46
151	J-59	4.476	0.06	23.446	18.93
153	J-60	4.85	0.04	23.445	18.56
155	J-61	4.37	0.06	23.424	19.02
157	J-62	4.511	0.04	23.423	18.87
159	J-63	4.604	0.1	23.385	18.74
161	J-64	4.456	0.02	23.385	18.89
163	J-65	3.945	0.12	23.236	19.25
165	J-66	4.178	0.03	23.236	19.02
167	J-67	4.017	0.1	23.16	19.1
169	J-68	4.327	0.06	23.157	18.79
171	J-69	4.125	0.03	23.14	18.98
173	J-70	4.175	0.01	23.14	18.93
175	J-71	4.135	0.03	23.128	18.95
177	J-72	4.139	0.01	23.128	18.95
179	J-73	4.082	0.05	23.115	18.99
181	J-74	4.408	0.03	23.115	18.67
183	J-75	4.39	0.06	23.086	18.66
185	J-76	4.503	0.08	23.082	18.54
187	J-77	4.804	0.01	23.082	18.24
189	J-78	4.446	0.05	23.08	18.6
191	J-79	4.18	0.07	23.051	18.83
193	J-80	4.713	0.04	23.051	18.3
195	J-81	3.897	0.04	23.041	19.11
197	J-82	4.304	0.01	23.041	18.7

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
199	J-83	3.98	0.06	23.026	19.01
201	J-84	4.716	0.01	23.026	18.27
203	J-85	4.349	0.14	22.992	18.6
205	J-86	4.127	0.03	22.945	18.78
207	J-87	4.541	0.14	22.944	18.37
209	J-88	4.619	0.02	22.935	18.28
211	J-89	4.765	0.01	22.936	18.13
213	J-90	4.619	0.04	22.936	18.28
216	J-91	4.507	0.12	22.946	18.4
220	J-92	5.106	0.06	22.933	17.79
223	J-93	5.282	0.1	22.914	17.6
225	J-94	4.765	0.02	22.914	18.11
227	J-95	4.858	0.02	22.914	18.02
229	J-96	5.156	0.09	22.902	17.71
231	J-97	4.083	0.02	22.902	18.78
233	J-98	4.79	0.05	22.893	18.07
235	J-99	7.027	0.01	22.893	15.83
237	J-100	4.951	0.05	22.887	17.9
239	J-101	4.123	0.01	22.887	18.73
241	J-102	5.048	0.06	22.876	17.79
243	J-103	5.247	0.01	22.875	17.59
245	J-104	4.438	0.01	22.876	18.4
247	J-105	4.876	0.01	22.876	17.96
249	J-106	3.918	0.15	22.929	18.97
251	J-107	4.675	0.13	22.919	18.21
253	J-108	5.063	0.03	22.919	17.82
255	J-109	4.819	0.05	22.919	18.06
259	J-110	4.259	(N/A)	(N/A)	(N/A)
261	J-111	5.36	0.05	24.358	18.96
263	J-112	5.011	0.3	23.668	18.62
265	J-113	4.812	0.05	23.667	18.82
267	J-114	5.281	0.38	23.597	18.28
271	J-115	5.022	0.2	24.063	19
274	J-116	4.756	0.06	24.061	19.27
276	J-117	5.245	0.01	24.061	18.78
278	J-118	4.71	0.01	24.061	19.31
280	J-119	5.506	0.26	23.573	18.03
282	J-120	4.79	0.02	23.573	18.74
284	J-121	5.36	0.12	23.606	18.21
286	J-122	5.149	0.04	23.603	18.42
288	J-123	5.349	0.01	23.603	18.22
290	J-124	5.363	0.01	23.601	18.2
292	J-125	5.304	0.1	23.601	18.26
295	J-126	5.345	0.08	23.596	18.21

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
297	J-127	4.797	0.17	23.688	18.85
299	J-128	4.771	0.1	23.681	18.87
301	J-129	5.118	0.02	23.681	18.53
303	J-130	4.578	0.06	23.679	19.06
305	J-131	5.353	0.05	23.686	18.3
307	J-132	4.949	0.06	23.711	18.72
309	J-133	5.222	0.02	23.711	18.45
311	J-134	5.009	0.07	23.777	18.73
313	J-135	5.119	0.02	23.777	18.62
315	J-136	4.852	0.09	23.832	18.94
317	J-137	4.895	0.15	23.822	18.89
319	J-138	4.571	0.01	23.822	19.21
321	J-139	5.237	0.11	23.809	18.53
323	J-140	4.947	0.02	23.832	18.85
325	J-141	4.797	0.04	23.86	19.02
327	J-142	5.064	0.02	23.86	18.76
329	J-143	4.865	0.06	23.916	19.01
331	J-144	5.249	0.02	23.916	18.63
333	J-145	5.621	0.01	23.916	18.26
335	J-146	5.101	0.07	23.963	18.82
337	J-147	4.966	0.03	23.962	18.96
339	J-148	5.047	0.13	24.014	18.93
341	J-149	4.963	0.11	23.997	19
343	J-150	4.908	0.02	23.997	19.05
345	J-151	5.045	0.01	23.997	18.91
347	J-152	5.06	0.08	24.049	18.95
349	J-153	4.672	0.04	24.048	19.34
351	J-154	4.693	0	24.048	19.32
353	J-155	4.61	0.02	24.048	19.4
355	J-156	4.82	0.01	24.048	19.19
357	J-157	4.493	0	24.048	19.52
359	J-158	5.056	0.08	24.144	19.05
361	J-159	5.056	0.15	24.15	19.06
363	J-160	5.044	0.14	24.305	19.22
365	J-161	4.701	0.03	24.304	19.56
367	J-162	5.07	0.04	24.333	19.22
369	J-163	4.684	0.01	24.333	19.61
371	J-164	4.951	0.08	24.355	19.36
373	J-165	4.735	0.05	24.353	19.58
375	J-166	5.012	0.1	24.396	19.34
377	J-167	4.609	0.06	24.394	19.74
379	J-168	5.072	0.06	24.432	19.32
381	J-169	4.922	0.02	24.432	19.47
383	J-170	5.085	0.08	24.464	19.34

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
385	J-171	4.713	0.03	24.463	19.71
387	J-172	5.221	0.14	24.527	19.27
389	J-173	5.166	0.08	24.521	19.32
391	J-174	5.247	0.12	24.594	19.31
393	J-175	4.497	0.07	24.59	20.05
395	J-176	5.289	0.06	24.622	19.29
397	J-177	4.935	0.02	24.622	19.65
399	J-178	5.198	0.12	24.679	19.44
401	J-179	4.698	0.08	24.675	19.94
403	J-180	4.969	0.01	24.675	19.67
405	J-181	4.605	0.03	24.674	20.03
407	J-182	4.598	0.02	24.679	20.04
409	J-183	5.369	0.13	24.781	19.37
411	J-184	4.385	0.06	24.778	20.35
413	J-185	5.374	0.1	24.825	19.41
415	J-186	4.674	0.03	24.825	20.11
417	J-187	5.544	0.14	24.962	19.38
419	J-188	4.623	0.03	24.962	20.3
421	J-189	4.515	0.14	24.069	19.51
423	J-190	5.251	0.04	24.068	18.78
425	J-191	4.611	0.06	24.099	19.45
428	J-192	4.554	0.24	23.992	19.4
430	J-193	4.28	0.05	23.991	19.67
432	J-194	4.379	0.01	23.991	19.57
434	J-195	4.56	0.02	23.99	19.39
436	J-196	4.605	0.04	23.99	19.35
439	J-197	3.345	(N/A)	(N/A)	(N/A)
441	J-198	4.225	0.18	23.874	19.61
443	J-199	3.572	0.02	23.874	20.26
445	J-200	5.95	0.12	23.864	17.88
447	J-201	3.6	0.02	23.864	20.22
449	J-202	4.517	0.02	23.812	19.26
451	J-203	4.25	0.12	23.762	19.47
453	J-204	4.566	0.07	23.748	19.14
455	J-205	4.566	0.09	23.746	19.14
457	J-206	4.397	0.01	23.746	19.31
459	J-207	3.857	0.07	23.742	19.84
461	J-208	4.293	0.09	23.678	19.35
463	J-209	4.065	0.05	23.677	19.57
465	J-210	4.43	0.01	23.677	19.21
467	J-211	4.143	0.01	23.677	19.49
469	J-212	4.375	0.08	23.644	19.23
471	J-213	4.68	0.04	23.643	18.92
473	J-214	4.565	0.18	23.613	19.01

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
475	J-215	4.332	0.07	23.609	19.24
477	J-216	4.005	0.16	23.546	19.5
479	J-217	4.274	0.02	23.546	19.23
481	J-218	4.188	0.1	23.538	19.31
483	J-219	3.825	0.03	23.538	19.67
485	J-220	3.957	0.11	23.539	19.54
487	J-221	3.913	0.12	23.538	19.59
489	J-222	3.456	0.04	23.537	20.04
491	J-223	3.478	0.02	23.537	20.02
494	J-224	4.415	0.11	23.533	19.08
496	J-225	4.089	0.04	23.532	19.4
498	J-226	4.439	0.02	23.533	19.06
500	J-227	4.611	0.19	23.871	19.22
502	J-228	4.962	0.04	23.869	18.87
504	J-229	4.879	0.01	23.869	18.95
506	J-230	4.914	0.04	23.868	18.92
508	J-231	4.437	0.02	23.868	19.39
510	J-232	4.766	0.01	23.868	19.06
512	J-233	4.136	0.05	23.252	19.08
514	J-234	4.393	0.02	23.251	18.82
516	J-235	4.29	0.07	23.251	18.92
518	J-236	4.389	0.03	23.251	18.82
520	J-237	4.162	0.03	23.251	19.05
522	J-238	4.57	0.2	23.256	18.65
525	J-239	4.464	0.26	23.089	18.59
527	J-240	4.036	0.03	23.088	19.01
529	J-241	4.731	0.43	22.529	17.76
531	J-242	4.308	0.29	21.976	17.63
533	J-243	4.14	0.02	21.976	17.8
535	J-244	4.252	0.03	21.935	17.65
537	J-245	4.056	0	21.935	17.84
539	J-246	4.11	0.03	21.924	17.78
541	J-247	4.093	0.01	21.924	17.8
543	J-248	4.229	0.04	21.908	17.64
545	J-249	4.048	0.01	21.908	17.82
547	J-250	4.276	0.05	21.877	17.57
549	J-251	4.49	0.02	21.877	17.35
551	J-252	3.979	0.03	21.859	17.84
553	J-253	3.686	0.03	21.858	18.14
555	J-254	4.241	0.09	21.848	17.57
557	J-255	4.104	0.22	21.708	17.57
559	J-256	4.269	0.12	21.822	17.52
561	J-257	4.368	0.08	21.816	17.41
565	J-259	4.091	0.02	21.789	17.66

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
567	J-260	4.409	0.04	21.705	17.26
569	J-261	4.685	0.15	21.695	16.98
571	J-262	4.353	0.04	21.694	17.31
573	J-263	4.587	0.08	21.69	17.07
575	J-264	4.16	0.1	21.703	17.51
577	J-265	4.31	0.02	21.703	17.36
579	J-266	4.192	0.02	21.703	17.48
581	J-267	5.567	0.15	23.6	18
584	J-268	4.907	0.03	23.6	18.66
586	J-269	5.347	0.06	24.666	19.28
590	J-270	5.266	0.08	23.946	18.64
592	J-271	5.526	0.01	23.946	18.38
594	J-272	5.085	0.12	23.907	18.78
596	J-273	5.012	0.07	23.903	18.85
598	J-274	4.918	0	23.903	18.95
600	J-275	5.037	0.04	23.902	18.83
602	J-276	4.872	0.1	23.882	18.97
604	J-277	4.59	0.01	23.882	19.25
606	J-278	4.517	0.06	23.865	19.31
608	J-279	4.484	0.09	23.86	19.34
610	J-280	4.599	0.01	23.86	19.22
612	J-281	4.61	0.06	23.858	19.21
614	J-282	4.67	0.13	23.862	19.15
616	J-283	4.482	0	23.862	19.34
618	J-284	4.799	0.18	23.839	19
620	J-285	4.394	0.09	23.828	19.4
622	J-286	4.237	0.01	23.828	19.55
624	J-287	4.868	0.08	23.832	18.93
626	J-288	4.781	0.13	23.826	19.01
629	J-289	4.653	0.08	23.823	19.13
631	J-290	5.165	0.01	23.823	18.62
633	J-291	5.46	0.07	23.227	17.73
635	J-292	4.556	0.04	23.226	18.63
637	J-293	4.685	0.02	23.823	19.1
640	J-294	5.466	0.04	24.69	19.19
642	J-295	4.793	0.02	24.69	19.86
644	J-296	4.933	0.17	24.645	19.67
646	J-297	4.759	0.14	24.618	19.82
648	J-298	5.47	0.07	24.495	18.99
650	J-299	5.204	0.01	24.495	19.25
652	J-300	5.332	0.07	24.255	18.89
654	J-301	6.429	0.02	24.707	18.24
656	J-302	5.318	0.06	24.121	18.77
658	J-303	4.893	0.01	24.121	19.19

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
663	J-304	4.664	0.21	23.499	18.8
665	J-305	4.462	0.08	23.497	19
667	J-306	4.565	0.07	23.405	18.8
669	J-307	4.519	0.05	23.4	18.84
671	J-308	4.516	0.02	23.4	18.85
673	J-309	4.847	0.07	23.393	18.51
675	J-310	4.802	0.01	23.393	18.55
677	J-311	4.464	0.14	23.384	18.88
679	J-312	4.47	0.02	23.384	18.88
681	J-313	4.646	0.02	23.384	18.7
683	J-314	4.59	0.06	23.381	18.75
685	J-315	4.531	0.07	23.378	18.81
687	J-316	4.415	0.01	23.378	18.93
689	J-317	4.409	0.03	23.378	18.93
691	J-318	4.517	0.04	23.363	18.81
693	J-319	4.601	0.02	23.363	18.72
695	J-320	4.675	0.04	23.35	18.64
697	J-321	4.761	0.02	23.35	18.55
699	J-322	4.791	0.07	23.329	18.5
701	J-323	4.976	0.09	23.32	18.31
703	J-324	5.813	0	23.32	17.47
705	J-325	5.199	0.04	23.319	18.08
707	J-326	4.914	0.03	23.323	18.37
709	J-327	4.927	0.01	23.323	18.36
711	J-328	4.801	0.1	23.31	18.47
713	J-329	4.485	0.07	23.306	18.78
715	J-330	4.799	0.07	23.302	18.47
717	J-331	4.339	0.02	23.301	18.92
719	J-332	4.765	0.06	23.284	18.48
723	J-334	4.759	0.01	23.284	18.49
725	J-335	4.555	0.13	23.28	18.69
727	J-336	4.709	0.03	23.279	18.53
729	J-337	4.557	0.14	23.246	18.65
731	J-338	4.154	0.04	23.246	19.05
733	J-339	4.308	0.02	23.246	18.9
735	J-340	4.868	0.06	23.272	18.37
737	J-341	4.619	0.04	23.271	18.61
739	J-342	4.971	0.05	23.259	18.25
741	J-343	4.881	0.01	23.259	18.34
743	J-344	4.571	0.12	23.206	18.6
745	J-345	4.481	0.02	23.196	18.68
747	J-346	4.6	0.14	23.196	18.56
750	J-347	4.56	0.14	23.167	18.57
752	J-348	4.882	0.03	23.167	18.25

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
754	J-349	3.931	0.01	23.167	19.2
756	J-350	4.942	0.13	23.229	18.25
759	J-351	4.685	0.04	23.229	18.51
761	J-352	4.858	0.09	23.209	18.31
763	J-353	5.287	0.08	23.861	18.54
765	J-354	4.396	(N/A)	(N/A)	(N/A)
768	J-355	5.347	0.08	24.656	19.27
772	J-356	5.305	0.03	23.964	18.62
775	J-357	5.305	0.16	23.939	18.6
780	J-358	4.705	0.04	23.86	19.12
782	J-359	5.281	0.04	23.808	18.49
784	J-360	4.872	0.01	23.808	18.9
786	J-361	5.223	0.02	23.783	18.52
788	J-362	5.094	0.01	23.783	18.65
790	J-363	5.296	0.05	23.762	18.43
792	J-364	4.791	0.03	23.761	18.93
794	J-365	5.281	0.05	23.741	18.42
796	J-366	4.788	0.04	23.741	18.91
798	J-367	5.245	0.06	23.729	18.45
800	J-368	4.714	0.11	23.721	18.97
802	J-369	4.658	0.01	23.721	19.02
804	J-370	5.327	0.06	23.722	18.36
807	J-371	5.427	0.07	23.71	18.25
809	J-372	4.777	0.05	23.709	18.89
811	J-373	5.543	0.1	23.68	18.1
813	J-374	5.129	0.07	23.677	18.51
815	J-375	4.913	0.02	23.677	18.73
817	J-376	5.228	0.03	23.676	18.41
819	J-377	5.708	0.14	23.451	17.71
821	J-378	5.906	0.1	23.382	17.44
823	J-379	5.134	0.03	23.381	18.21
825	J-380	5.787	0.08	23.342	17.52
827	J-381	5.085	0.03	23.342	18.22
829	J-382	5.298	0.08	23.308	17.97
831	J-383	5.022	0.01	23.308	18.25
833	J-384	5.332	0.1	23.269	17.9
835	J-385	5.332	0.08	23.256	17.89
837	J-386	5.239	0.08	23.245	17.97
839	J-387	5.093	0.04	23.244	18.11
841	J-388	5.538	0.09	23.236	17.66
843	J-389	5.334	0.02	23.222	17.85
849	J-390	4.537	0.05	23.267	18.69
851	J-391	5.693	0.07	23.415	17.69
853	J-392	5.434	0.02	23.415	17.94

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
855	J-393	5.473	0.03	23.409	17.9
857	J-394	5.247	0.01	23.409	18.13
859	J-395	5.58	0.04	23.406	17.79
861	J-396	5.288	0.02	23.406	18.08
863	J-397	5.531	0.03	23.402	17.84
865	J-398	5.218	0.02	23.402	18.15
867	J-399	5.567	0.05	23.401	17.8
869	J-400	5.099	0.02	23.401	18.27
871	J-401	5.598	0.14	23.398	17.76
873	J-402	4.567	0.13	23.387	18.78
875	J-403	4.313	0.03	23.387	19.04
877	J-404	3.92	0.01	23.387	19.43
879	J-405	5.499	0.07	23.399	17.86
881	J-406	4.676	0.01	23.399	18.69
883	J-407	5.288	0.08	23.405	18.08
885	J-408	4.167	0.03	23.405	19.2
887	J-409	5.485	0.04	23.41	17.89
889	J-410	4.943	0.02	23.41	18.43
891	J-411	5.477	0.04	23.415	17.9
893	J-412	4.929	0.02	23.415	18.45
895	J-413	5.618	0.06	23.424	17.77
897	J-414	5.138	0.01	23.424	18.25
899	J-415	5.676	0.15	23.458	17.75
901	J-416	4.895	0.03	23.458	18.53
903	J-417	4.936	(N/A)	(N/A)	(N/A)
905	J-418	5.146	0.1	24.611	19.43
907	J-419	5.116	0.03	24.611	19.46
909	J-420	5.42	0.12	24.516	19.06
911	J-421	5.3	0.06	24.513	19.17
913	J-422	5.327	0.2	24.502	19.14
915	J-423	5.3	0.06	24.5	19.16
917	J-424	5.437	0.26	24.32	18.85
919	J-425	5.119	0.02	24.32	19.16
921	J-426	5.288	0.12	24.063	18.74
923	J-427	5.107	0.02	24.063	18.92
925	J-428	5.475	0.02	24.044	18.53
927	J-429	5.35	0.01	24.044	18.66
929	J-430	5.569	0.03	24.031	18.42
931	J-431	5.371	0.02	24.031	18.62
933	J-432	5.477	0.08	24.019	18.5
935	J-433	5.351	0.02	24.019	18.63
937	J-434	5.554	0.1	23.809	18.22
939	J-435	5.334	0.02	23.809	18.44
941	J-436	5.617	0.04	23.742	18.09

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
943	J-437	5.18	0.01	23.742	18.52
945	J-438	5.356	0.04	23.713	18.32
947	J-439	5.065	0.01	23.713	18.61
949	J-440	4.909	0.06	23.668	18.72
951	J-441	4.11	0.01	23.668	19.52
953	J-442	4.911	0.03	23.611	18.66
1437	J-443	5.298	0.02	23.934	18.6
1447	J-444	4.944	0.21	23.338	18.36
1480	J-451	5.306	0.03	23.979	18.64
1487	J-453	5.521	0.22	25.086	19.53
1505	J-457	5.016	0.19	23.81	18.76
1509	J-458	3.979	0.07	21.858	17.84
1512	J-459	4.229	0.03	21.858	17.59
1514	J-460	4.35	0.11	21.789	17.4
1517	J-461	4.409	0.13	21.708	17.26
1526	J-463	3.543	0.07	21.768	18.19
1529	J-464	5.036	0.04	24.655	19.58
1533	J-465	5.35	0.07	23.22	17.83
1547	J-467	5.472	0.16	24.798	19.29
1550	J-468	5.424	0.1	24.792	19.33
1555	J-469	5.617	0.16	24.707	19.05
1567	J-471	5.1	0.09	23.595	18.46
1584	J-474	5.573	0.06	24.36	18.75
1587	J-475	5.55	0.09	24.36	18.77
1594	J-476	5.136	0.06	22.875	17.7
1597	J-477	4.8	0.04	22.874	18.04
1599	J-478	4.647	0.25	23.816	19.13
1602	J-479	4	0.16	23.774	19.73
1604	J-480	3.571	0.24	21.759	18.15
1607	J-481	4.36	0.05	21.757	17.36
1609	J-255/1	4.206	0.04	21.707	17.47
1612	J-305/1	4.402	0.06	23.494	19.05

Table 9.2 : Junction Details of DI Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
31	J-1	5.498	0.01	25.023	19.49
33	J-2	5.341	0.16	24.375	19
35	J-3	5.62	0.1	24.368	18.71
37	J-4	4.64	0.12	23.746	19.07
39	J-5	4.23	0.03	23.746	19.48
41	J-6	4.616	0.06	23.726	19.07
43	J-7	4.798	0.14	23.703	18.87
45	J-8	4.42	0.02	23.726	19.27

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
47	J-9	4.445	0.15	23.673	19.19
49	J-10	4.832	0.02	23.673	18.8
51	J-11	4.623	0.05	23.697	19.04
53	J-12	3.969	0.02	23.697	19.69
55	J-13	4.57	0.05	23.689	19.08
57	J-14	4.145	0.01	23.689	19.5
59	J-15	4.599	0.12	23.683	19.05
61	J-16	4.25	0.15	23.672	19.38
64	J-17	4.605	0.02	23.672	19.03
66	J-18	4.467	0.06	23.664	19.16
68	J-19	5.049	0.01	23.664	18.58
70	J-20	4.605	0.09	23.661	19.02
72	J-21	4.313	0.09	23.661	19.31
74	J-22	4.449	0.21	23.655	19.17
76	J-23	6.315	0.03	23.655	17.31
78	J-24	4.666	0.05	23.655	18.95
80	J-25	4.826	0.17	23.655	18.79
82	J-26	4.714	(N/A)	(N/A)	(N/A)
84	J-27	4.969	0.1	23.669	18.66
86	J-28	4.134	0.05	23.669	19.5
89	J-29	4.855	0.45	24.335	19.44
92	J-30	4.523	0.25	24.166	19.6
94	J-31	4.183	0.01	24.166	19.94
96	J-32	4.747	0.08	24.158	19.37
98	J-33	5.025	0.09	24.145	19.08
100	J-34	5.296	0.01	24.145	18.81
102	J-35	4.4	0.03	24.145	19.71
104	J-36	5.184	0.06	24.14	18.92
106	J-37	5.095	0.04	24.137	19
108	J-38	4.318	0.01	24.137	19.78
110	J-39	5.169	0.08	24.137	18.93
112	J-40	4.097	0.03	24.137	20
114	J-41	4.996	0.09	24.136	19.1
117	J-42	3.936	0.02	24.136	20.16
119	J-43	4.524	0.02	24.136	19.57
121	J-44	5.445	0.07	24.14	18.66
123	J-45	4.995	0.01	24.14	19.11
125	J-46	4.664	0.04	24.14	19.44
127	J-47	3.94	0.09	24.02	20.04
129	J-48	4.744	0.03	24.02	19.24
131	J-49	4.194	0.06	23.966	19.73
133	J-50	4.789	0.03	23.966	19.14
135	J-51	4.37	0.05	23.929	19.52
137	J-52	4.653	0.03	23.929	19.24

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
139	J-53	4.375	0.07	23.896	19.48
141	J-54	7.336	0.06	23.896	16.53
143	J-55	7.336	0.01	23.896	16.53
145	J-56	4.798	0.01	23.896	19.06
147	J-57	4.458	0.06	23.867	19.37
149	J-58	4.973	0.04	23.867	18.86
151	J-59	4.476	0.06	23.847	19.33
153	J-60	4.85	0.04	23.847	18.96
155	J-61	4.37	0.06	23.83	19.42
157	J-62	4.511	0.04	23.83	19.28
159	J-63	4.604	0.1	23.799	19.16
161	J-64	4.456	0.02	23.799	19.3
163	J-65	3.945	0.12	23.683	19.7
165	J-66	4.178	0.03	23.683	19.47
167	J-67	4.017	0.1	23.623	19.57
169	J-68	4.327	0.06	23.622	19.26
171	J-69	4.125	0.03	23.608	19.44
173	J-70	4.175	0.01	23.608	19.39
175	J-71	4.135	0.03	23.598	19.42
177	J-72	4.139	0.01	23.598	19.42
179	J-73	4.082	0.05	23.588	19.47
181	J-74	4.408	0.03	23.588	19.14
183	J-75	4.39	0.06	23.566	19.14
185	J-76	4.503	0.08	23.565	19.02
187	J-77	4.804	0.01	23.565	18.72
189	J-78	4.446	0.05	23.565	19.08
191	J-79	4.18	0.07	23.538	19.32
193	J-80	4.713	0.04	23.538	18.79
195	J-81	3.897	0.04	23.531	19.59
197	J-82	4.304	0.01	23.531	19.19
199	J-83	3.98	0.06	23.519	19.5
201	J-84	4.716	0.01	23.519	18.76
203	J-85	4.349	0.14	23.492	19.1
205	J-86	4.127	0.03	23.466	19.3
207	J-87	4.541	0.14	23.461	18.88
209	J-88	4.619	0.02	23.459	18.8
211	J-89	4.765	0.01	23.46	18.66
213	J-90	4.619	0.04	23.46	18.8
216	J-91	4.507	0.12	23.466	18.92
220	J-92	5.106	0.06	23.457	18.31
223	J-93	5.282	0.1	23.443	18.12
225	J-94	4.765	0.02	23.443	18.64
227	J-95	4.858	0.02	23.443	18.55
229	J-96	5.156	0.09	23.433	18.24

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
231	J-97	4.083	0.02	23.433	19.31
233	J-98	4.79	0.05	23.429	18.6
235	J-99	7.027	0.01	23.429	16.37
237	J-100	4.951	0.05	23.429	18.44
239	J-101	4.123	0.01	23.429	19.27
241	J-102	5.048	0.06	23.427	18.34
243	J-103	5.247	0.01	23.427	18.14
245	J-104	4.438	0.01	23.427	18.95
247	J-105	4.876	0.01	23.427	18.51
249	J-106	3.918	0.15	23.452	19.49
251	J-107	4.675	0.13	23.447	18.73
253	J-108	5.063	0.03	23.447	18.35
255	J-109	4.819	0.05	23.447	18.59
259	J-110	4.259	(N/A)	(N/A)	(N/A)
261	J-111	5.36	0.05	24.337	18.94
263	J-112	5.011	0.3	23.926	18.88
265	J-113	4.812	0.05	23.926	19.08
267	J-114	5.281	0.38	23.846	18.53
271	J-115	5.022	0.2	24.177	19.12
274	J-116	4.756	0.06	24.177	19.38
276	J-117	5.245	0.01	24.177	18.89
278	J-118	4.71	0.01	24.177	19.43
280	J-119	5.506	0.26	24.103	18.56
282	J-120	4.79	0.02	24.103	19.27
284	J-121	5.36	0.12	24.118	18.72
286	J-122	5.149	0.04	24.117	18.93
288	J-123	5.349	0.01	24.117	18.73
290	J-124	5.363	0.01	24.116	18.72
292	J-125	5.304	0.1	24.116	18.77
295	J-126	5.345	0.08	24.115	18.73
297	J-127	4.797	0.17	24.188	19.35
299	J-128	4.771	0.1	24.187	19.38
301	J-129	5.118	0.02	24.187	19.03
303	J-130	4.578	0.06	24.187	19.57
305	J-131	5.353	0.05	24.188	18.8
307	J-132	4.949	0.06	24.208	19.22
309	J-133	5.222	0.02	24.208	18.95
311	J-134	5.009	0.07	24.265	19.22
313	J-135	5.119	0.02	24.265	19.11
315	J-136	4.852	0.09	24.313	19.42
317	J-137	4.895	0.15	24.309	19.38
319	J-138	4.571	0.01	24.309	19.7
321	J-139	5.237	0.11	24.307	19.03
323	J-140	4.947	0.02	24.313	19.33

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
325	J-141	4.797	0.04	24.337	19.5
327	J-142	5.064	0.02	24.337	19.23
329	J-143	4.865	0.06	24.385	19.48
331	J-144	5.249	0.02	24.385	19.1
333	J-145	5.621	0.01	24.385	18.73
335	J-146	5.101	0.07	24.426	19.29
337	J-147	4.966	0.03	24.426	19.42
339	J-148	5.047	0.13	24.466	19.38
341	J-149	4.963	0.11	24.463	19.46
343	J-150	4.908	0.02	24.463	19.52
345	J-151	5.045	0.01	24.463	19.38
347	J-152	5.06	0.08	24.493	19.39
349	J-153	4.672	0.04	24.493	19.78
351	J-154	4.693	0	24.493	19.76
353	J-155	4.61	0.02	24.493	19.84
355	J-156	4.82	0.01	24.493	19.63
357	J-157	4.493	0	24.493	19.96
359	J-158	5.056	0.08	24.568	19.47
361	J-159	5.056	0.15	24.57	19.47
363	J-160	5.044	0.14	24.646	19.56
365	J-161	4.701	0.03	24.646	19.9
367	J-162	5.07	0.04	24.66	19.55
369	J-163	4.684	0.01	24.66	19.94
371	J-164	4.951	0.08	24.671	19.68
373	J-165	4.735	0.05	24.67	19.9
375	J-166	5.012	0.1	24.691	19.64
377	J-167	4.609	0.06	24.69	20.04
379	J-168	5.072	0.06	24.709	19.6
381	J-169	4.922	0.02	24.709	19.75
383	J-170	5.085	0.08	24.724	19.6
385	J-171	4.713	0.03	24.724	19.97
387	J-172	5.221	0.14	24.755	19.49
389	J-173	5.166	0.08	24.754	19.55
391	J-174	5.247	0.12	24.788	19.5
393	J-175	4.497	0.07	24.787	20.25
395	J-176	5.289	0.06	24.801	19.47
397	J-177	4.935	0.02	24.801	19.83
399	J-178	5.198	0.12	24.829	19.59
401	J-179	4.698	0.08	24.829	20.09
403	J-180	4.969	0.01	24.829	19.82
405	J-181	4.605	0.03	24.829	20.18
407	J-182	4.598	0.02	24.829	20.19
409	J-183	5.369	0.13	24.879	19.47
411	J-184	4.385	0.06	24.878	20.45

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
413	J-185	5.374	0.1	24.901	19.49
415	J-186	4.674	0.03	24.901	20.19
417	J-187	5.544	0.14	24.968	19.38
419	J-188	4.623	0.03	24.968	20.3
421	J-189	4.515	0.14	24.541	19.99
423	J-190	5.251	0.04	24.541	19.25
425	J-191	4.611	0.06	24.552	19.9
428	J-192	4.554	0.24	24.514	19.92
430	J-193	4.28	0.05	24.514	20.19
432	J-194	4.379	0.01	24.514	20.09
434	J-195	4.56	0.02	24.514	19.91
436	J-196	4.605	0.04	24.514	19.87
439	J-197	3.345	(N/A)	(N/A)	(N/A)
441	J-198	4.225	0.18	24.473	20.21
443	J-199	3.572	0.02	24.473	20.86
445	J-200	5.95	0.12	24.469	18.48
447	J-201	3.6	0.02	24.469	20.83
449	J-202	4.517	0.02	24.451	19.89
451	J-203	4.25	0.12	24.407	20.12
453	J-204	4.566	0.07	24.402	19.8
455	J-205	4.566	0.09	24.402	19.8
457	J-206	4.397	0.01	24.402	19.96
459	J-207	3.857	0.07	24.402	20.5
461	J-208	4.293	0.09	24.335	20
463	J-209	4.065	0.05	24.335	20.23
465	J-210	4.43	0.01	24.335	19.86
467	J-211	4.143	0.01	24.335	20.15
469	J-212	4.375	0.08	24.305	19.89
471	J-213	4.68	0.04	24.305	19.59
473	J-214	4.565	0.18	24.279	19.67
475	J-215	4.332	0.07	24.278	19.91
477	J-216	4.005	0.16	24.221	20.18
479	J-217	4.274	0.02	24.221	19.91
481	J-218	4.188	0.1	24.218	19.99
483	J-219	3.825	0.03	24.218	20.35
485	J-220	3.957	0.11	24.219	20.22
487	J-221	3.913	0.12	24.218	20.26
489	J-222	3.456	0.04	24.218	20.72
491	J-223	3.478	0.02	24.218	20.7
494	J-224	4.415	0.11	24.216	19.76
496	J-225	4.089	0.04	24.216	20.09
498	J-226	4.439	0.02	24.216	19.74
500	J-227	4.611	0.19	24.353	19.7
502	J-228	4.962	0.04	24.352	19.35

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
504	J-229	4.879	0.01	24.352	19.43
506	J-230	4.914	0.04	24.352	19.4
508	J-231	4.437	0.02	24.352	19.88
510	J-232	4.766	0.01	24.352	19.55
512	J-233	4.136	0.05	23.87	19.69
514	J-234	4.393	0.02	23.87	19.44
516	J-235	4.29	0.07	23.87	19.54
518	J-236	4.389	0.03	23.87	19.44
520	J-237	4.162	0.03	23.87	19.67
522	J-238	4.57	0.2	23.872	19.26
525	J-239	4.464	0.26	23.741	19.24
527	J-240	4.036	0.03	23.741	19.67
529	J-241	4.731	0.43	23.304	18.54
531	J-242	4.308	0.29	22.872	18.53
533	J-243	4.14	0.02	22.872	18.69
535	J-244	4.252	0.03	22.84	18.55
537	J-245	4.056	0	22.84	18.75
539	J-246	4.11	0.03	22.832	18.68
541	J-247	4.093	0.01	22.832	18.7
543	J-248	4.229	0.04	22.819	18.55
545	J-249	4.048	0.01	22.819	18.73
547	J-250	4.276	0.05	22.795	18.48
549	J-251	4.49	0.02	22.795	18.27
551	J-252	3.979	0.03	22.781	18.76
553	J-253	3.686	0.03	22.781	19.06
555	J-254	4.241	0.09	22.772	18.49
557	J-255	4.104	0.22	22.722	18.58
559	J-256	4.269	0.12	22.749	18.44
561	J-257	4.368	0.08	22.748	18.34
565	J-259	4.091	0.02	22.738	18.61
567	J-260	4.409	0.04	22.708	18.26
569	J-261	4.685	0.15	22.704	17.98
571	J-262	4.353	0.04	22.704	18.31
573	J-263	4.587	0.08	22.704	18.08
575	J-264	4.16	0.1	22.707	18.51
577	J-265	4.31	0.02	22.707	18.36
579	J-266	4.192	0.02	22.707	18.48
581	J-267	5.567	0.15	24.113	18.51
584	J-268	4.907	0.03	24.113	19.17
586	J-269	5.347	0.06	24.843	19.46
590	J-270	5.266	0.08	24.577	19.27
592	J-271	5.526	0.01	24.577	19.01
594	J-272	5.085	0.12	24.546	19.42
596	J-273	5.012	0.07	24.546	19.49

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
598	J-274	4.918	0	24.546	19.59
600	J-275	5.037	0.04	24.545	19.47
602	J-276	4.872	0.1	24.527	19.62
604	J-277	4.59	0.01	24.527	19.9
606	J-278	4.517	0.06	24.513	19.96
608	J-279	4.484	0.09	24.513	19.99
610	J-280	4.599	0.01	24.513	19.87
612	J-281	4.61	0.06	24.512	19.86
614	J-282	4.67	0.13	24.511	19.8
616	J-283	4.482	0	24.511	19.99
618	J-284	4.799	0.18	24.494	19.66
620	J-285	4.394	0.09	24.491	20.06
622	J-286	4.237	0.01	24.491	20.21
624	J-287	4.868	0.08	24.492	19.58
626	J-288	4.781	0.13	24.49	19.67
629	J-289	4.653	0.08	24.489	19.8
631	J-290	5.165	0.01	24.489	19.29
633	J-291	5.46	0.07	24.011	18.51
635	J-292	4.556	0.04	24.011	19.42
637	J-293	4.685	0.02	24.489	19.76
640	J-294	5.466	0.04	24.849	19.34
642	J-295	4.793	0.02	24.849	20.02
644	J-296	4.933	0.17	24.833	19.86
646	J-297	4.759	0.14	24.829	20.03
648	J-298	5.47	0.07	24.78	19.27
650	J-299	5.204	0.01	24.78	19.54
652	J-300	5.332	0.07	24.695	19.32
654	J-301	6.429	0.02	24.856	18.39
656	J-302	5.318	0.06	24.647	19.29
658	J-303	4.893	0.01	24.647	19.71
663	J-304	4.664	0.21	24.216	19.51
665	J-305	4.462	0.08	24.216	19.71
667	J-306	4.565	0.07	24.14	19.54
669	J-307	4.519	0.05	24.138	19.58
671	J-308	4.516	0.02	24.138	19.58
673	J-309	4.847	0.07	24.135	19.25
675	J-310	4.802	0.01	24.135	19.29
677	J-311	4.464	0.14	24.132	19.63
679	J-312	4.47	0.02	24.132	19.62
681	J-313	4.646	0.02	24.132	19.45
683	J-314	4.59	0.06	24.132	19.5
685	J-315	4.531	0.07	24.118	19.55
687	J-316	4.415	0.01	24.118	19.66
689	J-317	4.409	0.03	24.118	19.67

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
691	J-318	4.517	0.04	24.105	19.55
693	J-319	4.601	0.02	24.105	19.46
695	J-320	4.675	0.04	24.094	19.38
697	J-321	4.761	0.02	24.094	19.29
699	J-322	4.791	0.07	24.077	19.25
701	J-323	4.976	0.09	24.076	19.06
703	J-324	5.813	0	24.076	18.23
705	J-325	5.199	0.04	24.075	18.84
707	J-326	4.914	0.03	24.072	19.12
709	J-327	4.927	0.01	24.072	19.11
711	J-328	4.801	0.1	24.061	19.22
713	J-329	4.485	0.07	24.06	19.54
715	J-330	4.799	0.07	24.054	19.22
717	J-331	4.339	0.02	24.054	19.68
719	J-332	4.765	0.06	24.039	19.24
723	J-334	4.759	0.01	24.039	19.24
725	J-335	4.555	0.13	24.038	19.44
727	J-336	4.709	0.03	24.038	19.29
729	J-337	4.557	0.14	24.033	19.44
731	J-338	4.154	0.04	24.033	19.84
733	J-339	4.308	0.02	24.033	19.69
735	J-340	4.868	0.06	24.034	19.13
737	J-341	4.619	0.04	24.034	19.38
739	J-342	4.971	0.05	24.029	19.02
741	J-343	4.881	0.01	24.029	19.11
743	J-344	4.571	0.12	24.006	19.4
745	J-345	4.481	0.02	24.003	19.48
747	J-346	4.6	0.14	24.003	19.36
750	J-347	4.56	0.14	23.998	19.4
752	J-348	4.882	0.03	23.998	19.08
754	J-349	3.931	0.01	23.998	20.03
756	J-350	4.942	0.13	24.017	19.04
759	J-351	4.685	0.04	24.017	19.29
761	J-352	4.858	0.09	24.007	19.11
763	J-353	5.287	0.08	24.504	19.18
765	J-354	4.396	(N/A)	(N/A)	(N/A)
768	J-355	5.347	0.08	24.839	19.45
772	J-356	5.305	0.03	24.591	19.25
775	J-357	5.305	0.16	24.571	19.23
780	J-358	4.705	0.04	24.504	19.76
782	J-359	5.281	0.04	24.463	19.14
784	J-360	4.872	0.01	24.463	19.55
786	J-361	5.223	0.02	24.444	19.18
788	J-362	5.094	0.01	24.444	19.31

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
790	J-363	5.296	0.05	24.427	19.09
792	J-364	4.791	0.03	24.427	19.6
794	J-365	5.281	0.05	24.411	19.09
796	J-366	4.788	0.04	24.411	19.58
798	J-367	5.245	0.06	24.401	19.12
800	J-368	4.714	0.11	24.397	19.64
802	J-369	4.658	0.01	24.397	19.7
804	J-370	5.327	0.06	24.396	19.03
807	J-371	5.427	0.07	24.387	18.92
809	J-372	4.777	0.05	24.387	19.57
811	J-373	5.543	0.1	24.364	18.78
813	J-374	5.129	0.07	24.363	19.2
815	J-375	4.913	0.02	24.363	19.41
817	J-376	5.228	0.03	24.363	19.1
819	J-377	5.708	0.14	24.166	18.42
821	J-378	5.906	0.1	24.111	18.17
823	J-379	5.134	0.03	24.111	18.94
825	J-380	5.787	0.08	24.08	18.26
827	J-381	5.085	0.03	24.08	18.96
829	J-382	5.298	0.08	24.052	18.72
831	J-383	5.022	0.01	24.052	18.99
833	J-384	5.332	0.1	24.022	18.65
835	J-385	5.332	0.08	24.018	18.65
837	J-386	5.239	0.08	24.015	18.74
839	J-387	5.093	0.04	24.015	18.88
841	J-388	5.538	0.09	24.014	18.44
843	J-389	5.334	0.02	24.01	18.64
849	J-390	4.537	0.05	24.022	19.45
851	J-391	5.693	0.07	24.152	18.42
853	J-392	5.434	0.02	24.152	18.68
855	J-393	5.473	0.03	24.149	18.64
857	J-394	5.247	0.01	24.149	18.86
859	J-395	5.58	0.04	24.148	18.53
861	J-396	5.288	0.02	24.148	18.82
863	J-397	5.531	0.03	24.146	18.58
865	J-398	5.218	0.02	24.146	18.89
867	J-399	5.567	0.05	24.146	18.54
869	J-400	5.099	0.02	24.145	19.01
871	J-401	5.598	0.14	24.144	18.51
873	J-402	4.567	0.13	24.14	19.53
875	J-403	4.313	0.03	24.14	19.79
877	J-404	3.92	0.01	24.14	20.18
879	J-405	5.499	0.07	24.144	18.61
881	J-406	4.676	0.01	24.144	19.43

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
883	J-407	5.288	0.08	24.145	18.82
885	J-408	4.167	0.03	24.145	19.94
887	J-409	5.485	0.04	24.147	18.62
889	J-410	4.943	0.02	24.147	19.16
891	J-411	5.477	0.04	24.148	18.63
893	J-412	4.929	0.02	24.148	19.18
895	J-413	5.618	0.06	24.151	18.5
897	J-414	5.138	0.01	24.151	18.97
899	J-415	5.676	0.15	24.161	18.45
901	J-416	4.895	0.03	24.161	19.23
903	J-417	4.936	(N/A)	(N/A)	(N/A)
905	J-418	5.146	0.1	24.805	19.62
907	J-419	5.116	0.03	24.805	19.65
909	J-420	5.42	0.12	24.733	19.27
911	J-421	5.3	0.06	24.733	19.39
913	J-422	5.327	0.2	24.723	19.36
915	J-423	5.3	0.06	24.723	19.38
917	J-424	5.437	0.26	24.588	19.11
919	J-425	5.119	0.02	24.588	19.43
921	J-426	5.288	0.12	24.378	19.05
923	J-427	5.107	0.02	24.378	19.23
925	J-428	5.475	0.02	24.363	18.85
927	J-429	5.35	0.01	24.363	18.97
929	J-430	5.569	0.03	24.352	18.74
931	J-431	5.371	0.02	24.352	18.94
933	J-432	5.477	0.08	24.342	18.83
935	J-433	5.351	0.02	24.342	18.95
937	J-434	5.554	0.1	24.273	18.68
939	J-435	5.334	0.02	24.273	18.9
941	J-436	5.617	0.04	24.251	18.6
943	J-437	5.18	0.01	24.251	19.03
945	J-438	5.356	0.04	24.242	18.85
947	J-439	5.065	0.01	24.242	19.14
949	J-440	4.909	0.06	24.227	19.28
951	J-441	4.11	0.01	24.227	20.08
953	J-442	4.911	0.03	24.209	19.26
1437	J-443	5.298	0.02	24.561	19.22
1447	J-444	4.944	0.21	23.662	18.68
1480	J-451	5.306	0.03	24.597	19.25
1487	J-453	5.521	0.22	25.028	19.47
1505	J-457	5.016	0.19	24.023	18.97
1509	J-458	3.979	0.07	22.781	18.76
1512	J-459	4.229	0.03	22.781	18.51
1514	J-460	4.35	0.11	22.738	18.35

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
1517	J-461	4.409	0.13	22.709	18.26
1526	J-463	3.543	0.07	22.743	19.16
1529	J-464	5.036	0.04	24.839	19.76
1533	J-465	5.35	0.07	24.009	18.62
1547	J-467	5.472	0.16	24.887	19.38
1550	J-468	5.424	0.1	24.885	19.42
1555	J-469	5.617	0.16	24.856	19.2
1567	J-471	5.1	0.09	24.204	19.07
1584	J-474	5.573	0.06	24.337	18.73
1587	J-475	5.55	0.09	24.337	18.75
1594	J-476	5.136	0.06	23.427	18.25
1597	J-477	4.8	0.04	23.427	18.59
1599	J-478	4.647	0.25	24.452	19.76
1602	J-479	4	0.16	24.446	20.4
1604	J-480	3.571	0.24	22.74	19.13
1607	J-481	4.36	0.05	22.74	18.34
1609	J-255/1	4.206	0.04	22.722	18.48
1612	J-305/1	4.402	0.06	24.215	19.77

Table 9.3 : Junction Details of HDPE Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
31	J-1	5.498	0.01	25.052	19.51
33	J-2	5.341	0.16	23.727	18.35
35	J-3	5.62	0.1	23.711	18.05
37	J-4	4.64	0.12	22.76	18.08
39	J-5	4.23	0.03	22.76	18.49
41	J-6	4.616	0.06	22.734	18.08
43	J-7	4.798	0.14	22.704	17.87
45	J-8	4.42	0.02	22.734	18.28
47	J-9	4.445	0.15	22.649	18.17
49	J-10	4.832	0.02	22.649	17.78
51	J-11	4.623	0.05	22.696	18.04
53	J-12	3.969	0.02	22.696	18.69
55	J-13	4.57	0.05	22.684	18.08
57	J-14	4.145	0.01	22.684	18.5
59	J-15	4.599	0.12	22.675	18.04
61	J-16	4.25	0.15	22.647	18.36
64	J-17	4.605	0.02	22.647	18.01
66	J-18	4.467	0.06	22.635	18.13
68	J-19	5.049	0.01	22.635	17.55
70	J-20	4.605	0.09	22.63	17.99
72	J-21	4.313	0.09	22.63	18.28
74	J-22	4.449	0.21	22.613	18.13

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
76	J-23	6.315	0.03	22.612	16.26
78	J-24	4.666	0.05	22.612	17.91
80	J-25	4.826	0.17	22.613	17.75
82	J-26	4.714	(N/A)	(N/A)	(N/A)
84	J-27	4.969	0.1	22.644	17.64
86	J-28	4.134	0.05	22.642	18.47
89	J-29	4.855	0.45	23.639	18.75
92	J-30	4.523	0.25	23.157	18.6
94	J-31	4.183	0.01	23.157	18.94
96	J-32	4.747	0.08	23.136	18.35
98	J-33	5.025	0.09	23.121	18.06
100	J-34	5.296	0.01	23.121	17.79
102	J-35	4.4	0.03	23.12	18.68
104	J-36	5.184	0.06	23.115	17.89
106	J-37	5.095	0.04	23.107	17.98
108	J-38	4.318	0.01	23.107	18.75
110	J-39	5.169	0.08	23.105	17.9
112	J-40	4.097	0.03	23.105	18.97
114	J-41	4.996	0.09	23.102	18.07
117	J-42	3.936	0.02	23.102	19.13
119	J-43	4.524	0.02	23.102	18.54
121	J-44	5.445	0.07	23.112	17.63
123	J-45	4.995	0.01	23.112	18.08
125	J-46	4.664	0.04	23.112	18.41
127	J-47	3.94	0.09	22.959	18.98
129	J-48	4.744	0.03	22.959	18.18
131	J-49	4.194	0.06	22.889	18.66
133	J-50	4.789	0.03	22.889	18.06
135	J-51	4.37	0.05	22.843	18.44
137	J-52	4.653	0.03	22.842	18.15
139	J-53	4.375	0.07	22.801	18.39
141	J-54	7.336	0.06	22.799	15.43
143	J-55	7.336	0.01	22.799	15.43
145	J-56	4.798	0.01	22.799	17.97
147	J-57	4.458	0.06	22.763	18.27
149	J-58	4.973	0.04	22.762	17.75
151	J-59	4.476	0.06	22.737	18.22
153	J-60	4.85	0.04	22.736	17.85
155	J-61	4.37	0.06	22.715	18.31
157	J-62	4.511	0.04	22.714	18.17
159	J-63	4.604	0.1	22.676	18.04
161	J-64	4.456	0.02	22.676	18.18
163	J-65	3.945	0.12	22.527	18.54
165	J-66	4.178	0.03	22.527	18.31

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
167	J-67	4.017	0.1	22.45	18.4
169	J-68	4.327	0.06	22.448	18.08
171	J-69	4.125	0.03	22.431	18.27
173	J-70	4.175	0.01	22.431	18.22
175	J-71	4.135	0.03	22.418	18.25
177	J-72	4.139	0.01	22.418	18.24
179	J-73	4.082	0.05	22.406	18.29
181	J-74	4.408	0.03	22.405	17.96
183	J-75	4.39	0.06	22.377	17.95
185	J-76	4.503	0.08	22.373	17.83
187	J-77	4.804	0.01	22.373	17.53
189	J-78	4.446	0.05	22.371	17.89
191	J-79	4.18	0.07	22.342	18.13
193	J-80	4.713	0.04	22.341	17.59
195	J-81	3.897	0.04	22.332	18.4
197	J-82	4.304	0.01	22.332	17.99
199	J-83	3.98	0.06	22.317	18.3
201	J-84	4.716	0.01	22.317	17.57
203	J-85	4.349	0.14	22.282	17.9
205	J-86	4.127	0.03	22.236	18.07
207	J-87	4.541	0.14	22.235	17.66
209	J-88	4.619	0.02	22.226	17.57
211	J-89	4.765	0.01	22.227	17.43
213	J-90	4.619	0.04	22.227	17.57
216	J-91	4.507	0.12	22.236	17.69
220	J-92	5.106	0.06	22.224	17.08
223	J-93	5.282	0.1	22.204	16.89
225	J-94	4.765	0.02	22.204	17.4
227	J-95	4.858	0.02	22.204	17.31
229	J-96	5.156	0.09	22.193	17
231	J-97	4.083	0.02	22.192	18.07
233	J-98	4.79	0.05	22.184	17.36
235	J-99	7.027	0.01	22.184	15.13
237	J-100	4.951	0.05	22.178	17.19
239	J-101	4.123	0.01	22.178	18.02
241	J-102	5.048	0.06	22.166	17.08
243	J-103	5.247	0.01	22.165	16.88
245	J-104	4.438	0.01	22.166	17.69
247	J-105	4.876	0.01	22.166	17.26
249	J-106	3.918	0.15	22.22	18.26
251	J-107	4.675	0.13	22.209	17.5
253	J-108	5.063	0.03	22.209	17.11
255	J-109	4.819	0.05	22.21	17.36
259	J-110	4.259	(N/A)	(N/A)	(N/A)

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
261	J-111	5.36	0.05	23.649	18.25
263	J-112	5.011	0.3	22.959	17.91
265	J-113	4.812	0.05	22.957	18.11
267	J-114	5.281	0.38	22.888	17.57
271	J-115	5.022	0.2	23.354	18.3
274	J-116	4.756	0.06	23.352	18.56
276	J-117	5.245	0.01	23.352	18.07
278	J-118	4.71	0.01	23.352	18.6
280	J-119	5.506	0.26	23.542	18
282	J-120	4.79	0.02	23.542	18.71
284	J-121	5.36	0.12	23.576	18.18
286	J-122	5.149	0.04	23.572	18.39
288	J-123	5.349	0.01	23.572	18.19
290	J-124	5.363	0.01	23.571	18.17
292	J-125	5.304	0.1	23.571	18.23
295	J-126	5.345	0.08	23.566	18.18
297	J-127	4.797	0.17	23.657	18.82
299	J-128	4.771	0.1	23.65	18.84
301	J-129	5.118	0.02	23.65	18.5
303	J-130	4.578	0.06	23.648	19.03
305	J-131	5.353	0.05	23.656	18.27
307	J-132	4.949	0.06	23.681	18.69
309	J-133	5.222	0.02	23.681	18.42
311	J-134	5.009	0.07	23.747	18.7
313	J-135	5.119	0.02	23.746	18.59
315	J-136	4.852	0.09	23.801	18.91
317	J-137	4.895	0.15	23.792	18.86
319	J-138	4.571	0.01	23.792	19.18
321	J-139	5.237	0.11	23.779	18.5
323	J-140	4.947	0.02	23.801	18.82
325	J-141	4.797	0.04	23.83	18.99
327	J-142	5.064	0.02	23.829	18.73
329	J-143	4.865	0.06	23.886	18.98
331	J-144	5.249	0.02	23.886	18.6
333	J-145	5.621	0.01	23.886	18.23
335	J-146	5.101	0.07	23.932	18.79
337	J-147	4.966	0.03	23.932	18.93
339	J-148	5.047	0.13	23.984	18.9
341	J-149	4.963	0.11	23.967	18.97
343	J-150	4.908	0.02	23.966	19.02
345	J-151	5.045	0.01	23.967	18.88
347	J-152	5.06	0.08	24.019	18.92
349	J-153	4.672	0.04	24.018	19.31
351	J-154	4.693	0	24.018	19.29

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
353	J-155	4.61	0.02	24.018	19.37
355	J-156	4.82	0.01	24.018	19.16
357	J-157	4.493	0	24.018	19.49
359	J-158	5.056	0.08	24.114	19.02
361	J-159	5.056	0.15	24.119	19.02
363	J-160	5.044	0.14	24.274	19.19
365	J-161	4.701	0.03	24.274	19.53
367	J-162	5.07	0.04	24.302	19.19
369	J-163	4.684	0.01	24.302	19.58
371	J-164	4.951	0.08	24.324	19.33
373	J-165	4.735	0.05	24.323	19.55
375	J-166	5.012	0.1	24.365	19.31
377	J-167	4.609	0.06	24.363	19.71
379	J-168	5.072	0.06	24.402	19.29
381	J-169	4.922	0.02	24.402	19.44
383	J-170	5.085	0.08	24.434	19.31
385	J-171	4.713	0.03	24.433	19.68
387	J-172	5.221	0.14	24.496	19.24
389	J-173	5.166	0.08	24.491	19.29
391	J-174	5.247	0.12	24.564	19.28
393	J-175	4.497	0.07	24.56	20.02
395	J-176	5.289	0.06	24.592	19.26
397	J-177	4.935	0.02	24.592	19.62
399	J-178	5.198	0.12	24.649	19.41
401	J-179	4.698	0.08	24.644	19.91
403	J-180	4.969	0.01	24.644	19.64
405	J-181	4.605	0.03	24.644	20
407	J-182	4.598	0.02	24.649	20.01
409	J-183	5.369	0.13	24.75	19.34
411	J-184	4.385	0.06	24.747	20.32
413	J-185	5.374	0.1	24.795	19.38
415	J-186	4.674	0.03	24.795	20.08
417	J-187	5.544	0.14	24.932	19.35
419	J-188	4.623	0.03	24.932	20.27
421	J-189	4.515	0.14	24.038	19.48
423	J-190	5.251	0.04	24.038	18.75
425	J-191	4.611	0.06	24.069	19.42
428	J-192	4.554	0.24	23.962	19.37
430	J-193	4.28	0.05	23.961	19.64
432	J-194	4.379	0.01	23.961	19.54
434	J-195	4.56	0.02	23.96	19.36
436	J-196	4.605	0.04	23.96	19.32
439	J-197	3.345	(N/A)	(N/A)	(N/A)
441	J-198	4.225	0.18	23.843	19.58

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
443	J-199	3.572	0.02	23.843	20.23
445	J-200	5.95	0.12	23.833	17.85
447	J-201	3.6	0.02	23.833	20.19
449	J-202	4.517	0.02	23.782	19.23
451	J-203	4.25	0.12	23.732	19.44
453	J-204	4.566	0.07	23.717	19.11
455	J-205	4.566	0.09	23.715	19.11
457	J-206	4.397	0.01	23.715	19.28
459	J-207	3.857	0.07	23.712	19.81
461	J-208	4.293	0.09	23.648	19.32
463	J-209	4.065	0.05	23.647	19.54
465	J-210	4.43	0.01	23.647	19.18
467	J-211	4.143	0.01	23.647	19.46
469	J-212	4.375	0.08	23.613	19.2
471	J-213	4.68	0.04	23.613	18.89
473	J-214	4.565	0.18	23.583	18.98
475	J-215	4.332	0.07	23.578	19.21
477	J-216	4.005	0.16	23.516	19.47
479	J-217	4.274	0.02	23.516	19.2
481	J-218	4.188	0.1	23.508	19.28
483	J-219	3.825	0.03	23.508	19.64
485	J-220	3.957	0.11	23.509	19.51
487	J-221	3.913	0.12	23.507	19.55
489	J-222	3.456	0.04	23.507	20.01
491	J-223	3.478	0.02	23.507	19.99
494	J-224	4.415	0.11	23.502	19.05
496	J-225	4.089	0.04	23.502	19.37
498	J-226	4.439	0.02	23.502	19.02
500	J-227	4.611	0.19	23.841	19.19
502	J-228	4.962	0.04	23.839	18.84
504	J-229	4.879	0.01	23.839	18.92
506	J-230	4.914	0.04	23.838	18.89
508	J-231	4.437	0.02	23.838	19.36
510	J-232	4.766	0.01	23.838	19.03
512	J-233	4.136	0.05	23.221	19.05
514	J-234	4.393	0.02	23.221	18.79
516	J-235	4.29	0.07	23.221	18.89
518	J-236	4.389	0.03	23.22	18.79
520	J-237	4.162	0.03	23.22	19.02
522	J-238	4.57	0.2	23.225	18.62
525	J-239	4.464	0.26	23.058	18.56
527	J-240	4.036	0.03	23.058	18.98
529	J-241	4.731	0.43	22.498	17.73
531	J-242	4.308	0.29	21.946	17.6

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
533	J-243	4.14	0.02	21.946	17.77
535	J-244	4.252	0.03	21.905	17.62
537	J-245	4.056	0	21.905	17.81
539	J-246	4.11	0.03	21.894	17.75
541	J-247	4.093	0.01	21.894	17.77
543	J-248	4.229	0.04	21.878	17.61
545	J-249	4.048	0.01	21.878	17.79
547	J-250	4.276	0.05	21.847	17.54
549	J-251	4.49	0.02	21.847	17.32
551	J-252	3.979	0.03	21.829	17.81
553	J-253	3.686	0.03	21.828	18.11
555	J-254	4.241	0.09	21.817	17.54
557	J-255	4.104	0.22	21.678	17.54
559	J-256	4.269	0.12	21.791	17.49
561	J-257	4.368	0.08	21.786	17.38
565	J-259	4.091	0.02	21.759	17.63
567	J-260	4.409	0.04	21.675	17.23
569	J-261	4.685	0.15	21.665	16.95
571	J-262	4.353	0.04	21.664	17.28
573	J-263	4.587	0.08	21.66	17.04
575	J-264	4.16	0.1	21.673	17.48
577	J-265	4.31	0.02	21.673	17.33
579	J-266	4.192	0.02	21.673	17.45
581	J-267	5.567	0.15	23.57	17.97
584	J-268	4.907	0.03	23.57	18.62
586	J-269	5.347	0.06	24.636	19.25
590	J-270	5.266	0.08	23.916	18.61
592	J-271	5.526	0.01	23.916	18.35
594	J-272	5.085	0.12	23.876	18.75
596	J-273	5.012	0.07	23.873	18.82
598	J-274	4.918	0	23.873	18.92
600	J-275	5.037	0.04	23.872	18.8
602	J-276	4.872	0.1	23.852	18.94
604	J-277	4.59	0.01	23.852	19.22
606	J-278	4.517	0.06	23.834	19.28
608	J-279	4.484	0.09	23.83	19.31
610	J-280	4.599	0.01	23.83	19.19
612	J-281	4.61	0.06	23.828	19.18
614	J-282	4.67	0.13	23.831	19.12
616	J-283	4.482	0	23.831	19.31
618	J-284	4.799	0.18	23.809	18.97
620	J-285	4.394	0.09	23.798	19.36
622	J-286	4.237	0.01	23.798	19.52
624	J-287	4.868	0.08	23.801	18.9

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
626	J-288	4.781	0.13	23.795	18.98
629	J-289	4.653	0.08	23.793	19.1
631	J-290	5.165	0.01	23.793	18.59
633	J-291	5.46	0.07	23.197	17.7
635	J-292	4.556	0.04	23.196	18.6
637	J-293	4.685	0.02	23.792	19.07
640	J-294	5.466	0.04	24.659	19.15
642	J-295	4.793	0.02	24.659	19.83
644	J-296	4.933	0.17	24.615	19.64
646	J-297	4.759	0.14	24.587	19.79
648	J-298	5.47	0.07	24.465	18.96
650	J-299	5.204	0.01	24.465	19.22
652	J-300	5.332	0.07	24.225	18.85
654	J-301	6.429	0.02	24.676	18.21
656	J-302	5.318	0.06	24.091	18.73
658	J-303	4.893	0.01	24.091	19.16
663	J-304	4.664	0.21	23.469	18.77
665	J-305	4.462	0.08	23.466	18.97
667	J-306	4.565	0.07	23.375	18.77
669	J-307	4.519	0.05	23.37	18.81
671	J-308	4.516	0.02	23.37	18.82
673	J-309	4.847	0.07	23.363	18.48
675	J-310	4.802	0.01	23.363	18.52
677	J-311	4.464	0.14	23.353	18.85
679	J-312	4.47	0.02	23.353	18.85
681	J-313	4.646	0.02	23.353	18.67
683	J-314	4.59	0.06	23.351	18.72
685	J-315	4.531	0.07	23.348	18.78
687	J-316	4.415	0.01	23.348	18.89
689	J-317	4.409	0.03	23.348	18.9
691	J-318	4.517	0.04	23.333	18.78
693	J-319	4.601	0.02	23.333	18.69
695	J-320	4.675	0.04	23.319	18.61
697	J-321	4.761	0.02	23.319	18.52
699	J-322	4.791	0.07	23.299	18.47
701	J-323	4.976	0.09	23.289	18.28
703	J-324	5.813	0	23.289	17.44
705	J-325	5.199	0.04	23.288	18.05
707	J-326	4.914	0.03	23.293	18.34
709	J-327	4.927	0.01	23.293	18.33
711	J-328	4.801	0.1	23.279	18.44
713	J-329	4.485	0.07	23.276	18.75
715	J-330	4.799	0.07	23.271	18.44
717	J-331	4.339	0.02	23.271	18.89

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
719	J-332	4.765	0.06	23.254	18.45
723	J-334	4.759	0.01	23.254	18.46
725	J-335	4.555	0.13	23.249	18.66
727	J-336	4.709	0.03	23.249	18.5
729	J-337	4.557	0.14	23.216	18.62
731	J-338	4.154	0.04	23.215	19.02
733	J-339	4.308	0.02	23.216	18.87
735	J-340	4.868	0.06	23.241	18.34
737	J-341	4.619	0.04	23.24	18.58
739	J-342	4.971	0.05	23.229	18.22
741	J-343	4.881	0.01	23.229	18.31
743	J-344	4.571	0.12	23.176	18.57
745	J-345	4.481	0.02	23.165	18.65
747	J-346	4.6	0.14	23.165	18.53
750	J-347	4.56	0.14	23.137	18.54
752	J-348	4.882	0.03	23.137	18.22
754	J-349	3.931	0.01	23.137	19.17
756	J-350	4.942	0.13	23.199	18.22
759	J-351	4.685	0.04	23.198	18.48
761	J-352	4.858	0.09	23.179	18.28
763	J-353	5.287	0.08	23.83	18.51
765	J-354	4.396	(N/A)	(N/A)	(N/A)
768	J-355	5.347	0.08	24.625	19.24
772	J-356	5.305	0.03	23.934	18.59
775	J-357	5.305	0.16	23.909	18.57
780	J-358	4.705	0.04	23.829	19.09
782	J-359	5.281	0.04	23.777	18.46
784	J-360	4.872	0.01	23.777	18.87
786	J-361	5.223	0.02	23.753	18.49
788	J-362	5.094	0.01	23.753	18.62
790	J-363	5.296	0.05	23.732	18.4
792	J-364	4.791	0.03	23.731	18.9
794	J-365	5.281	0.05	23.711	18.39
796	J-366	4.788	0.04	23.71	18.88
798	J-367	5.245	0.06	23.699	18.42
800	J-368	4.714	0.11	23.691	18.94
802	J-369	4.658	0.01	23.691	18.99
804	J-370	5.327	0.06	23.691	18.33
807	J-371	5.427	0.07	23.68	18.22
809	J-372	4.777	0.05	23.679	18.86
811	J-373	5.543	0.1	23.65	18.07
813	J-374	5.129	0.07	23.646	18.48
815	J-375	4.913	0.02	23.646	18.7
817	J-376	5.228	0.03	23.646	18.38

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
819	J-377	5.708	0.14	23.421	17.68
821	J-378	5.906	0.1	23.351	17.41
823	J-379	5.134	0.03	23.351	18.18
825	J-380	5.787	0.08	23.312	17.49
827	J-381	5.085	0.03	23.312	18.19
829	J-382	5.298	0.08	23.277	17.94
831	J-383	5.022	0.01	23.277	18.22
833	J-384	5.332	0.1	23.238	17.87
835	J-385	5.332	0.08	23.225	17.86
837	J-386	5.239	0.08	23.214	17.94
839	J-387	5.093	0.04	23.213	18.08
841	J-388	5.538	0.09	23.206	17.63
843	J-389	5.334	0.02	23.192	17.82
849	J-390	4.537	0.05	23.237	18.66
851	J-391	5.693	0.07	23.385	17.66
853	J-392	5.434	0.02	23.385	17.91
855	J-393	5.473	0.03	23.379	17.87
857	J-394	5.247	0.01	23.379	18.1
859	J-395	5.58	0.04	23.375	17.76
861	J-396	5.288	0.02	23.375	18.05
863	J-397	5.531	0.03	23.372	17.8
865	J-398	5.218	0.02	23.372	18.12
867	J-399	5.567	0.05	23.371	17.77
869	J-400	5.099	0.02	23.371	18.24
871	J-401	5.598	0.14	23.367	17.73
873	J-402	4.567	0.13	23.357	18.75
875	J-403	4.313	0.03	23.357	19.01
877	J-404	3.92	0.01	23.357	19.4
879	J-405	5.499	0.07	23.369	17.83
881	J-406	4.676	0.01	23.369	18.66
883	J-407	5.288	0.08	23.375	18.05
885	J-408	4.167	0.03	23.374	19.17
887	J-409	5.485	0.04	23.38	17.86
889	J-410	4.943	0.02	23.38	18.4
891	J-411	5.477	0.04	23.385	17.87
893	J-412	4.929	0.02	23.385	18.42
895	J-413	5.618	0.06	23.394	17.74
897	J-414	5.138	0.01	23.394	18.22
899	J-415	5.676	0.15	23.428	17.72
901	J-416	4.895	0.03	23.427	18.5
903	J-417	4.936	(N/A)	(N/A)	(N/A)
905	J-418	5.146	0.1	24.581	19.4
907	J-419	5.116	0.03	24.581	19.43
909	J-420	5.42	0.12	24.485	19.03

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
911	J-421	5.3	0.06	24.482	19.14
913	J-422	5.327	0.2	24.472	19.11
915	J-423	5.3	0.06	24.469	19.13
917	J-424	5.437	0.26	24.29	18.82
919	J-425	5.119	0.02	24.29	19.13
921	J-426	5.288	0.12	24.032	18.71
923	J-427	5.107	0.02	24.032	18.89
925	J-428	5.475	0.02	24.014	18.5
927	J-429	5.35	0.01	24.014	18.63
929	J-430	5.569	0.03	24.001	18.39
931	J-431	5.371	0.02	24	18.59
933	J-432	5.477	0.08	23.989	18.47
935	J-433	5.351	0.02	23.989	18.6
937	J-434	5.554	0.1	23.779	18.19
939	J-435	5.334	0.02	23.779	18.41
941	J-436	5.617	0.04	23.712	18.06
943	J-437	5.18	0.01	23.712	18.49
945	J-438	5.356	0.04	23.682	18.29
947	J-439	5.065	0.01	23.682	18.58
949	J-440	4.909	0.06	23.638	18.69
951	J-441	4.11	0.01	23.638	19.49
953	J-442	4.911	0.03	23.581	18.63
1437	J-443	5.298	0.02	23.904	18.57
1447	J-444	4.944	0.21	22.629	17.65
1480	J-451	5.306	0.03	23.949	18.61
1487	J-453	5.521	0.22	25.055	19.5
1505	J-457	5.016	0.19	23.1	18.05
1509	J-458	3.979	0.07	21.828	17.81
1512	J-459	4.229	0.03	21.828	17.56
1514	J-460	4.35	0.11	21.759	17.37
1517	J-461	4.409	0.13	21.677	17.23
1526	J-463	3.543	0.07	21.737	18.16
1529	J-464	5.036	0.04	24.625	19.55
1533	J-465	5.35	0.07	23.189	17.8
1547	J-467	5.472	0.16	24.768	19.26
1550	J-468	5.424	0.1	24.761	19.3
1555	J-469	5.617	0.16	24.676	19.02
1567	J-471	5.1	0.09	23.565	18.43
1584	J-474	5.573	0.06	23.65	18.04
1587	J-475	5.55	0.09	23.651	18.07
1594	J-476	5.136	0.06	22.165	16.99
1597	J-477	4.8	0.04	22.164	17.33
1599	J-478	4.647	0.25	23.785	19.1
1602	J-479	4	0.16	23.743	19.7

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
1604	J-480	3.571	0.24	21.728	18.12
1607	J-481	4.36	0.05	21.726	17.33
1609	J-255/1	4.206	0.04	21.677	17.44
1612	J-305/1	4.402	0.06	23.464	19.02

Table 9.4 : Junction Details of uPVC Pipe Network

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
31	J-1	5.498	0.01	25.044	19.51
33	J-2	5.341	0.16	24.188	18.81
35	J-3	5.62	0.1	24.178	18.52
37	J-4	4.64	0.12	23.729	19.05
39	J-5	4.23	0.03	23.729	19.46
41	J-6	4.616	0.06	23.712	19.06
43	J-7	4.798	0.14	23.693	18.86
45	J-8	4.42	0.02	23.712	19.25
47	J-9	4.445	0.15	23.679	19.2
49	J-10	4.832	0.02	23.679	18.81
51	J-11	4.623	0.05	23.689	19.03
53	J-12	3.969	0.02	23.689	19.68
55	J-13	4.57	0.05	23.684	19.08
57	J-14	4.145	0.01	23.684	19.5
59	J-15	4.599	0.12	23.68	19.04
61	J-16	4.25	0.15	23.678	19.39
64	J-17	4.605	0.02	23.678	19.03
66	J-18	4.467	0.06	23.675	19.17
68	J-19	5.049	0.01	23.675	18.59
70	J-20	4.605	0.09	23.674	19.03
72	J-21	4.313	0.09	23.674	19.32
74	J-22	4.449	0.21	23.671	19.18
76	J-23	6.315	0.03	23.671	17.32
78	J-24	4.666	0.05	23.671	18.97
80	J-25	4.826	0.17	23.671	18.81
82	J-26	4.714	(N/A)	(N/A)	(N/A)
84	J-27	4.969	0.1	23.677	18.67
86	J-28	4.134	0.05	23.677	19.5
89	J-29	4.855	0.45	23.939	19.05
92	J-30	4.523	0.25	22.93	18.37
94	J-31	4.183	0.01	22.93	18.71
96	J-32	4.747	0.08	22.885	18.1
98	J-33	5.025	0.09	22.881	17.82
100	J-34	5.296	0.01	22.881	17.55
102	J-35	4.4	0.03	22.881	18.44

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
104	J-36	5.184	0.06	22.88	17.66
106	J-37	5.095	0.04	22.879	17.75
108	J-38	4.318	0.01	22.879	18.52
110	J-39	5.169	0.08	22.879	17.67
112	J-40	4.097	0.03	22.879	18.74
114	J-41	4.996	0.09	22.879	17.85
117	J-42	3.936	0.02	22.879	18.9
119	J-43	4.524	0.02	22.879	18.32
121	J-44	5.445	0.07	22.88	17.4
123	J-45	4.995	0.01	22.88	17.85
125	J-46	4.664	0.04	22.88	18.18
127	J-47	3.94	0.09	22.771	18.79
129	J-48	4.744	0.03	22.771	17.99
131	J-49	4.194	0.06	22.726	18.49
133	J-50	4.789	0.03	22.726	17.9
135	J-51	4.37	0.05	22.696	18.29
137	J-52	4.653	0.03	22.696	18.01
139	J-53	4.375	0.07	22.668	18.26
141	J-54	7.336	0.06	22.668	15.3
143	J-55	7.336	0.01	22.668	15.3
145	J-56	4.798	0.01	22.668	17.83
147	J-57	4.458	0.06	22.644	18.15
149	J-58	4.973	0.04	22.644	17.64
151	J-59	4.476	0.06	22.627	18.11
153	J-60	4.85	0.04	22.627	17.74
155	J-61	4.37	0.06	22.613	18.21
157	J-62	4.511	0.04	22.613	18.07
159	J-63	4.604	0.1	22.588	17.95
161	J-64	4.456	0.02	22.588	18.1
163	J-65	3.945	0.12	22.492	18.51
165	J-66	4.178	0.03	22.492	18.28
167	J-67	4.017	0.1	22.442	18.39
169	J-68	4.327	0.06	22.442	18.08
171	J-69	4.125	0.03	22.43	18.27
173	J-70	4.175	0.01	22.43	18.22
175	J-71	4.135	0.03	22.422	18.25
177	J-72	4.139	0.01	22.422	18.25
179	J-73	4.082	0.05	22.413	18.29
181	J-74	4.408	0.03	22.413	17.97
183	J-75	4.39	0.06	22.395	17.97
185	J-76	4.503	0.08	22.395	17.86
187	J-77	4.804	0.01	22.395	17.56
189	J-78	4.446	0.05	22.395	17.91
191	J-79	4.18	0.07	22.372	18.16

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
193	J-80	4.713	0.04	22.372	17.62
195	J-81	3.897	0.04	22.366	18.43
197	J-82	4.304	0.01	22.366	18.03
199	J-83	3.98	0.06	22.356	18.34
201	J-84	4.716	0.01	22.356	17.6
203	J-85	4.349	0.14	22.334	17.95
205	J-86	4.127	0.03	22.326	18.16
207	J-87	4.541	0.14	22.325	17.75
209	J-88	4.619	0.02	22.324	17.67
211	J-89	4.765	0.01	22.325	17.52
213	J-90	4.619	0.04	22.325	17.67
216	J-91	4.507	0.12	22.326	17.78
220	J-92	5.106	0.06	22.324	17.18
223	J-93	5.282	0.1	22.32	17
225	J-94	4.765	0.02	22.32	17.52
227	J-95	4.858	0.02	22.32	17.43
229	J-96	5.156	0.09	22.317	17.13
231	J-97	4.083	0.02	22.317	18.2
233	J-98	4.79	0.05	22.316	17.49
235	J-99	7.027	0.01	22.316	15.26
237	J-100	4.951	0.05	22.316	17.33
239	J-101	4.123	0.01	22.316	18.16
241	J-102	5.048	0.06	22.316	17.23
243	J-103	5.247	0.01	22.315	17.03
245	J-104	4.438	0.01	22.316	17.84
247	J-105	4.876	0.01	22.316	17.4
249	J-106	3.918	0.15	22.322	18.37
251	J-107	4.675	0.13	22.321	17.61
253	J-108	5.063	0.03	22.321	17.22
255	J-109	4.819	0.05	22.321	17.47
259	J-110	4.259	(N/A)	(N/A)	(N/A)
261	J-111	5.36	0.05	24.177	18.78
263	J-112	5.011	0.3	23.838	18.79
265	J-113	4.812	0.05	23.838	18.99
267	J-114	5.281	0.38	23.811	18.49
271	J-115	5.022	0.2	24.047	18.99
274	J-116	4.756	0.06	24.047	19.25
276	J-117	5.245	0.01	24.047	18.76
278	J-118	4.71	0.01	24.047	19.3
280	J-119	5.506	0.26	23.355	17.81
282	J-120	4.79	0.02	23.355	18.53
284	J-121	5.36	0.12	23.364	17.97
286	J-122	5.149	0.04	23.364	18.18
288	J-123	5.349	0.01	23.364	17.98

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
290	J-124	5.363	0.01	23.364	17.96
292	J-125	5.304	0.1	23.364	18.02
295	J-126	5.345	0.08	23.363	17.98
297	J-127	4.797	0.17	23.384	18.55
299	J-128	4.771	0.1	23.384	18.58
301	J-129	5.118	0.02	23.384	18.23
303	J-130	4.578	0.06	23.383	18.77
305	J-131	5.353	0.05	23.384	17.99
307	J-132	4.949	0.06	23.389	18.4
309	J-133	5.222	0.02	23.389	18.13
311	J-134	5.009	0.07	23.405	18.36
313	J-135	5.119	0.02	23.405	18.25
315	J-136	4.852	0.09	23.418	18.53
317	J-137	4.895	0.15	23.418	18.49
319	J-138	4.571	0.01	23.418	18.81
321	J-139	5.237	0.11	23.417	18.14
323	J-140	4.947	0.02	23.418	18.43
325	J-141	4.797	0.04	23.425	18.59
327	J-142	5.064	0.02	23.425	18.32
329	J-143	4.865	0.06	23.439	18.54
331	J-144	5.249	0.02	23.439	18.15
333	J-145	5.621	0.01	23.439	17.78
335	J-146	5.101	0.07	23.45	18.31
337	J-147	4.966	0.03	23.45	18.45
339	J-148	5.047	0.13	23.483	18.4
341	J-149	4.963	0.11	23.483	18.48
343	J-150	4.908	0.02	23.483	18.54
345	J-151	5.045	0.01	23.483	18.4
347	J-152	5.06	0.08	23.506	18.41
349	J-153	4.672	0.04	23.506	18.8
351	J-154	4.693	0	23.506	18.77
353	J-155	4.61	0.02	23.506	18.86
355	J-156	4.82	0.01	23.506	18.65
357	J-157	4.493	0	23.506	18.97
359	J-158	5.056	0.08	23.567	18.47
361	J-159	5.056	0.15	23.587	18.49
363	J-160	5.044	0.14	24.158	19.08
365	J-161	4.701	0.03	24.158	19.42
367	J-162	5.07	0.04	24.261	19.15
369	J-163	4.684	0.01	24.261	19.54
371	J-164	4.951	0.08	24.342	19.35
373	J-165	4.735	0.05	24.342	19.57
375	J-166	5.012	0.1	24.492	19.44
377	J-167	4.609	0.06	24.492	19.84

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
379	J-168	5.072	0.06	24.628	19.52
381	J-169	4.922	0.02	24.628	19.67
383	J-170	5.085	0.08	24.648	19.52
385	J-171	4.713	0.03	24.648	19.9
387	J-172	5.221	0.14	24.689	19.43
389	J-173	5.166	0.08	24.689	19.48
391	J-174	5.247	0.12	24.732	19.45
393	J-175	4.497	0.07	24.732	20.19
395	J-176	5.289	0.06	24.751	19.42
397	J-177	4.935	0.02	24.751	19.78
399	J-178	5.198	0.12	24.787	19.55
401	J-179	4.698	0.08	24.787	20.05
403	J-180	4.969	0.01	24.787	19.78
405	J-181	4.605	0.03	24.787	20.14
407	J-182	4.598	0.02	24.787	20.15
409	J-183	5.369	0.13	24.853	19.44
411	J-184	4.385	0.06	24.853	20.43
413	J-185	5.374	0.1	24.882	19.47
415	J-186	4.674	0.03	24.882	20.17
417	J-187	5.544	0.14	24.97	19.39
419	J-188	4.623	0.03	24.97	20.31
421	J-189	4.515	0.14	23.532	18.98
423	J-190	5.251	0.04	23.532	18.24
425	J-191	4.611	0.06	23.562	18.91
428	J-192	4.554	0.24	23.455	18.86
430	J-193	4.28	0.05	23.455	19.14
432	J-194	4.379	0.01	23.455	19.04
434	J-195	4.56	0.02	23.454	18.86
436	J-196	4.605	0.04	23.454	18.81
439	J-197	3.345	(N/A)	(N/A)	(N/A)
441	J-198	4.225	0.18	23.336	19.07
443	J-199	3.572	0.02	23.336	19.72
445	J-200	5.95	0.12	23.327	17.34
447	J-201	3.6	0.02	23.327	19.69
449	J-202	4.517	0.02	23.275	18.72
451	J-203	4.25	0.12	23.263	18.97
453	J-204	4.566	0.07	23.259	18.66
455	J-205	4.566	0.09	23.259	18.66
457	J-206	4.397	0.01	23.259	18.82
459	J-207	3.857	0.07	23.259	19.36
461	J-208	4.293	0.09	23.243	18.91
463	J-209	4.065	0.05	23.243	19.14
465	J-210	4.43	0.01	23.243	18.77
467	J-211	4.143	0.01	23.243	19.06

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
469	J-212	4.375	0.08	23.235	18.82
471	J-213	4.68	0.04	23.235	18.52
473	J-214	4.565	0.18	23.227	18.62
475	J-215	4.332	0.07	23.227	18.86
477	J-216	4.005	0.16	23.211	19.17
479	J-217	4.274	0.02	23.211	18.9
481	J-218	4.188	0.1	23.209	18.98
483	J-219	3.825	0.03	23.209	19.34
485	J-220	3.957	0.11	23.209	19.21
487	J-221	3.913	0.12	23.209	19.26
489	J-222	3.456	0.04	23.209	19.71
491	J-223	3.478	0.02	23.209	19.69
494	J-224	4.415	0.11	23.208	18.75
496	J-225	4.089	0.04	23.208	19.08
498	J-226	4.439	0.02	23.208	18.73
500	J-227	4.611	0.19	23.577	18.93
502	J-228	4.962	0.04	23.577	18.58
504	J-229	4.879	0.01	23.577	18.66
506	J-230	4.914	0.04	23.577	18.63
508	J-231	4.437	0.02	23.577	19.1
510	J-232	4.766	0.01	23.577	18.77
512	J-233	4.136	0.05	23.179	19
514	J-234	4.393	0.02	23.179	18.75
516	J-235	4.29	0.07	23.178	18.85
518	J-236	4.389	0.03	23.178	18.75
520	J-237	4.162	0.03	23.178	18.98
522	J-238	4.57	0.2	23.18	18.57
525	J-239	4.464	0.26	23.072	18.57
527	J-240	4.036	0.03	23.072	19
529	J-241	4.731	0.43	22.71	17.94
531	J-242	4.308	0.29	22.353	18.01
533	J-243	4.14	0.02	22.353	18.18
535	J-244	4.252	0.03	22.327	18.04
537	J-245	4.056	0	22.327	18.23
539	J-246	4.11	0.03	22.32	18.17
541	J-247	4.093	0.01	22.32	18.19
543	J-248	4.229	0.04	22.309	18.04
545	J-249	4.048	0.01	22.309	18.22
547	J-250	4.276	0.05	22.289	17.98
549	J-251	4.49	0.02	22.289	17.76
551	J-252	3.979	0.03	22.278	18.26
553	J-253	3.686	0.03	22.277	18.55
555	J-254	4.241	0.09	22.27	17.99
557	J-255	4.104	0.22	22.233	18.09

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
559	J-256	4.269	0.12	22.264	17.96
561	J-257	4.368	0.08	22.263	17.86
565	J-259	4.091	0.02	22.255	18.13
567	J-260	4.409	0.04	22.233	17.79
569	J-261	4.685	0.15	22.23	17.51
571	J-262	4.353	0.04	22.23	17.84
573	J-263	4.587	0.08	22.23	17.61
575	J-264	4.16	0.1	22.232	18.04
577	J-265	4.31	0.02	22.232	17.89
579	J-266	4.192	0.02	22.232	18
581	J-267	5.567	0.15	23.363	17.76
584	J-268	4.907	0.03	23.363	18.42
586	J-269	5.347	0.06	24.692	19.31
590	J-270	5.266	0.08	24.103	18.8
592	J-271	5.526	0.01	24.103	18.54
594	J-272	5.085	0.12	24.077	18.95
596	J-273	5.012	0.07	24.077	19.03
598	J-274	4.918	0	24.077	19.12
600	J-275	5.037	0.04	24.077	19
602	J-276	4.872	0.1	24.061	19.15
604	J-277	4.59	0.01	24.061	19.43
606	J-278	4.517	0.06	24.05	19.49
608	J-279	4.484	0.09	24.05	19.53
610	J-280	4.599	0.01	24.05	19.41
612	J-281	4.61	0.06	24.049	19.4
614	J-282	4.67	0.13	24.048	19.34
616	J-283	4.482	0	24.048	19.53
618	J-284	4.799	0.18	24.034	19.2
620	J-285	4.394	0.09	24.032	19.6
622	J-286	4.237	0.01	24.032	19.76
624	J-287	4.868	0.08	24.032	19.13
626	J-288	4.781	0.13	24.031	19.21
629	J-289	4.653	0.08	24.031	19.34
631	J-290	5.165	0.01	24.031	18.83
633	J-291	5.46	0.07	23.804	18.31
635	J-292	4.556	0.04	23.804	19.21
637	J-293	4.685	0.02	24.031	19.31
640	J-294	5.466	0.04	24.766	19.26
642	J-295	4.793	0.02	24.766	19.93
644	J-296	4.933	0.17	24.726	19.75
646	J-297	4.759	0.14	24.723	19.92
648	J-298	5.47	0.07	24.591	19.08
650	J-299	5.204	0.01	24.591	19.35
652	J-300	5.332	0.07	24.375	19

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
654	J-301	6.429	0.02	24.746	18.28
656	J-302	5.318	0.06	24.255	18.9
658	J-303	4.893	0.01	24.255	19.32
663	J-304	4.664	0.21	23.876	19.17
665	J-305	4.462	0.08	23.876	19.37
667	J-306	4.565	0.07	23.83	19.23
669	J-307	4.519	0.05	23.828	19.27
671	J-308	4.516	0.02	23.828	19.27
673	J-309	4.847	0.07	23.826	18.94
675	J-310	4.802	0.01	23.826	18.99
677	J-311	4.464	0.14	23.824	19.32
679	J-312	4.47	0.02	23.824	19.32
681	J-313	4.646	0.02	23.824	19.14
683	J-314	4.59	0.06	23.824	19.19
685	J-315	4.531	0.07	23.817	19.25
687	J-316	4.415	0.01	23.817	19.36
689	J-317	4.409	0.03	23.817	19.37
691	J-318	4.517	0.04	23.811	19.25
693	J-319	4.601	0.02	23.811	19.17
695	J-320	4.675	0.04	23.805	19.09
697	J-321	4.761	0.02	23.805	19.01
699	J-322	4.791	0.07	23.796	18.97
701	J-323	4.976	0.09	23.795	18.78
703	J-324	5.813	0	23.795	17.95
705	J-325	5.199	0.04	23.795	18.56
707	J-326	4.914	0.03	23.794	18.84
709	J-327	4.927	0.01	23.794	18.83
711	J-328	4.801	0.1	23.788	18.95
713	J-329	4.485	0.07	23.788	19.26
715	J-330	4.799	0.07	23.785	18.95
717	J-331	4.339	0.02	23.785	19.41
719	J-332	4.765	0.06	23.779	18.98
723	J-334	4.759	0.01	23.779	18.98
725	J-335	4.555	0.13	23.778	19.18
727	J-336	4.709	0.03	23.778	19.03
729	J-337	4.557	0.14	23.774	19.18
731	J-338	4.154	0.04	23.774	19.58
733	J-339	4.308	0.02	23.774	19.43
735	J-340	4.868	0.06	23.778	18.87
737	J-341	4.619	0.04	23.778	19.12
739	J-342	4.971	0.05	23.777	18.77
741	J-343	4.881	0.01	23.777	18.86
743	J-344	4.571	0.12	23.776	19.17
745	J-345	4.481	0.02	23.773	19.25

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
747	J-346	4.6	0.14	23.773	19.13
750	J-347	4.56	0.14	23.77	19.17
752	J-348	4.882	0.03	23.77	18.85
754	J-349	3.931	0.01	23.77	19.8
756	J-350	4.942	0.13	23.776	18.8
759	J-351	4.685	0.04	23.776	19.05
761	J-352	4.858	0.09	23.782	18.89
763	J-353	5.287	0.08	24.056	18.73
765	J-354	4.396	(N/A)	(N/A)	(N/A)
768	J-355	5.347	0.08	24.678	19.29
772	J-356	5.305	0.03	24.114	18.77
775	J-357	5.305	0.16	24.101	18.76
780	J-358	4.705	0.04	24.055	19.31
782	J-359	5.281	0.04	24.023	18.7
784	J-360	4.872	0.01	24.023	19.11
786	J-361	5.223	0.02	24.009	18.75
788	J-362	5.094	0.01	24.009	18.88
790	J-363	5.296	0.05	23.996	18.66
792	J-364	4.791	0.03	23.996	19.17
794	J-365	5.281	0.05	23.983	18.66
796	J-366	4.788	0.04	23.983	19.16
798	J-367	5.245	0.06	23.976	18.69
800	J-368	4.714	0.11	23.973	19.22
802	J-369	4.658	0.01	23.973	19.28
804	J-370	5.327	0.06	23.972	18.61
807	J-371	5.427	0.07	23.965	18.5
809	J-372	4.777	0.05	23.965	19.15
811	J-373	5.543	0.1	23.948	18.37
813	J-374	5.129	0.07	23.947	18.78
815	J-375	4.913	0.02	23.947	19
817	J-376	5.228	0.03	23.947	18.68
819	J-377	5.708	0.14	23.898	18.15
821	J-378	5.906	0.1	23.872	17.93
823	J-379	5.134	0.03	23.872	18.7
825	J-380	5.787	0.08	23.857	18.03
827	J-381	5.085	0.03	23.857	18.73
829	J-382	5.298	0.08	23.843	18.51
831	J-383	5.022	0.01	23.843	18.78
833	J-384	5.332	0.1	23.826	18.46
835	J-385	5.332	0.08	23.819	18.45
837	J-386	5.239	0.08	23.815	18.54
839	J-387	5.093	0.04	23.815	18.68
841	J-388	5.538	0.09	23.811	18.24
843	J-389	5.334	0.02	23.8	18.43

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
849	J-390	4.537	0.05	23.826	19.25
851	J-391	5.693	0.07	23.897	18.17
853	J-392	5.434	0.02	23.897	18.43
855	J-393	5.473	0.03	23.897	18.39
857	J-394	5.247	0.01	23.897	18.61
859	J-395	5.58	0.04	23.897	18.28
861	J-396	5.288	0.02	23.897	18.57
863	J-397	5.531	0.03	23.897	18.33
865	J-398	5.218	0.02	23.897	18.64
867	J-399	5.567	0.05	23.897	18.29
869	J-400	5.099	0.02	23.897	18.76
871	J-401	5.598	0.14	23.899	18.26
873	J-402	4.567	0.13	23.896	19.29
875	J-403	4.313	0.03	23.896	19.54
877	J-404	3.92	0.01	23.896	19.94
879	J-405	5.499	0.07	23.905	18.37
881	J-406	4.676	0.01	23.905	19.19
883	J-407	5.288	0.08	23.915	18.59
885	J-408	4.167	0.03	23.915	19.71
887	J-409	5.485	0.04	23.921	18.4
889	J-410	4.943	0.02	23.921	18.94
891	J-411	5.477	0.04	23.926	18.41
893	J-412	4.929	0.02	23.926	18.96
895	J-413	5.618	0.06	23.934	18.28
897	J-414	5.138	0.01	23.934	18.76
899	J-415	5.676	0.15	23.96	18.25
901	J-416	4.895	0.03	23.96	19.03
903	J-417	4.936	(N/A)	(N/A)	(N/A)
905	J-418	5.146	0.1	24.64	19.45
907	J-419	5.116	0.03	24.64	19.48
909	J-420	5.42	0.12	24.555	19.1
911	J-421	5.3	0.06	24.555	19.22
913	J-422	5.327	0.2	24.543	19.18
915	J-423	5.3	0.06	24.542	19.2
917	J-424	5.437	0.26	24.37	18.89
919	J-425	5.119	0.02	24.37	19.21
921	J-426	5.288	0.12	24.272	18.95
923	J-427	5.107	0.02	24.272	19.13
925	J-428	5.475	0.02	24.265	18.75
927	J-429	5.35	0.01	24.265	18.88
929	J-430	5.569	0.03	24.26	18.65
931	J-431	5.371	0.02	24.26	18.85
933	J-432	5.477	0.08	24.255	18.74
935	J-433	5.351	0.02	24.255	18.87

ID	Label	Elevation (m)	Demand (L/s)	Hydraulic Grade (m)	Pressure (m H2O)
937	J-434	5.554	0.1	24.156	18.57
939	J-435	5.334	0.02	24.156	18.78
941	J-436	5.617	0.04	24.123	18.47
943	J-437	5.18	0.01	24.123	18.91
945	J-438	5.356	0.04	24.108	18.71
947	J-439	5.065	0.01	24.108	19
949	J-440	4.909	0.06	24.085	19.14
951	J-441	4.11	0.01	24.085	19.93
953	J-442	4.911	0.03	24.053	19.1
1437	J-443	5.298	0.02	24.1	18.76
1447	J-444	4.944	0.21	23.674	18.69
1480	J-451	5.306	0.03	24.127	18.78
1487	J-453	5.521	0.22	25.05	19.49
1505	J-457	5.016	0.19	23.92	18.87
1509	J-458	3.979	0.07	22.277	18.26
1512	J-459	4.229	0.03	22.277	18.01
1514	J-460	4.35	0.11	22.255	17.87
1517	J-461	4.409	0.13	22.233	17.79
1526	J-463	3.543	0.07	22.249	18.67
1529	J-464	5.036	0.04	24.678	19.6
1533	J-465	5.35	0.07	23.797	18.41
1547	J-467	5.472	0.16	24.864	19.35
1550	J-468	5.424	0.1	24.856	19.39
1555	J-469	5.617	0.16	24.746	19.09
1567	J-471	5.1	0.09	24.044	18.91
1584	J-474	5.573	0.06	24.177	18.57
1587	J-475	5.55	0.09	24.177	18.59
1594	J-476	5.136	0.06	22.315	17.14
1597	J-477	4.8	0.04	22.315	17.48
1599	J-478	4.647	0.25	23.278	18.59
1602	J-479	4	0.16	23.274	19.23
1604	J-480	3.571	0.24	22.246	18.64
1607	J-481	4.36	0.05	22.246	17.85
1609	J-255/1	4.206	0.04	22.233	17.99
1612	J-305/1	4.402	0.06	23.876	19.43

Appendix – II

10 Pipe Details

Table 10.1: Pipe Details of Existing Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-2	1,595	J-1	J-2	200	DI K7	140	8.35	0.27	0.406
P-3	20	J-2	J-3	170.4	HDPE	145	8.19	0.36	0.801
P-5	47	J-4	J-5	53.6	HDPE	145	0.03	0.01	0.006
P-6	27	J-4	J-6	93.8	HDPE	145	1.89	0.27	0.972
P-7	33	J-6	J-7	93.8	HDPE	145	1.8	0.26	0.892
P-8	40	J-6	J-8	53.6	HDPE	145	0.02	0.01	0.005
P-9	182	J-7	J-9	63.8	HDPE	145	0.37	0.11	0.304
P-10	39	J-9	J-10	53.6	HDPE	145	0.02	0.01	0.005
P-11	17	J-7	J-11	93.8	HDPE	145	1.3	0.19	0.483
P-12	29	J-11	J-12	53.6	HDPE	145	0.02	0.01	0.003
P-13	28	J-11	J-13	93.8	HDPE	145	1.23	0.18	0.441
P-14	24	J-13	J-14	53.6	HDPE	145	0.01	0.01	0.002
P-15	22	J-13	J-15	93.8	HDPE	145	1.17	0.17	0.401
P-16	132	J-15	J-16	76.6	HDPE	145	0.48	0.1	0.209
P-17	20	J-16	J-9	63.8	HDPE	145	-0.19	0.06	0.094
P-18	36	J-16	J-17	53.6	HDPE	145	0.02	0.01	0.004
P-19	55	J-16	J-18	76.6	HDPE	145	0.51	0.11	0.227
P-20	22	J-18	J-19	53.6	HDPE	145	0.01	0.01	0.002
P-21	27	J-18	J-20	76.6	HDPE	145	0.43	0.09	0.167
P-22	11	J-20	J-21	53.6	HDPE	145	0.08	0.04	0.032
P-23	115	J-20	J-22	63.8	HDPE	145	0.26	0.08	0.154
P-24	49	J-22	J-23	53.6	HDPE	145	0.03	0.01	0.007
P-25	74	J-22	J-24	53.6	HDPE	145	0.05	0.02	0.015
P-26	97	J-22	J-25	53.6	HDPE	145	-0.03	0.01	0.003
P-27	150	J-25	J-26	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-29	77	J-27	J-28	53.6	HDPE	145	0.05	0.02	0.016
P-30	46	J-27	J-15	63.8	HDPE	145	-0.57	0.18	0.68
P-4(1)	129	J-3	J-29	170.4	HDPE	145	6.73	0.3	0.557
P-31	366	J-29	J-30	119.4	HDPE	145	4.2	0.37	1.314
P-32	24	J-30	J-31	53.6	HDPE	145	0.01	0.01	0.002
P-33	19	J-30	J-32	119.4	HDPE	145	3.93	0.35	1.164
P-34	47	J-32	J-33	76.6	HDPE	145	0.61	0.13	0.318
P-35	20	J-33	J-34	53.6	HDPE	145	0.01	0.01	0.001
P-36	48	J-33	J-35	53.6	HDPE	145	0.03	0.01	0.007
P-37	31	J-33	J-36	76.6	HDPE	145	0.48	0.1	0.203
P-38	37	J-36	J-37	63.8	HDPE	145	0.3	0.09	0.208
P-39	24	J-37	J-38	53.6	HDPE	145	0.01	0.01	0.002

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-William s C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-40	12	J-37	J-39	63.8	HDPE	145	0.24	0.07	0.137
P-41	49	J-39	J-40	53.6	HDPE	145	0.03	0.01	0.007
P-43	68	J-39	J-41	63.8	HDPE	145	0.13	0.04	0.044
P-44	38	J-41	J-42	53.6	HDPE	145	0.02	0.01	0.004
P-45	34	J-41	J-43	53.6	HDPE	145	0.02	0.01	0.003
P-46	23	J-36	J-44	53.6	HDPE	145	0.12	0.05	0.093
P-47	20	J-44	J-45	53.6	HDPE	145	0.01	0.01	0.001
P-48	68	J-44	J-46	53.6	HDPE	145	0.04	0.02	0.013
P-49	67	J-32	J-47	93.8	HDPE	145	3.24	0.47	2.64
P-50	44	J-47	J-48	53.6	HDPE	145	0.03	0.01	0.006
P-51	28	J-47	J-49	93.8	HDPE	145	3.13	0.45	2.473
P-52	48	J-49	J-50	53.6	HDPE	145	0.03	0.01	0.007
P-53	20	J-49	J-51	93.8	HDPE	145	3.04	0.44	2.345
P-54	49	J-51	J-52	53.6	HDPE	145	0.03	0.01	0.007
P-55	19	J-51	J-53	93.8	HDPE	145	2.96	0.43	2.227
P-56	79	J-53	J-54	63.8	HDPE	145	0.07	0.02	0.015
P-57	10	J-54	J-55	53.6	HDPE	145	0.01	0	0
P-58	10	J-54	J-56	53.6	HDPE	145	0.01	0	0
P-59	18	J-53	J-57	93.8	HDPE	145	2.81	0.41	2.029
P-60	66	J-57	J-58	53.6	HDPE	145	0.04	0.02	0.012
P-61	14	J-57	J-59	93.8	HDPE	145	2.71	0.39	1.896
P-62	67	J-59	J-60	53.6	HDPE	145	0.04	0.02	0.012
P-63	12	J-59	J-61	93.8	HDPE	145	2.61	0.38	1.771
P-64	65	J-61	J-62	53.6	HDPE	145	0.04	0.02	0.012
P-65	24	J-61	J-63	93.8	HDPE	145	2.51	0.36	1.645
P-66	33	J-63	J-64	53.6	HDPE	145	0.02	0.01	0.003
P-67	99	J-63	J-65	93.8	HDPE	145	2.4	0.35	1.507
P-68	46	J-65	J-66	53.6	HDPE	145	0.03	0.01	0.006
P-69	58	J-65	J-67	93.8	HDPE	145	2.24	0.32	1.334
P-70	96	J-67	J-68	53.6	HDPE	145	0.06	0.03	0.024
P-71	16	J-67	J-69	93.8	HDPE	145	2.08	0.3	1.16
P-72	14	J-69	J-70	53.6	HDPE	145	0.01	0	0.001
P-73	11	J-69	J-71	93.8	HDPE	145	2.05	0.3	1.125
P-74	20	J-71	J-72	53.6	HDPE	145	0.01	0.01	0.001
P-75	12	J-71	J-73	93.8	HDPE	145	2.01	0.29	1.085
P-76	48	J-73	J-74	53.6	HDPE	145	0.03	0.01	0.007
P-77	28	J-73	J-75	93.8	HDPE	145	1.92	0.28	1.004
P-78	34	J-75	J-76	53.6	HDPE	145	0.14	0.06	0.124
P-79	10	J-76	J-77	53.6	HDPE	145	0.01	0	0
P-80	89	J-76	J-78	53.6	HDPE	145	0.05	0.02	0.021
P-81	43	J-75	J-79	93.8	HDPE	145	1.72	0.25	0.812
P-82	62	J-79	J-80	53.6	HDPE	145	0.04	0.02	0.011
P-83	14	J-79	J-81	93.8	HDPE	145	1.61	0.23	0.718
P-84	24	J-81	J-82	53.6	HDPE	145	0.01	0.01	0.002

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-85	22	J-81	J-83	93.8	HDPE	145	1.55	0.22	0.676
P-86	18	J-83	J-84	53.6	HDPE	145	0.01	0	0.001
P-87	56	J-83	J-85	93.8	HDPE	145	1.48	0.21	0.621
P-89	74	J-85	J-87	76.6	HDPE	145	0.89	0.19	0.641
P-91(1)	10	J-88	J-90	63.8	HDPE	145	-0.25	0.08	0.145
P-91(2)	18	J-90	J-89	53.6	HDPE	145	0.01	0	0.001
P-88(1)	101	J-85	J-91	63.8	HDPE	145	0.46	0.14	0.455
P-88(2)	54	J-91	J-86	53.6	HDPE	145	0.03	0.01	0.008
P-92	43	J-90	J-91	63.8	HDPE	145	-0.3	0.09	0.211
P-90(1)	50	J-87	J-92	76.6	HDPE	145	0.5	0.11	0.219
P-90(2)	14	J-92	J-88	63.8	HDPE	145	-0.23	0.07	0.129
P-94	36	J-93	J-94	53.6	HDPE	145	0.02	0.01	0.004
P-95	37	J-93	J-95	53.6	HDPE	145	0.02	0.01	0.004
P-96	73	J-93	J-96	76.6	HDPE	145	0.42	0.09	0.162
P-97	31	J-96	J-97	53.6	HDPE	145	0.02	0.01	0.003
P-98	39	J-96	J-98	63.8	HDPE	145	0.32	0.1	0.231
P-99	21	J-98	J-99	53.6	HDPE	145	0.01	0.01	0.002
P-100	16	J-98	J-100	53.6	HDPE	145	0.26	0.11	0.365
P-101	16	J-100	J-101	53.6	HDPE	145	0.01	0	0.001
P-102	51	J-100	J-102	53.6	HDPE	145	0.19	0.09	0.221
P-104	19	J-102	J-104	53.6	HDPE	145	0.01	0.01	0.001
P-105	16	J-102	J-105	53.6	HDPE	145	0.01	0	0.001
P-106	99	J-87	J-106	63.8	HDPE	145	0.25	0.08	0.154
P-107	141	J-106	J-107	53.6	HDPE	145	0.11	0.05	0.071
P-108	41	J-107	J-108	53.6	HDPE	145	0.03	0.01	0.005
P-93(1)	38	J-92	J-109	76.6	HDPE	145	0.66	0.14	0.375
P-93(2)	19	J-109	J-93	76.6	HDPE	145	0.57	0.12	0.28
P-109	25	J-107	J-109	63.8	HDPE	145	-0.05	0.01	0.007
P-110	267	J-106	J-110	63.8	HDPE	145	(N/A)	(N/A)	(N/A)
P-113	76	J-112	J-113	53.6	HDPE	145	0.05	0.02	0.016
P-4(2)(1)	241	J-29	J-114	76.6	HDPE	145	2.08	0.45	3.113
P-4(2)(2)	115	J-114	J-4	93.8	HDPE	145	2.04	0.29	1.115
P-114	268	J-112	J-114	63.8	HDPE	145	0.34	0.11	0.263
P-115	49	J-115	J-116	53.6	HDPE	145	0.08	0.04	0.044
P-116	20	J-116	J-117	53.6	HDPE	145	0.01	0.01	0.001
P-117	22	J-116	J-118	53.6	HDPE	145	0.01	0.01	0.002
P-119	29	J-119	J-120	53.6	HDPE	145	0.02	0.01	0.003
P-121	26	J-121	J-122	63.8	HDPE	145	0.24	0.07	0.136
P-122	24	J-122	J-123	53.6	HDPE	145	0.01	0.01	0.002
P-123(1)	20	J-122	J-125	63.8	HDPE	145	0.18	0.06	0.081
P-123(2)	14	J-125	J-124	53.6	HDPE	145	0.01	0	0.001
P-124	122	J-125	J-126	53.6	HDPE	145	0.08	0.03	0.038
P-125	147	J-121	J-127	76.6	HDPE	145	-0.82	0.18	0.556
P-126	35	J-127	J-128	53.6	HDPE	145	0.18	0.08	0.197

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-William s C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-127	35	J-128	J-129	53.6	HDPE	145	0.02	0.01	0.004
P-128	96	J-128	J-130	53.6	HDPE	145	0.06	0.03	0.024
P-129	82	J-127	J-131	53.6	HDPE	145	0.05	0.02	0.018
P-130	20	J-127	J-132	76.6	HDPE	145	-1.23	0.27	1.175
P-131	35	J-132	J-133	53.6	HDPE	145	0.02	0.01	0.004
P-132	49	J-132	J-134	76.6	HDPE	145	-1.31	0.29	1.331
P-133	25	J-134	J-135	53.6	HDPE	145	0.02	0.01	0.002
P-134	37	J-134	J-136	76.6	HDPE	145	-1.4	0.3	1.492
P-135	55	J-136	J-137	63.8	HDPE	145	0.27	0.09	0.177
P-136	21	J-137	J-138	53.6	HDPE	145	0.01	0.01	0.002
P-137	174	J-137	J-139	53.6	HDPE	145	0.11	0.05	0.073
P-138	37	J-136	J-140	53.6	HDPE	145	0.02	0.01	0.004
P-139	12	J-136	J-141	76.6	HDPE	145	-1.78	0.39	2.336
P-140	38	J-141	J-142	53.6	HDPE	145	0.02	0.01	0.004
P-141	22	J-141	J-143	76.6	HDPE	145	-1.85	0.4	2.503
P-142	36	J-143	J-144	53.6	HDPE	145	0.02	0.01	0.004
P-143	20	J-143	J-145	53.6	HDPE	145	0.01	0.01	0.001
P-144	17	J-143	J-146	76.6	HDPE	145	-1.94	0.42	2.739
P-145	56	J-146	J-147	53.6	HDPE	145	0.03	0.02	0.009
P-146	46	J-146	J-148	93.8	HDPE	145	-2.05	0.3	1.129
P-147	140	J-148	J-149	53.6	HDPE	145	0.14	0.06	0.124
P-148	32	J-149	J-150	53.6	HDPE	145	0.02	0.01	0.003
P-149	14	J-149	J-151	53.6	HDPE	145	0.01	0	0.001
P-150	24	J-148	J-152	93.8	HDPE	145	-2.32	0.34	1.421
P-151	44	J-152	J-153	63.8	HDPE	145	0.07	0.02	0.013
P-152	7	J-153	J-154	53.6	HDPE	145	0	0	0
P-153	10	J-153	J-155	53.6	HDPE	145	0.03	0.01	0.005
P-154	9	J-155	J-156	53.6	HDPE	145	0.01	0	0
P-155	7	J-155	J-157	53.6	HDPE	145	0	0	0
P-156	60	J-152	J-158	93.8	HDPE	145	-2.47	0.36	1.591
P-157	13	J-158	J-159	170.4	HDPE	145	-5.6	0.25	0.397
P-158	147	J-159	J-160	170.4	HDPE	145	-9.48	0.42	1.051
P-159	54	J-160	J-161	53.6	HDPE	145	0.03	0.01	0.008
P-160	26	J-160	J-162	170.4	HDPE	145	-9.65	0.42	1.087
P-161	15	J-162	J-163	53.6	HDPE	145	0.01	0	0.001
P-162	20	J-162	J-164	170.4	HDPE	145	-9.7	0.43	1.097
P-163	81	J-164	J-165	53.6	HDPE	145	0.05	0.02	0.018
P-164	36	J-164	J-166	170.4	HDPE	145	-9.83	0.43	1.125
P-165	92	J-166	J-167	53.6	HDPE	145	0.06	0.03	0.022
P-166	32	J-166	J-168	170.4	HDPE	145	-9.99	0.44	1.158
P-167	40	J-168	J-169	53.6	HDPE	145	0.02	0.01	0.005
P-168	27	J-168	J-170	170.4	HDPE	145	-10.07	0.44	1.177
P-169	57	J-170	J-171	53.6	HDPE	145	0.03	0.02	0.009

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-170	52	J-170	J-172	170.4	HDPE	145	-10.19	0.45	1.202
P-171	129	J-172	J-173	53.6	HDPE	145	0.08	0.04	0.042
P-172	54	J-172	J-174	170.4	HDPE	145	-10.42	0.46	1.252
P-173	119	J-174	J-175	53.6	HDPE	145	0.07	0.03	0.036
P-174	22	J-174	J-176	170.4	HDPE	145	-10.61	0.47	1.295
P-175	26	J-176	J-177	53.6	HDPE	145	0.02	0.01	0.002
P-176	43	J-176	J-178	170.4	HDPE	145	-10.68	0.47	1.311
P-177	48	J-178	J-179	53.6	HDPE	145	0.12	0.05	0.091
P-178	22	J-179	J-180	53.6	HDPE	145	0.01	0.01	0.002
P-179	51	J-179	J-181	53.6	HDPE	145	0.03	0.01	0.008
P-180	35	J-178	J-182	53.6	HDPE	145	0.02	0.01	0.004
P-181	74	J-178	J-183	170.4	HDPE	145	-10.95	0.48	1.372
P-182	104	J-183	J-184	53.6	HDPE	145	0.06	0.03	0.028
P-183	31	J-183	J-185	170.4	HDPE	145	-11.14	0.49	1.417
P-184	43	J-185	J-186	53.6	HDPE	145	0.03	0.01	0.006
P-185	95	J-185	J-187	170.4	HDPE	145	-11.27	0.49	1.448
P-186	53	J-187	J-188	53.6	HDPE	145	0.03	0.01	0.008
P-188	65	J-189	J-190	53.6	HDPE	145	0.04	0.02	0.012
P-187(1)	62	J-158	J-191	119.4	HDPE	145	3.05	0.27	0.728
P-187(2)	44	J-191	J-189	119.4	HDPE	145	2.99	0.27	0.7
P-189	123	J-189	J-192	119.4	HDPE	145	2.8	0.25	0.622
P-190	28	J-192	J-193	63.8	HDPE	145	0.13	0.04	0.042
P-191	17	J-193	J-194	53.6	HDPE	145	0.01	0	0.001
P-192(1)	43	J-193	J-196	63.8	HDPE	145	0.06	0.02	0.011
P-192(2)	27	J-196	J-195	53.6	HDPE	145	0.02	0.01	0.002
P-193	125	J-196	J-197	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-194	247	J-192	J-198	119.4	HDPE	145	2.43	0.22	0.479
P-195	27	J-198	J-199	53.6	HDPE	145	0.02	0.01	0.002
P-196	24	J-198	J-200	119.4	HDPE	145	2.23	0.2	0.409
P-197	34	J-200	J-201	53.6	HDPE	145	0.02	0.01	0.004
P-199	25	J-202	J-203	76.6	HDPE	145	1.66	0.36	2.044
P-200	106	J-203	J-204	63.8	HDPE	145	0.24	0.07	0.135
P-201	13	J-204	J-205	53.6	HDPE	145	0.16	0.07	0.16
P-202	15	J-205	J-206	53.6	HDPE	145	0.01	0	0.001
P-203	112	J-205	J-207	53.6	HDPE	145	0.07	0.03	0.032
P-204	64	J-203	J-208	76.6	HDPE	145	1.3	0.28	1.307
P-205	42	J-208	J-209	53.6	HDPE	145	0.07	0.03	0.032
P-206	16	J-209	J-210	53.6	HDPE	145	0.01	0	0.001
P-207	19	J-209	J-211	53.6	HDPE	145	0.01	0.01	0.001
P-208	33	J-208	J-212	76.6	HDPE	145	1.15	0.25	1.035

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-209	65	J-212	J-213	53.6	HDPE	145	0.04	0.02	0.012
P-210	36	J-212	J-214	76.6	HDPE	145	1.03	0.22	0.84
P-211	122	J-214	J-215	53.6	HDPE	145	0.07	0.03	0.037
P-212	135	J-214	J-216	76.6	HDPE	145	0.77	0.17	0.495
P-213	35	J-216	J-217	53.6	HDPE	145	0.02	0.01	0.004
P-214	73	J-216	J-218	63.8	HDPE	145	0.21	0.07	0.109
P-215	46	J-218	J-219	53.6	HDPE	145	0.03	0.01	0.006
P-216	22	J-216	J-220	63.8	HDPE	145	0.37	0.12	0.317
P-217	74	J-220	J-221	63.8	HDPE	145	0.09	0.03	0.023
P-218	58	J-221	J-222	53.6	HDPE	145	0.04	0.02	0.009
P-219	33	J-221	J-223	53.6	HDPE	145	0.02	0.01	0.003
P-220	36	J-221	J-218	63.8	HDPE	145	-0.09	0.03	0.022
P-221	88	J-220	J-224	63.8	HDPE	145	0.17	0.05	0.073
P-222	62	J-224	J-225	53.6	HDPE	145	0.04	0.02	0.011
P-223	33	J-224	J-226	53.6	HDPE	145	0.02	0.01	0.003
P-224	81	J-159	J-227	93.8	HDPE	145	3.73	0.54	3.426
P-225	21	J-227	J-228	53.6	HDPE	145	0.12	0.05	0.094
P-226	21	J-228	J-229	53.6	HDPE	145	0.01	0.01	0.001
P-227	21	J-228	J-230	53.6	HDPE	145	0.07	0.03	0.034
P-228	32	J-230	J-231	53.6	HDPE	145	0.02	0.01	0.003
P-229	16	J-230	J-232	53.6	HDPE	145	0.01	0	0.001
P-231	38	J-233	J-234	53.6	HDPE	145	0.02	0.01	0.004
P-232	12	J-233	J-235	63.8	HDPE	145	0.14	0.04	0.048
P-233	53	J-235	J-236	53.6	HDPE	145	0.03	0.01	0.008
P-234	52	J-235	J-237	53.6	HDPE	145	0.03	0.01	0.008
P-230(1)	211	J-227	J-238	93.8	HDPE	145	3.42	0.49	2.91
P-230(2)	37	J-238	J-233	63.8	HDPE	145	0.21	0.07	0.111
P-235	73	J-238	J-239	93.8	HDPE	145	3.01	0.44	2.297
P-236	57	J-239	J-240	53.6	HDPE	145	0.03	0.02	0.009
P-237	295	J-239	J-241	93.8	HDPE	145	2.71	0.39	1.897
P-238	400	J-241	J-242	93.8	HDPE	145	2.29	0.33	1.381
P-239	26	J-242	J-243	53.6	HDPE	145	0.02	0.01	0.002
P-240	38	J-242	J-244	93.8	HDPE	145	1.98	0.29	1.063
P-241	7	J-244	J-245	53.6	HDPE	145	0	0	0
P-242	11	J-244	J-246	93.8	HDPE	145	1.95	0.28	1.026
P-243	18	J-246	J-247	53.6	HDPE	145	0.01	0	0.001
P-244	16	J-246	J-248	93.8	HDPE	145	1.91	0.28	0.989
P-245	18	J-248	J-249	53.6	HDPE	145	0.01	0.01	0.001
P-246	33	J-248	J-250	93.8	HDPE	145	1.85	0.27	0.938
P-247	32	J-250	J-251	53.6	HDPE	145	0.02	0.01	0.003
P-248	20	J-250	J-252	93.8	HDPE	145	1.78	0.26	0.872
P-250	16	J-252	J-254	93.8	HDPE	145	1.63	0.24	0.737
P-252	39	J-254	J-256	76.6	HDPE	145	0.91	0.2	0.667
P-253	132	J-256	J-257	53.6	HDPE	145	0.08	0.04	0.043

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-254	32	J-256	J-460	63.8	HDPE	145	0.7	0.22	1.01
P-256	128	J-460	J-260	63.8	HDPE	145	(N/A)	(N/A)	(N/A)
P-257	61	J-260	J-261	63.8	HDPE	145	0.26	0.08	0.166
P-258	62	J-261	J-262	53.6	HDPE	145	0.04	0.02	0.011
P-259	122	J-261	J-263	53.6	HDPE	145	0.08	0.03	0.038
P-261	35	J-264	J-265	53.6	HDPE	145	0.02	0.01	0.004
P-262	33	J-264	J-266	53.6	HDPE	145	0.02	0.01	0.003
P-120(1)	150	J-119	J-267	63.8	HDPE	145	-0.28	0.09	0.183
P-120(2)	31	J-267	J-121	76.6	HDPE	145	-0.46	0.1	0.189
P-263	56	J-267	J-268	53.6	HDPE	145	0.03	0.02	0.009
P-267	15	J-270	J-271	53.6	HDPE	145	0.01	0	0.001
P-268	79	J-270	J-272	93.8	HDPE	145	1.32	0.19	0.497
P-269	41	J-272	J-273	53.6	HDPE	145	0.12	0.05	0.087
P-270	7	J-273	J-274	53.6	HDPE	145	0	0	0
P-271	68	J-273	J-275	53.6	HDPE	145	0.04	0.02	0.013
P-272	71	J-272	J-276	93.8	HDPE	145	1.08	0.16	0.345
P-273	24	J-276	J-277	53.6	HDPE	145	0.01	0.01	0.002
P-274	62	J-276	J-278	93.8	HDPE	145	0.97	0.14	0.282
P-275	27	J-278	J-279	53.6	HDPE	145	0.16	0.07	0.154
P-276	19	J-279	J-280	53.6	HDPE	145	0.01	0.01	0.001
P-277	98	J-279	J-281	53.6	HDPE	145	0.06	0.03	0.025
P-278	16	J-278	J-282	93.8	HDPE	145	0.74	0.11	0.173
P-279	7	J-282	J-283	53.6	HDPE	145	0	0	0
P-280	186	J-282	J-284	93.8	HDPE	145	0.61	0.09	0.12
P-281	59	J-284	J-285	53.6	HDPE	145	0.18	0.08	0.188
P-282	23	J-285	J-286	53.6	HDPE	145	0.01	0.01	0.002
P-283	51	J-284	J-287	63.8	HDPE	145	0.25	0.08	0.15
P-284	80	J-287	J-288	63.8	HDPE	145	0.17	0.05	0.073
P-285	58	J-288	J-285	53.6	HDPE	145	-0.08	0.04	0.042
P-286	79	J-288	J-289	63.8	HDPE	145	0.12	0.04	0.037
P-287	23	J-289	J-290	53.6	HDPE	145	0.01	0.01	0.002
P-289	70	J-291	J-292	53.6	HDPE	145	0.04	0.02	0.013
P-288(1)	32	J-289	J-293	53.6	HDPE	145	0.02	0.01	0.003
P-291	26	J-294	J-295	53.6	HDPE	145	0.02	0.01	0.002
P-292	11	J-294	J-296	119.4	HDPE	145	7.57	0.68	3.92
P-293	228	J-296	J-297	53.6	HDPE	145	0.14	0.06	0.12
P-294	41	J-296	J-298	119.4	HDPE	145	7.26	0.65	3.626
P-295	11	J-298	J-299	53.6	HDPE	145	0.01	0	0
P-296	68	J-298	J-300	119.4	HDPE	145	7.18	0.64	3.552
P-298	38	J-300	J-302	119.4	HDPE	145	7.11	0.64	3.493
P-299	15	J-302	J-303	53.6	HDPE	145	0.01	0	0.001
P-303	24	J-304	J-305	53.6	HDPE	145	0.14	0.06	0.114
P-304	69	J-304	J-306	93.8	HDPE	145	2.27	0.33	1.369
P-305	14	J-306	J-307	63.8	HDPE	145	0.4	0.12	0.351

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-306	40	J-307	J-308	53.6	HDPE	145	0.02	0.01	0.005
P-307	31	J-307	J-309	63.8	HDPE	145	0.32	0.1	0.235
P-308	15	J-309	J-310	53.6	HDPE	145	0.01	0	0.001
P-309	67	J-309	J-311	63.8	HDPE	145	0.24	0.07	0.139
P-310	30	J-311	J-312	53.6	HDPE	145	0.02	0.01	0.003
P-311	30	J-311	J-313	53.6	HDPE	145	0.02	0.01	0.003
P-312	102	J-311	J-314	53.6	HDPE	145	0.06	0.03	0.027
P-313	30	J-306	J-315	93.8	HDPE	145	1.81	0.26	0.896
P-314	11	J-315	J-316	53.6	HDPE	145	0.01	0	0
P-315	53	J-315	J-317	53.6	HDPE	145	0.03	0.01	0.008
P-316	19	J-315	J-318	93.8	HDPE	145	1.7	0.25	0.799
P-317	29	J-318	J-319	53.6	HDPE	145	0.02	0.01	0.003
P-318	18	J-318	J-320	93.8	HDPE	145	1.64	0.24	0.749
P-319	25	J-320	J-321	53.6	HDPE	145	0.02	0.01	0.002
P-320	30	J-320	J-322	93.8	HDPE	145	1.58	0.23	0.699
P-321	73	J-322	J-323	53.6	HDPE	145	0.14	0.06	0.126
P-322	8	J-323	J-324	53.6	HDPE	145	0	0	0
P-323	73	J-323	J-325	53.6	HDPE	145	0.04	0.02	0.014
P-324	10	J-322	J-326	93.8	HDPE	145	1.37	0.2	0.534
P-325	16	J-326	J-327	53.6	HDPE	145	0.01	0	0.001
P-326	28	J-326	J-328	93.8	HDPE	145	1.32	0.19	0.503
P-327	112	J-328	J-329	53.6	HDPE	145	0.07	0.03	0.032
P-328	20	J-328	J-330	93.8	HDPE	145	1.16	0.17	0.392
P-329	36	J-330	J-331	53.6	HDPE	145	0.02	0.01	0.004
P-330	52	J-330	J-332	93.8	HDPE	145	1.07	0.15	0.338
P-332	13	J-332	J-334	53.6	HDPE	145	0.01	0	0.001
P-333	16	J-332	J-335	63.8	HDPE	145	0.35	0.11	0.284
P-334	45	J-335	J-336	53.6	HDPE	145	0.03	0.01	0.006
P-335	143	J-335	J-337	53.6	HDPE	145	0.2	0.09	0.232
P-336	62	J-337	J-338	53.6	HDPE	145	0.04	0.02	0.011
P-337	29	J-337	J-339	53.6	HDPE	145	0.02	0.01	0.003
P-338	14	J-332	J-340	63.8	HDPE	145	0.65	0.2	0.879
P-339	67	J-340	J-341	53.6	HDPE	145	0.04	0.02	0.012
P-340	20	J-340	J-342	63.8	HDPE	145	0.55	0.17	0.639
P-341	8	J-342	J-343	53.6	HDPE	145	0.01	0	0
P-343(1)	42	J-344	J-346	63.8	HDPE	145	0.33	0.1	0.258
P-343(2)	31	J-346	J-345	53.6	HDPE	145	0.02	0.01	0.003
P-344	158	J-346	J-347	53.6	HDPE	145	0.17	0.08	0.18
P-345	50	J-347	J-348	53.6	HDPE	145	0.03	0.01	0.007
P-346	13	J-347	J-349	53.6	HDPE	145	0.01	0	0.001
P-342(1)	57	J-342	J-350	63.8	HDPE	145	0.49	0.15	0.52
P-342(2)	94	J-350	J-344	63.8	HDPE	145	0.32	0.1	0.243
P-347	59	J-350	J-351	53.6	HDPE	145	0.04	0.02	0.01
P-348	57	J-344	J-352	63.8	HDPE	145	-0.13	0.04	0.044

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-351	22	J-269	J-355	119.4	HDPE	145	2.42	0.22	0.474
P-266(2)	32	J-356	J-270	93.8	HDPE	145	1.4	0.2	0.559
P-302(2)	247	J-357	J-304	93.8	HDPE	145	2.62	0.38	1.778
P-352	12	J-356	J-357	93.8	HDPE	145	2.78	0.4	1.984
P-354	68	J-353	J-358	53.6	HDPE	145	0.04	0.02	0.013
P-355	29	J-353	J-359	93.8	HDPE	145	2.65	0.38	1.819
P-356	21	J-359	J-360	53.6	HDPE	145	0.01	0.01	0.002
P-357	14	J-359	J-361	93.8	HDPE	145	2.6	0.38	1.753
P-358	11	J-361	J-362	53.6	HDPE	145	0.01	0	0
P-359	12	J-361	J-363	93.8	HDPE	145	2.57	0.37	1.717
P-360	57	J-363	J-364	53.6	HDPE	145	0.03	0.02	0.009
P-361	13	J-363	J-365	93.8	HDPE	145	2.48	0.36	1.613
P-362	66	J-365	J-366	53.6	HDPE	145	0.04	0.02	0.012
P-363	8	J-365	J-367	93.8	HDPE	145	2.39	0.35	1.502
P-364	78	J-367	J-368	53.6	HDPE	145	0.13	0.06	0.098
P-365	24	J-368	J-369	53.6	HDPE	145	0.01	0.01	0.002
P-366	85	J-368	J-370	53.6	HDPE	145	0	0	0.004
P-367	6	J-370	J-367	93.8	HDPE	145	-2.21	0.32	1.294
P-368	9	J-370	J-371	93.8	HDPE	145	2.14	0.31	1.227
P-369	75	J-371	J-372	53.6	HDPE	145	0.05	0.02	0.015
P-370	27	J-371	J-373	93.8	HDPE	145	2.03	0.29	1.108
P-371	41	J-373	J-374	53.6	HDPE	145	0.12	0.05	0.088
P-372	26	J-374	J-375	53.6	HDPE	145	0.02	0.01	0.002
P-373	49	J-374	J-376	53.6	HDPE	145	0.03	0.01	0.007
P-374	95	J-373	J-377	76.6	HDPE	145	1.81	0.39	2.407
P-375	63	J-377	J-378	76.6	HDPE	145	1.18	0.26	1.091
P-376	48	J-378	J-379	53.6	HDPE	145	0.03	0.01	0.007
P-377	45	J-378	J-380	76.6	HDPE	145	1.05	0.23	0.885
P-378	42	J-380	J-381	53.6	HDPE	145	0.03	0.01	0.005
P-379	48	J-380	J-382	76.6	HDPE	145	0.95	0.21	0.724
P-380	19	J-382	J-383	53.6	HDPE	145	0.01	0.01	0.001
P-381	65	J-382	J-384	76.6	HDPE	145	0.85	0.19	0.599
P-382	13	J-384	J-385	63.8	HDPE	145	0.71	0.22	1.027
P-383	26	J-385	J-386	63.8	HDPE	145	0.43	0.14	0.414
P-384	66	J-386	J-387	53.6	HDPE	145	0.04	0.02	0.012
P-385	37	J-386	J-388	63.8	HDPE	145	0.31	0.1	0.226
P-386(1)	24	J-388	J-291	63.8	HDPE	145	0.42	0.13	0.391
P-386(2)	21	J-291	J-389	63.8	HDPE	145	0.31	0.1	0.218
P-387	86	J-385	J-388	53.6	HDPE	145	0.2	0.09	0.226
P-388	81	J-384	J-390	53.6	HDPE	145	0.05	0.02	0.018
P-389	69	J-377	J-391	63.8	HDPE	145	0.49	0.15	0.521
P-390	36	J-391	J-392	53.6	HDPE	145	0.02	0.01	0.004
P-391	17	J-391	J-393	63.8	HDPE	145	0.39	0.12	0.347
P-392	23	J-393	J-394	53.6	HDPE	145	0.01	0.01	0.002

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-393	12	J-393	J-395	63.8	HDPE	145	0.35	0.11	0.276
P-394	32	J-395	J-396	53.6	HDPE	145	0.02	0.01	0.003
P-395	18	J-395	J-397	63.8	HDPE	145	0.29	0.09	0.197
P-396	29	J-397	J-398	53.6	HDPE	145	0.02	0.01	0.003
P-397	7	J-397	J-399	63.8	HDPE	145	0.24	0.07	0.138
P-398	29	J-399	J-400	53.6	HDPE	145	0.02	0.01	0.003
P-399	50	J-399	J-401	63.8	HDPE	145	0.17	0.05	0.073
P-400	146	J-401	J-402	63.8	HDPE	145	0.17	0.05	0.071
P-401	47	J-402	J-403	53.6	HDPE	145	0.03	0.01	0.006
P-402	15	J-402	J-404	53.6	HDPE	145	0.01	0	0.001
P-403	33	J-401	J-405	63.8	HDPE	145	-0.14	0.04	0.05
P-404	24	J-405	J-406	53.6	HDPE	145	0.01	0.01	0.002
P-405	50	J-405	J-407	63.8	HDPE	145	-0.22	0.07	0.117
P-406	53	J-407	J-408	53.6	HDPE	145	0.03	0.01	0.008
P-407	21	J-407	J-409	63.8	HDPE	145	-0.33	0.1	0.247
P-408	33	J-409	J-410	53.6	HDPE	145	0.02	0.01	0.003
P-409	14	J-409	J-411	63.8	HDPE	145	-0.39	0.12	0.341
P-410	31	J-411	J-412	53.6	HDPE	145	0.02	0.01	0.003
P-411	20	J-411	J-413	63.8	HDPE	145	-0.45	0.14	0.443
P-412	20	J-413	J-414	53.6	HDPE	145	0.01	0.01	0.001
P-413	58	J-413	J-415	63.8	HDPE	145	-0.52	0.16	0.585
P-414	47	J-415	J-416	53.6	HDPE	145	0.03	0.01	0.006
P-416	32	J-355	J-418	93.8	HDPE	145	2.3	0.33	1.398
P-417	52	J-418	J-419	53.6	HDPE	145	0.03	0.01	0.008
P-418	76	J-418	J-420	93.8	HDPE	145	2.17	0.31	1.255
P-419	103	J-420	J-421	53.6	HDPE	145	0.06	0.03	0.027
P-420	13	J-420	J-422	93.8	HDPE	145	1.99	0.29	1.068
P-421	97	J-422	J-423	53.6	HDPE	145	0.06	0.03	0.025
P-422	221	J-422	J-424	93.8	HDPE	145	1.73	0.25	0.822
P-423	34	J-424	J-425	53.6	HDPE	145	0.02	0.01	0.003
P-424	161	J-424	J-426	76.6	HDPE	145	1.45	0.31	1.596
P-425	28	J-426	J-427	53.6	HDPE	145	0.02	0.01	0.002
P-426	14	J-426	J-428	76.6	HDPE	145	1.31	0.28	1.319
P-427	16	J-428	J-429	53.6	HDPE	145	0.01	0	0.001
P-428	11	J-428	J-430	76.6	HDPE	145	1.27	0.28	1.256
P-429	35	J-430	J-431	53.6	HDPE	145	0.02	0.01	0.004
P-430	10	J-430	J-432	76.6	HDPE	145	1.22	0.26	1.156
P-431	33	J-432	J-433	53.6	HDPE	145	0.02	0.01	0.003
P-432	87	J-432	J-434	63.8	HDPE	145	1.12	0.35	2.402
P-433	38	J-434	J-435	53.6	HDPE	145	0.02	0.01	0.004
P-434	35	J-434	J-436	63.8	HDPE	145	1	0.31	1.941
P-435	17	J-436	J-437	53.6	HDPE	145	0.01	0	0.001
P-436	17	J-436	J-438	63.8	HDPE	145	0.94	0.3	1.757
P-437	19	J-438	J-439	53.6	HDPE	145	0.01	0.01	0.001

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-William s C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-438	28	J-438	J-440	63.8	HDPE	145	0.89	0.28	1.586
P-439	22	J-440	J-441	53.6	HDPE	145	0.01	0.01	0.002
P-440	42	J-440	J-442	63.8	HDPE	145	0.82	0.26	1.363
P-349(2)	37	J-443	J-353	93.8	HDPE	145	2.78	0.4	1.98
P-28(1)	174	J-25	J-444	63.8	HDPE	145	-0.19	0.06	0.09
P-28(2)	38	J-444	J-27	63.8	HDPE	145	-0.42	0.13	0.389
P-447	137	J-444	J-21	53.6	HDPE	145	0.01	0.01	0.009
P-1(1)	19	T-1	J-453	250	DI K7	140	30.57	0.62	1.516
P-1(2)	11	J-453	J-1	250	DI K7	140	8.35	0.17	0.137
P-446(1)	41	J-302	J-451	119.4	HDPE	145	7.05	0.63	3.432
P-445(2)	11	J-451	J-356	119.4	HDPE	145	4.22	0.38	1.325
P-448(1)	83	J-187	J-453	170.4	HDPE	145	-11.44	0.5	1.49
P-118(2)	245	J-2	J-119	76.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-112(2)(1)	165	J-115	J-457	63.8	HDPE	145	0.88	0.27	1.533
P-112(2)(2)	146	J-457	J-112	63.8	HDPE	145	0.69	0.21	0.973
P-249(1)	11	J-252	J-458	53.6	HDPE	145	0.12	0.06	0.096
P-249(2)	50	J-458	J-253	53.6	HDPE	145	0.03	0.01	0.007
P-450	46	J-458	J-459	53.6	HDPE	145	0.03	0.01	0.006
P-255(2)	26	J-460	J-259	53.6	HDPE	145	0.02	0.01	0.002
P-451	116	J-460	J-461	63.8	HDPE	145	0.58	0.18	0.706
P-260(1)	11	J-260	J-461	63.8	HDPE	145	-0.31	0.1	0.221
P-260(2)	89	J-461	J-264	63.8	HDPE	145	0.14	0.04	0.049
P-251(1)	96	J-254	J-463	63.8	HDPE	145	0.63	0.2	0.831
P-350(2)(1)	69	J-355	J-464	53.6	HDPE	145	0.04	0.02	0.013
P-350(2)(2)	142	J-464	J-354	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-452	91	J-352	J-465	63.8	HDPE	145	-0.22	0.07	0.118
P-290(2)(2)(1)	224	J-453	J-467	170.4	HDPE	145	10.55	0.46	1.282
P-290(2)(2)(2)	27	J-467	J-294	119.4	HDPE	145	7.63	0.68	3.974
P-453	11	J-467	J-468	119.4	HDPE	145	2.77	0.25	0.607
P-297(2)	36	J-469	J-301	53.6	HDPE	145	0.02	0.01	0.004
P-264(2)(1)	149	J-468	J-469	119.4	HDPE	145	2.67	0.24	0.568
P-264(2)(2)	81	J-469	J-269	119.4	HDPE	145	2.48	0.22	0.497
P-454	22	J-451	J-443	93.8	HDPE	145	2.8	0.4	2.01
P-455	15	J-465	J-389	63.8	HDPE	145	-0.28	0.09	0.19
P-415(1)	137	J-415	J-471	63.8	HDPE	145	-0.7	0.22	1.004
P-415(2)	40	J-471	J-417	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-456	13	J-442	J-471	63.8	HDPE	145	0.79	0.25	1.262
P-111(2)	79	J-474	J-111	53.6	HDPE	145	0.05	0.02	0.017
P-112(1)(1)	17	J-3	J-475	63.8	HDPE	145	1.35	0.42	3.427
P-112(1)(2)	115	J-475	J-115	63.8	HDPE	145	1.16	0.36	2.576
P-457	12	J-474	J-475	53.6	HDPE	145	-0.1	0.05	0.069
P-103(1)	15	J-102	J-476	53.6	HDPE	145	0.11	0.05	0.078

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Head loss Gradient (m/km)
P-103(2)	18	J-476	J-103	53.6	HDPE	145	0.01	0	0.001
P-458	65	J-476	J-477	53.6	HDPE	145	0.04	0.02	0.012
P-198(1)	133	J-200	J-478	119.4	HDPE	145	2.1	0.19	0.363
P-198(2)	13	J-478	J-202	119.4	HDPE	145	1.68	0.15	0.241
P-459	265	J-478	J-479	53.6	HDPE	145	0.16	0.07	0.158
P-251(2)(1)	14	J-463	J-480	63.8	HDPE	145	0.56	0.18	0.675
P-251(2)(2)	293	J-480	J-255	63.8	HDPE	145	0.27	0.08	0.171
P-460	86	J-480	J-481	53.6	HDPE	145	0.05	0.02	0.02
P-461	72	J-255	J-255/1	53.6	HDPE	145	0.04	0.02	0.014
P-462	99	J-305	J-305/1	53.6	HDPE	145	0.06	0.03	0.026

Table 10.2 : Pipe Details of DI Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-2	1,595	J-1	J-2	200	DI K7	140	8.35	0.27	0.406
P-3	20	J-2	J-3	200	DI K7	140	8.19	0.26	0.392
P-5	47	J-4	J-5	80	DI K7	140	0.03	0.01	0.001
P-6	27	J-4	J-6	100	DI K7	140	1.89	0.24	0.76
P-7	33	J-6	J-7	100	DI K7	140	1.8	0.23	0.697
P-8	40	J-6	J-8	80	DI K7	140	0.02	0	0.001
P-9	182	J-7	J-9	80	DI K7	140	0.46	0.09	0.163
P-10	39	J-9	J-10	80	DI K7	140	0.02	0	0.001
P-11	17	J-7	J-11	100	DI K7	140	1.2	0.15	0.33
P-12	29	J-11	J-12	80	DI K7	140	0.02	0	0
P-13	28	J-11	J-13	100	DI K7	140	1.14	0.15	0.298
P-14	24	J-13	J-14	80	DI K7	140	0.01	0	0
P-15	22	J-13	J-15	100	DI K7	140	1.08	0.14	0.27
P-16	132	J-15	J-16	80	DI K7	140	0.32	0.06	0.083
P-17	20	J-16	J-9	80	DI K7	140	-0.29	0.06	0.068
P-18	36	J-16	J-17	80	DI K7	140	0.02	0	0.001
P-19	55	J-16	J-18	80	DI K7	140	0.43	0.09	0.147
P-20	22	J-18	J-19	80	DI K7	140	0.01	0	0
P-21	27	J-18	J-20	80	DI K7	140	0.36	0.07	0.102
P-22	11	J-20	J-21	80	DI K7	140	0.02	0	0
P-23	115	J-20	J-22	80	DI K7	140	0.24	0.05	0.051
P-24	49	J-22	J-23	80	DI K7	140	0.03	0.01	0.001
P-25	74	J-22	J-24	80	DI K7	140	0.05	0.01	0.002
P-26	97	J-22	J-25	80	DI K7	140	-0.04	0.01	0.002
P-27	150	J-25	J-26	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-29	77	J-27	J-28	80	DI K7	140	0.05	0.01	0.002
P-30	46	J-27	J-15	80	DI K7	140	-0.64	0.13	0.302
P-4(1)	129	J-3	J-29	200	DI K7	140	6.43	0.2	0.251
P-31	366	J-29	J-30	150	DI K7	140	4.2	0.24	0.462
P-32	24	J-30	J-31	80	DI K7	140	0.01	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-33	19	J-30	J-32	150	DI K7	140	3.93	0.22	0.409
P-34	47	J-32	J-33	80	DI K7	140	0.61	0.12	0.274
P-35	20	J-33	J-34	80	DI K7	140	0.01	0	0
P-36	48	J-33	J-35	80	DI K7	140	0.03	0.01	0.001
P-37	31	J-33	J-36	80	DI K7	140	0.48	0.09	0.175
P-38	37	J-36	J-37	80	DI K7	140	0.3	0.06	0.074
P-39	24	J-37	J-38	80	DI K7	140	0.01	0	0
P-40	12	J-37	J-39	80	DI K7	140	0.24	0.05	0.049
P-41	49	J-39	J-40	80	DI K7	140	0.03	0.01	0.001
P-43	68	J-39	J-41	80	DI K7	140	0.13	0.03	0.016
P-44	38	J-41	J-42	80	DI K7	140	0.02	0	0.001
P-45	34	J-41	J-43	80	DI K7	140	0.02	0	0
P-46	23	J-36	J-44	80	DI K7	140	0.12	0.02	0.014
P-47	20	J-44	J-45	80	DI K7	140	0.01	0	0
P-48	68	J-44	J-46	80	DI K7	140	0.04	0.01	0.002
P-49	67	J-32	J-47	100	DI K7	140	3.24	0.41	2.063
P-50	44	J-47	J-48	80	DI K7	140	0.03	0.01	0.001
P-51	28	J-47	J-49	100	DI K7	140	3.13	0.4	1.932
P-52	48	J-49	J-50	80	DI K7	140	0.03	0.01	0.001
P-53	20	J-49	J-51	100	DI K7	140	3.04	0.39	1.832
P-54	49	J-51	J-52	80	DI K7	140	0.03	0.01	0.001
P-55	19	J-51	J-53	100	DI K7	140	2.96	0.38	1.74
P-56	79	J-53	J-54	80	DI K7	140	0.07	0.01	0.005
P-57	10	J-54	J-55	80	DI K7	140	0.01	0	0
P-58	10	J-54	J-56	80	DI K7	140	0.01	0	0
P-59	18	J-53	J-57	100	DI K7	140	2.81	0.36	1.585
P-60	66	J-57	J-58	80	DI K7	140	0.04	0.01	0.002
P-61	14	J-57	J-59	100	DI K7	140	2.71	0.35	1.481
P-62	67	J-59	J-60	80	DI K7	140	0.04	0.01	0.002
P-63	12	J-59	J-61	100	DI K7	140	2.61	0.33	1.384
P-64	65	J-61	J-62	80	DI K7	140	0.04	0.01	0.002
P-65	24	J-61	J-63	100	DI K7	140	2.51	0.32	1.285
P-66	33	J-63	J-64	80	DI K7	140	0.02	0	0
P-67	99	J-63	J-65	100	DI K7	140	2.4	0.3	1.178
P-68	46	J-65	J-66	80	DI K7	140	0.03	0.01	0.001
P-69	58	J-65	J-67	100	DI K7	140	2.24	0.29	1.042
P-70	96	J-67	J-68	80	DI K7	140	0.06	0.01	0.004
P-71	16	J-67	J-69	100	DI K7	140	2.08	0.26	0.906
P-72	14	J-69	J-70	80	DI K7	140	0.01	0	0
P-73	11	J-69	J-71	100	DI K7	140	2.05	0.26	0.879
P-74	20	J-71	J-72	80	DI K7	140	0.01	0	0
P-75	12	J-71	J-73	100	DI K7	140	2.01	0.26	0.848
P-76	48	J-73	J-74	80	DI K7	140	0.03	0.01	0.001
P-77	28	J-73	J-75	100	DI K7	140	1.92	0.24	0.784
P-78	34	J-75	J-76	80	DI K7	140	0.14	0.03	0.019
P-79	10	J-76	J-77	80	DI K7	140	0.01	0	0
P-80	89	J-76	J-78	80	DI K7	140	0.05	0.01	0.003
P-81	43	J-75	J-79	100	DI K7	140	1.72	0.22	0.635
P-82	62	J-79	J-80	80	DI K7	140	0.04	0.01	0.002
P-83	14	J-79	J-81	100	DI K7	140	1.61	0.2	0.561
P-84	24	J-81	J-82	80	DI K7	140	0.01	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-85	22	J-81	J-83	100	DI K7	140	1.55	0.2	0.528
P-86	18	J-83	J-84	80	DI K7	140	0.01	0	0
P-87	56	J-83	J-85	100	DI K7	140	1.48	0.19	0.485
P-89	74	J-85	J-87	80	DI K7	140	0.76	0.15	0.417
P-91(1)	10	J-88	J-90	80	DI K7	140	-0.37	0.07	0.111
P-91(2)	18	J-90	J-89	80	DI K7	140	0.01	0	0
P-88(1)	101	J-85	J-91	80	DI K7	140	0.58	0.12	0.254
P-88(2)	54	J-91	J-86	80	DI K7	140	0.03	0.01	0.001
P-92	43	J-90	J-91	80	DI K7	140	-0.43	0.08	0.143
P-90(1)	50	J-87	J-92	80	DI K7	140	0.29	0.06	0.07
P-90(2)	14	J-92	J-88	80	DI K7	140	-0.36	0.07	0.103
P-94	36	J-93	J-94	80	DI K7	140	0.02	0	0.001
P-95	37	J-93	J-95	80	DI K7	140	0.02	0	0.001
P-96	73	J-93	J-96	80	DI K7	140	0.42	0.08	0.14
P-97	31	J-96	J-97	80	DI K7	140	0.02	0	0
P-98	39	J-96	J-98	80	DI K7	140	0.32	0.06	0.082
P-99	21	J-98	J-99	80	DI K7	140	0.01	0	0
P-100	16	J-98	J-100	80	DI K7	140	0.26	0.05	0.055
P-101	16	J-100	J-101	80	DI K7	140	0.01	0	0
P-102	51	J-100	J-102	80	DI K7	140	0.19	0.04	0.034
P-104	19	J-102	J-104	80	DI K7	140	0.01	0	0
P-105	16	J-102	J-105	80	DI K7	140	0.01	0	0
P-106	99	J-87	J-106	80	DI K7	140	0.33	0.07	0.09
P-107	141	J-106	J-107	80	DI K7	140	0.18	0.04	0.03
P-108	41	J-107	J-108	80	DI K7	140	0.03	0.01	0.001
P-93(1)	38	J-92	J-109	80	DI K7	140	0.58	0.12	0.256
P-93(2)	19	J-109	J-93	80	DI K7	140	0.57	0.11	0.242
P-109	25	J-107	J-109	80	DI K7	140	0.03	0.01	0.001
P-110	267	J-106	J-110	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-113	76	J-112	J-113	80	DI K7	140	0.05	0.01	0.002
P-4(2)(1)	241	J-29	J-114	80	DI K7	140	1.79	0.36	2.026
P-4(2)(2)	115	J-114	J-4	100	DI K7	140	2.04	0.26	0.871
P-114	268	J-112	J-114	80	DI K7	140	0.63	0.13	0.297
P-115	49	J-115	J-116	80	DI K7	140	0.08	0.02	0.007
P-116	20	J-116	J-117	80	DI K7	140	0.01	0	0
P-117	22	J-116	J-118	80	DI K7	140	0.01	0	0
P-119	29	J-119	J-120	80	DI K7	140	0.02	0	0
P-121	26	J-121	J-122	80	DI K7	140	0.24	0.05	0.048
P-122	24	J-122	J-123	80	DI K7	140	0.01	0	0
P-123(1)	20	J-122	J-125	80	DI K7	140	0.18	0.04	0.029
P-123(2)	14	J-125	J-124	80	DI K7	140	0.01	0	0
P-124	122	J-125	J-126	80	DI K7	140	0.08	0.01	0.006
P-125	147	J-121	J-127	80	DI K7	140	-0.82	0.16	0.48
P-126	35	J-127	J-128	80	DI K7	140	0.18	0.04	0.03
P-127	35	J-128	J-129	80	DI K7	140	0.02	0	0.001
P-128	96	J-128	J-130	80	DI K7	140	0.06	0.01	0.004
P-129	82	J-127	J-131	80	DI K7	140	0.05	0.01	0.003
P-130	20	J-127	J-132	80	DI K7	140	-1.23	0.24	1.015
P-131	35	J-132	J-133	80	DI K7	140	0.02	0	0.001
P-132	49	J-132	J-134	80	DI K7	140	-1.31	0.26	1.15
P-133	25	J-134	J-135	80	DI K7	140	0.02	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-134	37	J-134	J-136	80	DI K7	140	-1.4	0.28	1.289
P-135	55	J-136	J-137	80	DI K7	140	0.27	0.05	0.063
P-136	21	J-137	J-138	80	DI K7	140	0.01	0	0
P-137	174	J-137	J-139	80	DI K7	140	0.11	0.02	0.011
P-138	37	J-136	J-140	80	DI K7	140	0.02	0	0.001
P-139	12	J-136	J-141	80	DI K7	140	-1.78	0.35	2.017
P-140	38	J-141	J-142	80	DI K7	140	0.02	0	0.001
P-141	22	J-141	J-143	80	DI K7	140	-1.85	0.37	2.162
P-142	36	J-143	J-144	80	DI K7	140	0.02	0	0.001
P-143	20	J-143	J-145	80	DI K7	140	0.01	0	0
P-144	17	J-143	J-146	80	DI K7	140	-1.94	0.39	2.366
P-145	56	J-146	J-147	80	DI K7	140	0.03	0.01	0.001
P-146	46	J-146	J-148	100	DI K7	140	-2.05	0.26	0.882
P-147	140	J-148	J-149	80	DI K7	140	0.14	0.03	0.019
P-148	32	J-149	J-150	80	DI K7	140	0.02	0	0.001
P-149	14	J-149	J-151	80	DI K7	140	0.01	0	0
P-150	24	J-148	J-152	100	DI K7	140	-2.32	0.3	1.11
P-151	44	J-152	J-153	80	DI K7	140	0.07	0.01	0.005
P-152	7	J-153	J-154	80	DI K7	140	0	0	0
P-153	10	J-153	J-155	80	DI K7	140	0.03	0.01	0.001
P-154	9	J-155	J-156	80	DI K7	140	0.01	0	0
P-155	7	J-155	J-157	80	DI K7	140	0	0	0
P-156	60	J-152	J-158	100	DI K7	140	-2.47	0.31	1.243
P-157	13	J-158	J-159	200	DI K7	140	-5.6	0.18	0.194
P-158	147	J-159	J-160	200	DI K7	140	-9.48	0.3	0.514
P-159	54	J-160	J-161	80	DI K7	140	0.03	0.01	0.001
P-160	26	J-160	J-162	200	DI K7	140	-9.65	0.31	0.532
P-161	15	J-162	J-163	80	DI K7	140	0.01	0	0
P-162	20	J-162	J-164	200	DI K7	140	-9.7	0.31	0.536
P-163	81	J-164	J-165	80	DI K7	140	0.05	0.01	0.003
P-164	36	J-164	J-166	200	DI K7	140	-9.83	0.31	0.55
P-165	92	J-166	J-167	80	DI K7	140	0.06	0.01	0.003
P-166	32	J-166	J-168	200	DI K7	140	-9.99	0.32	0.566
P-167	40	J-168	J-169	80	DI K7	140	0.02	0	0.001
P-168	27	J-168	J-170	200	DI K7	140	-10.07	0.32	0.575
P-169	57	J-170	J-171	80	DI K7	140	0.03	0.01	0.001
P-170	52	J-170	J-172	200	DI K7	140	-10.19	0.32	0.588
P-171	129	J-172	J-173	80	DI K7	140	0.08	0.02	0.006
P-172	54	J-172	J-174	200	DI K7	140	-10.42	0.33	0.612
P-173	119	J-174	J-175	80	DI K7	140	0.07	0.01	0.005
P-174	22	J-174	J-176	200	DI K7	140	-10.61	0.34	0.633
P-175	26	J-176	J-177	80	DI K7	140	0.02	0	0
P-176	43	J-176	J-178	200	DI K7	140	-10.68	0.34	0.641
P-177	48	J-178	J-179	80	DI K7	140	0.12	0.02	0.014
P-178	22	J-179	J-180	80	DI K7	140	0.01	0	0
P-179	51	J-179	J-181	80	DI K7	140	0.03	0.01	0.001
P-180	35	J-178	J-182	80	DI K7	140	0.02	0	0.001

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-181	74	J-178	J-183	200	DI K7	140	-10.95	0.35	0.671
P-182	104	J-183	J-184	80	DI K7	140	0.06	0.01	0.004
P-183	31	J-183	J-185	200	DI K7	140	-11.14	0.35	0.693
P-184	43	J-185	J-186	80	DI K7	140	0.03	0.01	0.001
P-185	95	J-185	J-187	200	DI K7	140	-11.27	0.36	0.708
P-186	53	J-187	J-188	80	DI K7	140	0.03	0.01	0.001
P-188	65	J-189	J-190	80	DI K7	140	0.04	0.01	0.002
P-187(1)	62	J-158	J-191	150	DI K7	140	3.05	0.17	0.256
P-187(2)	44	J-191	J-189	150	DI K7	140	2.99	0.17	0.246
P-189	123	J-189	J-192	150	DI K7	140	2.8	0.16	0.219
P-190	28	J-192	J-193	80	DI K7	140	0.13	0.02	0.015
P-191	17	J-193	J-194	80	DI K7	140	0.01	0	0
P-192(1)	43	J-193	J-196	80	DI K7	140	0.06	0.01	0.004
P-192(2)	27	J-196	J-195	80	DI K7	140	0.02	0	0
P-193	125	J-196	J-197	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-194	247	J-192	J-198	150	DI K7	140	2.43	0.14	0.168
P-195	27	J-198	J-199	80	DI K7	140	0.02	0	0
P-196	24	J-198	J-200	150	DI K7	140	2.23	0.13	0.144
P-197	34	J-200	J-201	80	DI K7	140	0.02	0	0
P-199	25	J-202	J-203	80	DI K7	140	1.66	0.33	1.765
P-200	106	J-203	J-204	80	DI K7	140	0.24	0.05	0.048
P-201	13	J-204	J-205	80	DI K7	140	0.16	0.03	0.024
P-202	15	J-205	J-206	80	DI K7	140	0.01	0	0
P-203	112	J-205	J-207	80	DI K7	140	0.07	0.01	0.005
P-204	64	J-203	J-208	80	DI K7	140	1.3	0.26	1.128
P-205	42	J-208	J-209	80	DI K7	140	0.07	0.01	0.005
P-206	16	J-209	J-210	80	DI K7	140	0.01	0	0
P-207	19	J-209	J-211	80	DI K7	140	0.01	0	0
P-208	33	J-208	J-212	80	DI K7	140	1.15	0.23	0.894
P-209	65	J-212	J-213	80	DI K7	140	0.04	0.01	0.002
P-210	36	J-212	J-214	80	DI K7	140	1.03	0.2	0.725
P-211	122	J-214	J-215	80	DI K7	140	0.07	0.01	0.006
P-212	135	J-214	J-216	80	DI K7	140	0.77	0.15	0.427
P-213	35	J-216	J-217	80	DI K7	140	0.02	0	0.001
P-214	73	J-216	J-218	80	DI K7	140	0.21	0.04	0.039
P-215	46	J-218	J-219	80	DI K7	140	0.03	0.01	0.001
P-216	22	J-216	J-220	80	DI K7	140	0.37	0.07	0.112
P-217	74	J-220	J-221	80	DI K7	140	0.09	0.02	0.008
P-218	58	J-221	J-222	80	DI K7	140	0.04	0.01	0.001
P-219	33	J-221	J-223	80	DI K7	140	0.02	0	0.001
P-220	36	J-221	J-218	80	DI K7	140	-0.09	0.02	0.008
P-221	88	J-220	J-224	80	DI K7	140	0.17	0.03	0.026
P-222	62	J-224	J-225	80	DI K7	140	0.04	0.01	0.002
P-223	33	J-224	J-226	80	DI K7	140	0.02	0	0
P-224	81	J-159	J-227	100	DI K7	140	3.73	0.48	2.677
P-225	21	J-227	J-228	80	DI K7	140	0.12	0.02	0.014
P-226	21	J-228	J-229	80	DI K7	140	0.01	0	0
P-227	21	J-228	J-230	80	DI K7	140	0.07	0.01	0.005
P-228	32	J-230	J-231	80	DI K7	140	0.02	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-229	16	J-230	J-232	80	DI K7	140	0.01	0	0
P-231	38	J-233	J-234	80	DI K7	140	0.02	0	0.001
P-232	12	J-233	J-235	80	DI K7	140	0.14	0.03	0.017
P-233	53	J-235	J-236	80	DI K7	140	0.03	0.01	0.001
P-234	52	J-235	J-237	80	DI K7	140	0.03	0.01	0.001
P-230(1)	211	J-227	J-238	100	DI K7	140	3.42	0.44	2.273
P-230(2)	37	J-238	J-233	80	DI K7	140	0.21	0.04	0.039
P-235	73	J-238	J-239	100	DI K7	140	3.01	0.38	1.795
P-236	57	J-239	J-240	80	DI K7	140	0.03	0.01	0.001
P-237	295	J-239	J-241	100	DI K7	140	2.71	0.35	1.482
P-238	400	J-241	J-242	100	DI K7	140	2.29	0.29	1.079
P-239	26	J-242	J-243	80	DI K7	140	0.02	0	0
P-240	38	J-242	J-244	100	DI K7	140	1.98	0.25	0.831
P-241	7	J-244	J-245	80	DI K7	140	0	0	0
P-242	11	J-244	J-246	100	DI K7	140	1.95	0.25	0.801
P-243	18	J-246	J-247	80	DI K7	140	0.01	0	0
P-244	16	J-246	J-248	100	DI K7	140	1.91	0.24	0.772
P-245	18	J-248	J-249	80	DI K7	140	0.01	0	0
P-246	33	J-248	J-250	100	DI K7	140	1.85	0.24	0.733
P-247	32	J-250	J-251	80	DI K7	140	0.02	0	0
P-248	20	J-250	J-252	100	DI K7	140	1.78	0.23	0.681
P-250	16	J-252	J-254	100	DI K7	140	1.63	0.21	0.576
P-252	39	J-254	J-256	80	DI K7	140	0.91	0.18	0.576
P-253	132	J-256	J-257	80	DI K7	140	0.08	0.02	0.007
P-254	32	J-256	J-460	80	DI K7	140	0.7	0.14	0.358
P-256	128	J-460	J-260	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-257	61	J-260	J-261	80	DI K7	140	0.26	0.05	0.059
P-258	62	J-261	J-262	80	DI K7	140	0.04	0.01	0.002
P-259	122	J-261	J-263	80	DI K7	140	0.08	0.01	0.006
P-261	35	J-264	J-265	80	DI K7	140	0.02	0	0.001
P-262	33	J-264	J-266	80	DI K7	140	0.02	0	0.001
P-120(1)	150	J-119	J-267	80	DI K7	140	-0.28	0.06	0.065
P-120(2)	31	J-267	J-121	80	DI K7	140	-0.46	0.09	0.163
P-263	56	J-267	J-268	80	DI K7	140	0.03	0.01	0.001
P-267	15	J-270	J-271	80	DI K7	140	0.01	0	0
P-268	79	J-270	J-272	100	DI K7	140	1.32	0.17	0.388
P-269	41	J-272	J-273	80	DI K7	140	0.12	0.02	0.013
P-270	7	J-273	J-274	80	DI K7	140	0	0	0
P-271	68	J-273	J-275	80	DI K7	140	0.04	0.01	0.002
P-272	71	J-272	J-276	100	DI K7	140	1.08	0.14	0.27
P-273	24	J-276	J-277	80	DI K7	140	0.01	0	0
P-274	62	J-276	J-278	100	DI K7	140	0.97	0.12	0.22
P-275	27	J-278	J-279	80	DI K7	140	0.16	0.03	0.023
P-276	19	J-279	J-280	80	DI K7	140	0.01	0	0
P-277	98	J-279	J-281	80	DI K7	140	0.06	0.01	0.004
P-278	16	J-278	J-282	100	DI K7	140	0.74	0.09	0.135
P-279	7	J-282	J-283	80	DI K7	140	0	0	0
P-280	186	J-282	J-284	100	DI K7	140	0.61	0.08	0.094
P-281	59	J-284	J-285	80	DI K7	140	0.22	0.04	0.042
P-282	23	J-285	J-286	80	DI K7	140	0.01	0	0
P-283	51	J-284	J-287	80	DI K7	140	0.21	0.04	0.039

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-284	80	J-287	J-288	80	DI K7	140	0.13	0.03	0.016
P-285	58	J-288	J-285	80	DI K7	140	-0.12	0.02	0.013
P-286	79	J-288	J-289	80	DI K7	140	0.12	0.02	0.013
P-287	23	J-289	J-290	80	DI K7	140	0.01	0	0
P-289	70	J-291	J-292	80	DI K7	140	0.04	0.01	0.002
P-288(1)	32	J-289	J-293	80	DI K7	140	0.02	0	0.001
P-291	26	J-294	J-295	80	DI K7	140	0.02	0	0
P-292	11	J-294	J-296	150	DI K7	140	7.61	0.43	1.391
P-293	228	J-296	J-297	80	DI K7	140	0.14	0.03	0.018
P-294	41	J-296	J-298	150	DI K7	140	7.3	0.41	1.288
P-295	11	J-298	J-299	80	DI K7	140	0.01	0	0
P-296	68	J-298	J-300	150	DI K7	140	7.22	0.41	1.262
P-298	38	J-300	J-302	150	DI K7	140	7.16	0.41	1.241
P-299	15	J-302	J-303	80	DI K7	140	0.01	0	0
P-303	24	J-304	J-305	80	DI K7	140	0.14	0.03	0.017
P-304	69	J-304	J-306	100	DI K7	140	2.32	0.3	1.11
P-305	14	J-306	J-307	80	DI K7	140	0.4	0.08	0.124
P-306	40	J-307	J-308	80	DI K7	140	0.02	0	0.001
P-307	31	J-307	J-309	80	DI K7	140	0.32	0.06	0.083
P-308	15	J-309	J-310	80	DI K7	140	0.01	0	0
P-309	67	J-309	J-311	80	DI K7	140	0.24	0.05	0.049
P-310	30	J-311	J-312	80	DI K7	140	0.02	0	0
P-311	30	J-311	J-313	80	DI K7	140	0.02	0	0
P-312	102	J-311	J-314	80	DI K7	140	0.06	0.01	0.004
P-313	30	J-306	J-315	100	DI K7	140	1.85	0.24	0.733
P-314	11	J-315	J-316	80	DI K7	140	0.01	0	0
P-315	53	J-315	J-317	80	DI K7	140	0.03	0.01	0.001
P-316	19	J-315	J-318	100	DI K7	140	1.75	0.22	0.656
P-317	29	J-318	J-319	80	DI K7	140	0.02	0	0
P-318	18	J-318	J-320	100	DI K7	140	1.69	0.21	0.616
P-319	25	J-320	J-321	80	DI K7	140	0.02	0	0
P-320	30	J-320	J-322	100	DI K7	140	1.63	0.21	0.576
P-321	73	J-322	J-323	80	DI K7	140	0.14	0.03	0.019
P-322	8	J-323	J-324	80	DI K7	140	0	0	0
P-323	73	J-323	J-325	80	DI K7	140	0.04	0.01	0.002
P-324	10	J-322	J-326	100	DI K7	140	1.41	0.18	0.444
P-325	16	J-326	J-327	80	DI K7	140	0.01	0	0
P-326	28	J-326	J-328	100	DI K7	140	1.37	0.17	0.419
P-327	112	J-328	J-329	80	DI K7	140	0.07	0.01	0.005
P-328	20	J-328	J-330	100	DI K7	140	1.2	0.15	0.329
P-329	36	J-330	J-331	80	DI K7	140	0.02	0	0.001
P-330	52	J-330	J-332	100	DI K7	140	1.12	0.14	0.286
P-332	13	J-332	J-334	80	DI K7	140	0.01	0	0
P-333	16	J-332	J-335	80	DI K7	140	0.35	0.07	0.101
P-334	45	J-335	J-336	80	DI K7	140	0.03	0.01	0.001
P-335	143	J-335	J-337	80	DI K7	140	0.2	0.04	0.035
P-336	62	J-337	J-338	80	DI K7	140	0.04	0.01	0.002
P-337	29	J-337	J-339	80	DI K7	140	0.02	0	0
P-338	14	J-332	J-340	80	DI K7	140	0.7	0.14	0.354
P-339	67	J-340	J-341	80	DI K7	140	0.04	0.01	0.002
P-340	20	J-340	J-342	80	DI K7	140	0.59	0.12	0.263

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-341	8	J-342	J-343	80	DI K7	140	0.01	0	0
P-343(1)	42	J-344	J-346	80	DI K7	140	0.33	0.07	0.091
P-343(2)	31	J-346	J-345	80	DI K7	140	0.02	0	0
P-344	158	J-346	J-347	80	DI K7	140	0.17	0.03	0.027
P-345	50	J-347	J-348	80	DI K7	140	0.03	0.01	0.001
P-346	13	J-347	J-349	80	DI K7	140	0.01	0	0
P-342(1)	57	J-342	J-350	80	DI K7	140	0.54	0.11	0.218
P-342(2)	94	J-350	J-344	80	DI K7	140	0.37	0.07	0.11
P-347	59	J-350	J-351	80	DI K7	140	0.04	0.01	0.001
P-348	57	J-344	J-352	80	DI K7	140	-0.08	0.02	0.007
P-351	22	J-269	J-355	150	DI K7	140	2.37	0.13	0.161
P-266(2)	32	J-356	J-270	100	DI K7	140	1.4	0.18	0.437
P-302(2)	247	J-357	J-304	100	DI K7	140	2.67	0.34	1.435
P-352	12	J-356	J-357	100	DI K7	140	2.82	0.36	1.598
P-354	68	J-353	J-358	80	DI K7	140	0.04	0.01	0.002
P-355	29	J-353	J-359	100	DI K7	140	2.65	0.34	1.418
P-356	21	J-359	J-360	80	DI K7	140	0.01	0	0
P-357	14	J-359	J-361	100	DI K7	140	2.6	0.33	1.367
P-358	11	J-361	J-362	80	DI K7	140	0.01	0	0
P-359	12	J-361	J-363	100	DI K7	140	2.57	0.33	1.339
P-360	57	J-363	J-364	80	DI K7	140	0.03	0.01	0.001
P-361	13	J-363	J-365	100	DI K7	140	2.48	0.32	1.258
P-362	66	J-365	J-366	80	DI K7	140	0.04	0.01	0.002
P-363	8	J-365	J-367	100	DI K7	140	2.39	0.3	1.171
P-364	78	J-367	J-368	80	DI K7	140	0.25	0.05	0.052
P-365	24	J-368	J-369	80	DI K7	140	0.01	0	0
P-366	85	J-368	J-370	80	DI K7	140	0.12	0.02	0.013
P-367	6	J-370	J-367	100	DI K7	140	-2.09	0.27	0.911
P-368	9	J-370	J-371	100	DI K7	140	2.14	0.27	0.956
P-369	75	J-371	J-372	80	DI K7	140	0.05	0.01	0.002
P-370	27	J-371	J-373	100	DI K7	140	2.03	0.26	0.864
P-371	41	J-373	J-374	80	DI K7	140	0.12	0.02	0.013
P-372	26	J-374	J-375	80	DI K7	140	0.02	0	0
P-373	49	J-374	J-376	80	DI K7	140	0.03	0.01	0.001
P-374	95	J-373	J-377	80	DI K7	140	1.81	0.36	2.073
P-375	63	J-377	J-378	80	DI K7	140	1.13	0.23	0.875
P-376	48	J-378	J-379	80	DI K7	140	0.03	0.01	0.001
P-377	45	J-378	J-380	80	DI K7	140	1.01	0.2	0.704
P-378	42	J-380	J-381	80	DI K7	140	0.03	0.01	0.001
P-379	48	J-380	J-382	80	DI K7	140	0.9	0.18	0.57
P-380	19	J-382	J-383	80	DI K7	140	0.01	0	0
P-381	65	J-382	J-384	80	DI K7	140	0.81	0.16	0.466
P-382	13	J-384	J-385	80	DI K7	140	0.66	0.13	0.321
P-383	26	J-385	J-386	80	DI K7	140	0.34	0.07	0.096
P-384	66	J-386	J-387	80	DI K7	140	0.04	0.01	0.002
P-385	37	J-386	J-388	80	DI K7	140	0.22	0.04	0.044
P-386(1)	24	J-388	J-291	80	DI K7	140	0.37	0.07	0.111
P-386(2)	21	J-291	J-389	80	DI K7	140	0.26	0.05	0.057
P-387	86	J-385	J-388	80	DI K7	140	0.24	0.05	0.049
P-388	81	J-384	J-390	80	DI K7	140	0.05	0.01	0.003
P-389	69	J-377	J-391	80	DI K7	140	0.53	0.11	0.216

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-390	36	J-391	J-392	80	DI K7	140	0.02	0	0.001
P-391	17	J-391	J-393	80	DI K7	140	0.44	0.09	0.149
P-392	23	J-393	J-394	80	DI K7	140	0.01	0	0
P-393	12	J-393	J-395	80	DI K7	140	0.39	0.08	0.122
P-394	32	J-395	J-396	80	DI K7	140	0.02	0	0.001
P-395	18	J-395	J-397	80	DI K7	140	0.33	0.07	0.091
P-396	29	J-397	J-398	80	DI K7	140	0.02	0	0
P-397	7	J-397	J-399	80	DI K7	140	0.28	0.06	0.067
P-398	29	J-399	J-400	80	DI K7	140	0.02	0	0
P-399	50	J-399	J-401	80	DI K7	140	0.21	0.04	0.039
P-400	146	J-401	J-402	80	DI K7	140	0.17	0.03	0.025
P-401	47	J-402	J-403	80	DI K7	140	0.03	0.01	0.001
P-402	15	J-402	J-404	80	DI K7	140	0.01	0	0
P-403	33	J-401	J-405	80	DI K7	140	-0.1	0.02	0.009
P-404	24	J-405	J-406	80	DI K7	140	0.01	0	0
P-405	50	J-405	J-407	80	DI K7	140	-0.18	0.03	0.028
P-406	53	J-407	J-408	80	DI K7	140	0.03	0.01	0.001
P-407	21	J-407	J-409	80	DI K7	140	-0.28	0.06	0.067
P-408	33	J-409	J-410	80	DI K7	140	0.02	0	0.001
P-409	14	J-409	J-411	80	DI K7	140	-0.35	0.07	0.097
P-410	31	J-411	J-412	80	DI K7	140	0.02	0	0
P-411	20	J-411	J-413	80	DI K7	140	-0.41	0.08	0.13
P-412	20	J-413	J-414	80	DI K7	140	0.01	0	0
P-413	58	J-413	J-415	80	DI K7	140	-0.48	0.1	0.176
P-414	47	J-415	J-416	80	DI K7	140	0.03	0.01	0.001
P-416	32	J-355	J-418	100	DI K7	140	2.26	0.29	1.054
P-417	52	J-418	J-419	80	DI K7	140	0.03	0.01	0.001
P-418	76	J-418	J-420	100	DI K7	140	2.13	0.27	0.945
P-419	103	J-420	J-421	80	DI K7	140	0.06	0.01	0.004
P-420	13	J-420	J-422	100	DI K7	140	1.95	0.25	0.801
P-421	97	J-422	J-423	80	DI K7	140	0.06	0.01	0.004
P-422	221	J-422	J-424	100	DI K7	140	1.68	0.21	0.612
P-423	34	J-424	J-425	80	DI K7	140	0.02	0	0.001
P-424	161	J-424	J-426	80	DI K7	140	1.41	0.28	1.303
P-425	28	J-426	J-427	80	DI K7	140	0.02	0	0
P-426	14	J-426	J-428	80	DI K7	140	1.26	0.25	1.07
P-427	16	J-428	J-429	80	DI K7	140	0.01	0	0
P-428	11	J-428	J-430	80	DI K7	140	1.23	0.24	1.017
P-429	35	J-430	J-431	80	DI K7	140	0.02	0	0.001
P-430	10	J-430	J-432	80	DI K7	140	1.17	0.23	0.933
P-431	33	J-432	J-433	80	DI K7	140	0.02	0	0
P-432	87	J-432	J-434	80	DI K7	140	1.07	0.21	0.791
P-433	38	J-434	J-435	80	DI K7	140	0.02	0	0.001
P-434	35	J-434	J-436	80	DI K7	140	0.95	0.19	0.633
P-435	17	J-436	J-437	80	DI K7	140	0.01	0	0
P-436	17	J-436	J-438	80	DI K7	140	0.9	0.18	0.57
P-437	19	J-438	J-439	80	DI K7	140	0.01	0	0
P-438	28	J-438	J-440	80	DI K7	140	0.85	0.17	0.513
P-439	22	J-440	J-441	80	DI K7	140	0.01	0	0
P-440	42	J-440	J-442	80	DI K7	140	0.78	0.16	0.437
P-349(2)	37	J-443	J-353	100	DI K7	140	2.77	0.35	1.544

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-28(1)	174	J-25	J-444	80	DI K7	140	-0.2	0.04	0.037
P-28(2)	38	J-444	J-27	80	DI K7	140	-0.49	0.1	0.187
P-447	137	J-444	J-21	80	DI K7	140	0.07	0.01	0.005
P-1(1)	19	T-1	J-453	250	DI K7	140	30.57	0.97	4.496
P-1(2)	11	J-453	J-1	250	DI K7	140	8.35	0.27	0.407
P-446(1)	41	J-302	J-451	150	DI K7	140	7.09	0.4	1.219
P-445(2)	11	J-451	J-356	150	DI K7	140	4.26	0.24	0.475
P-448(1)	83	J-187	J-453	200	DI K7	140	-11.44	0.36	0.729
P-118(2)	245	J-2	J-119	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-112(2)(1)	165	J-115	J-457	80	DI K7	140	1.17	0.23	0.929
P-112(2)(2)	146	J-457	J-112	80	DI K7	140	0.98	0.2	0.668
P-249(1)	11	J-252	J-458	80	DI K7	140	0.12	0.02	0.014
P-249(2)	50	J-458	J-253	80	DI K7	140	0.03	0.01	0.001
P-450	46	J-458	J-459	80	DI K7	140	0.03	0.01	0.001
P-255(2)	26	J-460	J-259	80	DI K7	140	0.02	0	0
P-451	116	J-460	J-461	80	DI K7	140	0.58	0.11	0.25
P-260(1)	11	J-260	J-461	80	DI K7	140	-0.31	0.06	0.078
P-260(2)	89	J-461	J-264	80	DI K7	140	0.14	0.03	0.017
P-251(1)	96	J-254	J-463	80	DI K7	140	0.63	0.13	0.295
P-350(2)(1)	69	J-355	J-464	80	DI K7	140	0.04	0.01	0.002
P-350(2)(2)	142	J-464	J-354	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-452	91	J-352	J-465	80	DI K7	140	-0.17	0.03	0.027
P-290(2)(2)(1)	224	J-453	J-467	200	DI K7	140	10.55	0.34	0.627
P-290(2)(2)(2)	27	J-467	J-294	150	DI K7	140	7.67	0.43	1.41
P-453	11	J-467	J-468	150	DI K7	140	2.72	0.15	0.207
P-297(2)	36	J-469	J-301	80	DI K7	140	0.02	0	0.001
P-264(2)(1)	149	J-468	J-469	150	DI K7	140	2.62	0.15	0.194
P-264(2)(2)	81	J-469	J-269	150	DI K7	140	2.44	0.14	0.169
P-454	22	J-451	J-443	100	DI K7	140	2.8	0.36	1.568
P-455	15	J-465	J-389	80	DI K7	140	-0.24	0.05	0.049
P-415(1)	137	J-415	J-471	80	DI K7	140	-0.65	0.13	0.316
P-415(2)	40	J-471	J-417	80	DI K7	140	(N/A)	(N/A)	(N/A)
P-456	13	J-442	J-471	80	DI K7	140	0.75	0.15	0.403
P-111(2)	79	J-474	J-111	80	DI K7	140	0.05	0.01	0.003
P-112(1)(1)	17	J-3	J-475	80	DI K7	140	1.65	0.33	1.749
P-112(1)(2)	115	J-475	J-115	80	DI K7	140	1.46	0.29	1.388
P-457	12	J-474	J-475	80	DI K7	140	-0.1	0.02	0.011
P-103(1)	15	J-102	J-476	80	DI K7	140	0.11	0.02	0.012
P-103(2)	18	J-476	J-103	80	DI K7	140	0.01	0	0
P-458	65	J-476	J-477	80	DI K7	140	0.04	0.01	0.002
P-198(1)	133	J-200	J-478	150	DI K7	140	2.1	0.12	0.128
P-198(2)	13	J-478	J-202	150	DI K7	140	1.68	0.1	0.085
P-459	265	J-478	J-479	80	DI K7	140	0.16	0.03	0.024
P-251(2)(1)	14	J-463	J-480	80	DI K7	140	0.56	0.11	0.239
P-251(2)(2)	293	J-480	J-255	80	DI K7	140	0.27	0.05	0.061
P-460	86	J-480	J-481	80	DI K7	140	0.05	0.01	0.003
P-461	72	J-255	J-255/1	80	DI K7	140	0.04	0.01	0.002
P-462	99	J-305	J-305/1	80	DI K7	140	0.06	0.01	0.004

Table 10.3 : Pipe Details of HDPE Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-2	1,595	J-1	J-2	170.4	HDPE	145	8.35	0.37	0.831
P-3	20	J-2	J-3	170.4	HDPE	145	8.19	0.36	0.801
P-5	47	J-4	J-5	53.6	HDPE	145	0.03	0.01	0.006
P-6	27	J-4	J-6	93.8	HDPE	145	1.89	0.27	0.972
P-7	33	J-6	J-7	93.8	HDPE	145	1.8	0.26	0.892
P-8	40	J-6	J-8	53.6	HDPE	145	0.02	0.01	0.005
P-9	182	J-7	J-9	63.8	HDPE	145	0.37	0.11	0.304
P-10	39	J-9	J-10	53.6	HDPE	145	0.02	0.01	0.005
P-11	17	J-7	J-11	93.8	HDPE	145	1.3	0.19	0.483
P-12	29	J-11	J-12	53.6	HDPE	145	0.02	0.01	0.003
P-13	28	J-11	J-13	93.8	HDPE	145	1.23	0.18	0.441
P-14	24	J-13	J-14	53.6	HDPE	145	0.01	0.01	0.002
P-15	22	J-13	J-15	93.8	HDPE	145	1.17	0.17	0.401
P-16	132	J-15	J-16	76.6	HDPE	145	0.48	0.1	0.209
P-17	20	J-16	J-9	63.8	HDPE	145	-0.19	0.06	0.094
P-18	36	J-16	J-17	53.6	HDPE	145	0.02	0.01	0.004
P-19	55	J-16	J-18	76.6	HDPE	145	0.51	0.11	0.227
P-20	22	J-18	J-19	53.6	HDPE	145	0.01	0.01	0.002
P-21	27	J-18	J-20	76.6	HDPE	145	0.43	0.09	0.167
P-22	11	J-20	J-21	53.6	HDPE	145	0.08	0.04	0.032
P-23	115	J-20	J-22	63.8	HDPE	145	0.26	0.08	0.154
P-24	49	J-22	J-23	53.6	HDPE	145	0.03	0.01	0.007
P-25	74	J-22	J-24	53.6	HDPE	145	0.05	0.02	0.015
P-26	97	J-22	J-25	53.6	HDPE	145	-0.03	0.01	0.003
P-27	150	J-25	J-26	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-29	77	J-27	J-28	53.6	HDPE	145	0.05	0.02	0.016
P-30	46	J-27	J-15	63.8	HDPE	145	-0.57	0.18	0.68
P-4(1)	129	J-3	J-29	170.4	HDPE	145	6.73	0.3	0.557
P-31	366	J-29	J-30	119.4	HDPE	145	4.2	0.37	1.314
P-32	24	J-30	J-31	53.6	HDPE	145	0.01	0.01	0.002
P-33	19	J-30	J-32	119.4	HDPE	145	3.93	0.35	1.164
P-34	47	J-32	J-33	76.6	HDPE	145	0.61	0.13	0.318
P-35	20	J-33	J-34	53.6	HDPE	145	0.01	0.01	0.001
P-36	48	J-33	J-35	53.6	HDPE	145	0.03	0.01	0.007
P-37	31	J-33	J-36	76.6	HDPE	145	0.48	0.1	0.203
P-38	37	J-36	J-37	63.8	HDPE	145	0.3	0.09	0.208
P-39	24	J-37	J-38	53.6	HDPE	145	0.01	0.01	0.002
P-40	12	J-37	J-39	63.8	HDPE	145	0.24	0.07	0.137
P-41	49	J-39	J-40	53.6	HDPE	145	0.03	0.01	0.007
P-43	68	J-39	J-41	63.8	HDPE	145	0.13	0.04	0.044
P-44	38	J-41	J-42	53.6	HDPE	145	0.02	0.01	0.004
P-45	34	J-41	J-43	53.6	HDPE	145	0.02	0.01	0.003

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-46	23	J-36	J-44	53.6	HDPE	145	0.12	0.05	0.093
P-47	20	J-44	J-45	53.6	HDPE	145	0.01	0.01	0.001
P-48	68	J-44	J-46	53.6	HDPE	145	0.04	0.02	0.013
P-49	67	J-32	J-47	93.8	HDPE	145	3.24	0.47	2.64
P-50	44	J-47	J-48	53.6	HDPE	145	0.03	0.01	0.006
P-51	28	J-47	J-49	93.8	HDPE	145	3.13	0.45	2.473
P-52	48	J-49	J-50	53.6	HDPE	145	0.03	0.01	0.007
P-53	20	J-49	J-51	93.8	HDPE	145	3.04	0.44	2.345
P-54	49	J-51	J-52	53.6	HDPE	145	0.03	0.01	0.007
P-55	19	J-51	J-53	93.8	HDPE	145	2.96	0.43	2.227
P-56	79	J-53	J-54	63.8	HDPE	145	0.07	0.02	0.015
P-57	10	J-54	J-55	53.6	HDPE	145	0.01	0	0
P-58	10	J-54	J-56	53.6	HDPE	145	0.01	0	0
P-59	18	J-53	J-57	93.8	HDPE	145	2.81	0.41	2.029
P-60	66	J-57	J-58	53.6	HDPE	145	0.04	0.02	0.012
P-61	14	J-57	J-59	93.8	HDPE	145	2.71	0.39	1.896
P-62	67	J-59	J-60	53.6	HDPE	145	0.04	0.02	0.012
P-63	12	J-59	J-61	93.8	HDPE	145	2.61	0.38	1.771
P-64	65	J-61	J-62	53.6	HDPE	145	0.04	0.02	0.012
P-65	24	J-61	J-63	93.8	HDPE	145	2.51	0.36	1.645
P-66	33	J-63	J-64	53.6	HDPE	145	0.02	0.01	0.003
P-67	99	J-63	J-65	93.8	HDPE	145	2.4	0.35	1.507
P-68	46	J-65	J-66	53.6	HDPE	145	0.03	0.01	0.006
P-69	58	J-65	J-67	93.8	HDPE	145	2.24	0.32	1.334
P-70	96	J-67	J-68	53.6	HDPE	145	0.06	0.03	0.024
P-71	16	J-67	J-69	93.8	HDPE	145	2.08	0.3	1.16
P-72	14	J-69	J-70	53.6	HDPE	145	0.01	0	0.001
P-73	11	J-69	J-71	93.8	HDPE	145	2.05	0.3	1.125
P-74	20	J-71	J-72	53.6	HDPE	145	0.01	0.01	0.001
P-75	12	J-71	J-73	93.8	HDPE	145	2.01	0.29	1.085
P-76	48	J-73	J-74	53.6	HDPE	145	0.03	0.01	0.007
P-77	28	J-73	J-75	93.8	HDPE	145	1.92	0.28	1.004
P-78	34	J-75	J-76	53.6	HDPE	145	0.14	0.06	0.124
P-79	10	J-76	J-77	53.6	HDPE	145	0.01	0	0
P-80	89	J-76	J-78	53.6	HDPE	145	0.05	0.02	0.021
P-81	43	J-75	J-79	93.8	HDPE	145	1.72	0.25	0.812
P-82	62	J-79	J-80	53.6	HDPE	145	0.04	0.02	0.011
P-83	14	J-79	J-81	93.8	HDPE	145	1.61	0.23	0.718
P-84	24	J-81	J-82	53.6	HDPE	145	0.01	0.01	0.002
P-85	22	J-81	J-83	93.8	HDPE	145	1.55	0.22	0.676
P-86	18	J-83	J-84	53.6	HDPE	145	0.01	0	0.001
P-87	56	J-83	J-85	93.8	HDPE	145	1.48	0.21	0.621
P-89	74	J-85	J-87	76.6	HDPE	145	0.89	0.19	0.641
P-91(1)	10	J-88	J-90	63.8	HDPE	145	-0.25	0.08	0.145

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-91(2)	18	J-90	J-89	53.6	HDPE	145	0.01	0	0.001
P-88(1)	101	J-85	J-91	63.8	HDPE	145	0.46	0.14	0.455
P-88(2)	54	J-91	J-86	53.6	HDPE	145	0.03	0.01	0.008
P-92	43	J-90	J-91	63.8	HDPE	145	-0.3	0.09	0.211
P-90(1)	50	J-87	J-92	76.6	HDPE	145	0.5	0.11	0.219
P-90(2)	14	J-92	J-88	63.8	HDPE	145	-0.23	0.07	0.129
P-94	36	J-93	J-94	53.6	HDPE	145	0.02	0.01	0.004
P-95	37	J-93	J-95	53.6	HDPE	145	0.02	0.01	0.004
P-96	73	J-93	J-96	76.6	HDPE	145	0.42	0.09	0.162
P-97	31	J-96	J-97	53.6	HDPE	145	0.02	0.01	0.003
P-98	39	J-96	J-98	63.8	HDPE	145	0.32	0.1	0.231
P-99	21	J-98	J-99	53.6	HDPE	145	0.01	0.01	0.002
P-100	16	J-98	J-100	53.6	HDPE	145	0.26	0.11	0.365
P-101	16	J-100	J-101	53.6	HDPE	145	0.01	0	0.001
P-102	51	J-100	J-102	53.6	HDPE	145	0.19	0.09	0.221
P-104	19	J-102	J-104	53.6	HDPE	145	0.01	0.01	0.001
P-105	16	J-102	J-105	53.6	HDPE	145	0.01	0	0.001
P-106	99	J-87	J-106	63.8	HDPE	145	0.25	0.08	0.154
P-107	141	J-106	J-107	53.6	HDPE	145	0.11	0.05	0.071
P-108	41	J-107	J-108	53.6	HDPE	145	0.03	0.01	0.005
P-93(1)	38	J-92	J-109	76.6	HDPE	145	0.66	0.14	0.375
P-93(2)	19	J-109	J-93	76.6	HDPE	145	0.57	0.12	0.28
P-109	25	J-107	J-109	63.8	HDPE	145	-0.05	0.01	0.007
P-110	267	J-106	J-110	63.8	HDPE	145	(N/A)	(N/A)	(N/A)
P-113	76	J-112	J-113	53.6	HDPE	145	0.05	0.02	0.016
P-4(2)(1)	241	J-29	J-114	76.6	HDPE	145	2.08	0.45	3.113
P-4(2)(2)	115	J-114	J-4	93.8	HDPE	145	2.04	0.29	1.115
P-114	268	J-112	J-114	63.8	HDPE	145	0.34	0.11	0.263
P-115	49	J-115	J-116	53.6	HDPE	145	0.08	0.04	0.044
P-116	20	J-116	J-117	53.6	HDPE	145	0.01	0.01	0.001
P-117	22	J-116	J-118	53.6	HDPE	145	0.01	0.01	0.002
P-119	29	J-119	J-120	53.6	HDPE	145	0.02	0.01	0.003
P-121	26	J-121	J-122	63.8	HDPE	145	0.24	0.07	0.136
P-122	24	J-122	J-123	53.6	HDPE	145	0.01	0.01	0.002
P-123(1)	20	J-122	J-125	63.8	HDPE	145	0.18	0.06	0.081
P-123(2)	14	J-125	J-124	53.6	HDPE	145	0.01	0	0.001
P-124	122	J-125	J-126	53.6	HDPE	145	0.08	0.03	0.038
P-125	147	J-121	J-127	76.6	HDPE	145	-0.82	0.18	0.556
P-126	35	J-127	J-128	53.6	HDPE	145	0.18	0.08	0.197
P-127	35	J-128	J-129	53.6	HDPE	145	0.02	0.01	0.004
P-128	96	J-128	J-130	53.6	HDPE	145	0.06	0.03	0.024
P-129	82	J-127	J-131	53.6	HDPE	145	0.05	0.02	0.018
P-130	20	J-127	J-132	76.6	HDPE	145	-1.23	0.27	1.175
P-131	35	J-132	J-133	53.6	HDPE	145	0.02	0.01	0.004

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-132	49	J-132	J-134	76.6	HDPE	145	-1.31	0.29	1.331
P-133	25	J-134	J-135	53.6	HDPE	145	0.02	0.01	0.002
P-134	37	J-134	J-136	76.6	HDPE	145	-1.4	0.3	1.492
P-135	55	J-136	J-137	63.8	HDPE	145	0.27	0.09	0.177
P-136	21	J-137	J-138	53.6	HDPE	145	0.01	0.01	0.002
P-137	174	J-137	J-139	53.6	HDPE	145	0.11	0.05	0.073
P-138	37	J-136	J-140	53.6	HDPE	145	0.02	0.01	0.004
P-139	12	J-136	J-141	76.6	HDPE	145	-1.78	0.39	2.336
P-140	38	J-141	J-142	53.6	HDPE	145	0.02	0.01	0.004
P-141	22	J-141	J-143	76.6	HDPE	145	-1.85	0.4	2.503
P-142	36	J-143	J-144	53.6	HDPE	145	0.02	0.01	0.004
P-143	20	J-143	J-145	53.6	HDPE	145	0.01	0.01	0.001
P-144	17	J-143	J-146	76.6	HDPE	145	-1.94	0.42	2.739
P-145	56	J-146	J-147	53.6	HDPE	145	0.03	0.02	0.009
P-146	46	J-146	J-148	93.8	HDPE	145	-2.05	0.3	1.129
P-147	140	J-148	J-149	53.6	HDPE	145	0.14	0.06	0.124
P-148	32	J-149	J-150	53.6	HDPE	145	0.02	0.01	0.003
P-149	14	J-149	J-151	53.6	HDPE	145	0.01	0	0.001
P-150	24	J-148	J-152	93.8	HDPE	145	-2.32	0.34	1.421
P-151	44	J-152	J-153	63.8	HDPE	145	0.07	0.02	0.013
P-152	7	J-153	J-154	53.6	HDPE	145	0	0	0
P-153	10	J-153	J-155	53.6	HDPE	145	0.03	0.01	0.005
P-154	9	J-155	J-156	53.6	HDPE	145	0.01	0	0
P-155	7	J-155	J-157	53.6	HDPE	145	0	0	0
P-156	60	J-152	J-158	93.8	HDPE	145	-2.47	0.36	1.591
P-157	13	J-158	J-159	170.4	HDPE	145	-5.6	0.25	0.397
P-158	147	J-159	J-160	170.4	HDPE	145	-9.48	0.42	1.051
P-159	54	J-160	J-161	53.6	HDPE	145	0.03	0.01	0.008
P-160	26	J-160	J-162	170.4	HDPE	145	-9.65	0.42	1.087
P-161	15	J-162	J-163	53.6	HDPE	145	0.01	0	0.001
P-162	20	J-162	J-164	170.4	HDPE	145	-9.7	0.43	1.097
P-163	81	J-164	J-165	53.6	HDPE	145	0.05	0.02	0.018
P-164	36	J-164	J-166	170.4	HDPE	145	-9.83	0.43	1.125
P-165	92	J-166	J-167	53.6	HDPE	145	0.06	0.03	0.022
P-166	32	J-166	J-168	170.4	HDPE	145	-9.99	0.44	1.158
P-167	40	J-168	J-169	53.6	HDPE	145	0.02	0.01	0.005
P-168	27	J-168	J-170	170.4	HDPE	145	-10.07	0.44	1.177
P-169	57	J-170	J-171	53.6	HDPE	145	0.03	0.02	0.009
P-170	52	J-170	J-172	170.4	HDPE	145	-10.19	0.45	1.202
P-171	129	J-172	J-173	53.6	HDPE	145	0.08	0.04	0.042
P-172	54	J-172	J-174	170.4	HDPE	145	-10.42	0.46	1.252
P-173	119	J-174	J-175	53.6	HDPE	145	0.07	0.03	0.036

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-174	22	J-174	J-176	170.4	HDPE	145	-10.61	0.47	1.295
P-175	26	J-176	J-177	53.6	HDPE	145	0.02	0.01	0.002
P-176	43	J-176	J-178	170.4	HDPE	145	-10.68	0.47	1.311
P-177	48	J-178	J-179	53.6	HDPE	145	0.12	0.05	0.091
P-178	22	J-179	J-180	53.6	HDPE	145	0.01	0.01	0.002
P-179	51	J-179	J-181	53.6	HDPE	145	0.03	0.01	0.008
P-180	35	J-178	J-182	53.6	HDPE	145	0.02	0.01	0.004
P-181	74	J-178	J-183	170.4	HDPE	145	-10.95	0.48	1.372
P-182	104	J-183	J-184	53.6	HDPE	145	0.06	0.03	0.028
P-183	31	J-183	J-185	170.4	HDPE	145	-11.14	0.49	1.417
P-184	43	J-185	J-186	53.6	HDPE	145	0.03	0.01	0.006
P-185	95	J-185	J-187	170.4	HDPE	145	-11.27	0.49	1.448
P-186	53	J-187	J-188	53.6	HDPE	145	0.03	0.01	0.008
P-188	65	J-189	J-190	53.6	HDPE	145	0.04	0.02	0.012
P-187(1)	62	J-158	J-191	119.4	HDPE	145	3.05	0.27	0.728
P-187(2)	44	J-191	J-189	119.4	HDPE	145	2.99	0.27	0.7
P-189	123	J-189	J-192	119.4	HDPE	145	2.8	0.25	0.622
P-190	28	J-192	J-193	63.8	HDPE	145	0.13	0.04	0.042
P-191	17	J-193	J-194	53.6	HDPE	145	0.01	0	0.001
P-192(1)	43	J-193	J-196	63.8	HDPE	145	0.06	0.02	0.011
P-192(2)	27	J-196	J-195	53.6	HDPE	145	0.02	0.01	0.002
P-193	125	J-196	J-197	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-194	247	J-192	J-198	119.4	HDPE	145	2.43	0.22	0.479
P-195	27	J-198	J-199	53.6	HDPE	145	0.02	0.01	0.002
P-196	24	J-198	J-200	119.4	HDPE	145	2.23	0.2	0.409
P-197	34	J-200	J-201	53.6	HDPE	145	0.02	0.01	0.004
P-199	25	J-202	J-203	76.6	HDPE	145	1.66	0.36	2.044
P-200	106	J-203	J-204	63.8	HDPE	145	0.24	0.07	0.135
P-201	13	J-204	J-205	53.6	HDPE	145	0.16	0.07	0.16
P-202	15	J-205	J-206	53.6	HDPE	145	0.01	0	0.001
P-203	112	J-205	J-207	53.6	HDPE	145	0.07	0.03	0.032
P-204	64	J-203	J-208	76.6	HDPE	145	1.3	0.28	1.307
P-205	42	J-208	J-209	53.6	HDPE	145	0.07	0.03	0.032
P-206	16	J-209	J-210	53.6	HDPE	145	0.01	0	0.001
P-207	19	J-209	J-211	53.6	HDPE	145	0.01	0.01	0.001
P-208	33	J-208	J-212	76.6	HDPE	145	1.15	0.25	1.035
P-209	65	J-212	J-213	53.6	HDPE	145	0.04	0.02	0.012
P-210	36	J-212	J-214	76.6	HDPE	145	1.03	0.22	0.84
P-211	122	J-214	J-215	53.6	HDPE	145	0.07	0.03	0.037
P-212	135	J-214	J-216	76.6	HDPE	145	0.77	0.17	0.495
P-213	35	J-216	J-217	53.6	HDPE	145	0.02	0.01	0.004

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-214	73	J-216	J-218	63.8	HDPE	145	0.21	0.07	0.109
P-215	46	J-218	J-219	53.6	HDPE	145	0.03	0.01	0.006
P-216	22	J-216	J-220	63.8	HDPE	145	0.37	0.12	0.317
P-217	74	J-220	J-221	63.8	HDPE	145	0.09	0.03	0.023
P-218	58	J-221	J-222	53.6	HDPE	145	0.04	0.02	0.009
P-219	33	J-221	J-223	53.6	HDPE	145	0.02	0.01	0.003
P-220	36	J-221	J-218	63.8	HDPE	145	-0.09	0.03	0.022
P-221	88	J-220	J-224	63.8	HDPE	145	0.17	0.05	0.073
P-222	62	J-224	J-225	53.6	HDPE	145	0.04	0.02	0.011
P-223	33	J-224	J-226	53.6	HDPE	145	0.02	0.01	0.003
P-224	81	J-159	J-227	93.8	HDPE	145	3.73	0.54	3.426
P-225	21	J-227	J-228	53.6	HDPE	145	0.12	0.05	0.094
P-226	21	J-228	J-229	53.6	HDPE	145	0.01	0.01	0.002
P-227	21	J-228	J-230	53.6	HDPE	145	0.07	0.03	0.035
P-228	32	J-230	J-231	53.6	HDPE	145	0.02	0.01	0.003
P-229	16	J-230	J-232	53.6	HDPE	145	0.01	0	0.001
P-231	38	J-233	J-234	53.6	HDPE	145	0.02	0.01	0.004
P-232	12	J-233	J-235	63.8	HDPE	145	0.14	0.04	0.048
P-233	53	J-235	J-236	53.6	HDPE	145	0.03	0.01	0.008
P-234	52	J-235	J-237	53.6	HDPE	145	0.03	0.01	0.008
P-230(1)	211	J-227	J-238	93.8	HDPE	145	3.42	0.49	2.91
P-230(2)	37	J-238	J-233	63.8	HDPE	145	0.21	0.07	0.111
P-235	73	J-238	J-239	93.8	HDPE	145	3.01	0.44	2.297
P-236	57	J-239	J-240	53.6	HDPE	145	0.03	0.02	0.009
P-237	295	J-239	J-241	93.8	HDPE	145	2.71	0.39	1.897
P-238	400	J-241	J-242	93.8	HDPE	145	2.29	0.33	1.381
P-239	26	J-242	J-243	53.6	HDPE	145	0.02	0.01	0.002
P-240	38	J-242	J-244	93.8	HDPE	145	1.98	0.29	1.063
P-241	7	J-244	J-245	53.6	HDPE	145	0	0	0
P-242	11	J-244	J-246	93.8	HDPE	145	1.95	0.28	1.026
P-243	18	J-246	J-247	53.6	HDPE	145	0.01	0	0.001
P-244	16	J-246	J-248	93.8	HDPE	145	1.91	0.28	0.989
P-245	18	J-248	J-249	53.6	HDPE	145	0.01	0.01	0.001
P-246	33	J-248	J-250	93.8	HDPE	145	1.85	0.27	0.938
P-247	32	J-250	J-251	53.6	HDPE	145	0.02	0.01	0.003
P-248	20	J-250	J-252	93.8	HDPE	145	1.78	0.26	0.872
P-250	16	J-252	J-254	93.8	HDPE	145	1.63	0.24	0.737
P-252	39	J-254	J-256	76.6	HDPE	145	0.91	0.2	0.667
P-253	132	J-256	J-257	53.6	HDPE	145	0.08	0.04	0.043
P-254	32	J-256	J-460	63.8	HDPE	145	0.7	0.22	1.01
P-256	128	J-460	J-260	63.8	HDPE	145	(N/A)	(N/A)	(N/A)
P-257	61	J-260	J-261	63.8	HDPE	145	0.26	0.08	0.166
P-258	62	J-261	J-262	53.6	HDPE	145	0.04	0.02	0.011
P-259	122	J-261	J-263	53.6	HDPE	145	0.08	0.03	0.038

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-261	35	J-264	J-265	53.6	HDPE	145	0.02	0.01	0.004
P-262	33	J-264	J-266	53.6	HDPE	145	0.02	0.01	0.003
P-120(1)	150	J-119	J-267	63.8	HDPE	145	-0.28	0.09	0.183
P-120(2)	31	J-267	J-121	76.6	HDPE	145	-0.46	0.1	0.189
P-263	56	J-267	J-268	53.6	HDPE	145	0.03	0.02	0.009
P-267	15	J-270	J-271	53.6	HDPE	145	0.01	0	0.001
P-268	79	J-270	J-272	93.8	HDPE	145	1.32	0.19	0.497
P-269	41	J-272	J-273	53.6	HDPE	145	0.12	0.05	0.087
P-270	7	J-273	J-274	53.6	HDPE	145	0	0	0
P-271	68	J-273	J-275	53.6	HDPE	145	0.04	0.02	0.013
P-272	71	J-272	J-276	93.8	HDPE	145	1.08	0.16	0.345
P-273	24	J-276	J-277	53.6	HDPE	145	0.01	0.01	0.002
P-274	62	J-276	J-278	93.8	HDPE	145	0.97	0.14	0.282
P-275	27	J-278	J-279	53.6	HDPE	145	0.16	0.07	0.154
P-276	19	J-279	J-280	53.6	HDPE	145	0.01	0.01	0.001
P-277	98	J-279	J-281	53.6	HDPE	145	0.06	0.03	0.025
P-278	16	J-278	J-282	93.8	HDPE	145	0.74	0.11	0.173
P-279	7	J-282	J-283	53.6	HDPE	145	0	0	0
P-280	186	J-282	J-284	93.8	HDPE	145	0.61	0.09	0.12
P-281	59	J-284	J-285	53.6	HDPE	145	0.18	0.08	0.188
P-282	23	J-285	J-286	53.6	HDPE	145	0.01	0.01	0.002
P-283	51	J-284	J-287	63.8	HDPE	145	0.25	0.08	0.15
P-284	80	J-287	J-288	63.8	HDPE	145	0.17	0.05	0.073
P-285	58	J-288	J-285	53.6	HDPE	145	-0.08	0.04	0.042
P-286	79	J-288	J-289	63.8	HDPE	145	0.12	0.04	0.037
P-287	23	J-289	J-290	53.6	HDPE	145	0.01	0.01	0.002
P-289	70	J-291	J-292	53.6	HDPE	145	0.04	0.02	0.013
P-288(1)	32	J-289	J-293	53.6	HDPE	145	0.02	0.01	0.003
P-291	26	J-294	J-295	53.6	HDPE	145	0.02	0.01	0.002
P-292	11	J-294	J-296	119.4	HDPE	145	7.57	0.68	3.92
P-293	228	J-296	J-297	53.6	HDPE	145	0.14	0.06	0.12
P-294	41	J-296	J-298	119.4	HDPE	145	7.26	0.65	3.626
P-295	11	J-298	J-299	53.6	HDPE	145	0.01	0	0
P-296	68	J-298	J-300	119.4	HDPE	145	7.18	0.64	3.552
P-298	38	J-300	J-302	119.4	HDPE	145	7.11	0.64	3.493
P-299	15	J-302	J-303	53.6	HDPE	145	0.01	0	0.001
P-303	24	J-304	J-305	53.6	HDPE	145	0.14	0.06	0.114
P-304	69	J-304	J-306	93.8	HDPE	145	2.27	0.33	1.369
P-305	14	J-306	J-307	63.8	HDPE	145	0.4	0.12	0.351
P-306	40	J-307	J-308	53.6	HDPE	145	0.02	0.01	0.005
P-307	31	J-307	J-309	63.8	HDPE	145	0.32	0.1	0.235
P-308	15	J-309	J-310	53.6	HDPE	145	0.01	0	0.001
P-309	67	J-309	J-311	63.8	HDPE	145	0.24	0.07	0.139
P-310	30	J-311	J-312	53.6	HDPE	145	0.02	0.01	0.003

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-311	30	J-311	J-313	53.6	HDPE	145	0.02	0.01	0.003
P-312	102	J-311	J-314	53.6	HDPE	145	0.06	0.03	0.027
P-313	30	J-306	J-315	93.8	HDPE	145	1.81	0.26	0.896
P-314	11	J-315	J-316	53.6	HDPE	145	0.01	0	0
P-315	53	J-315	J-317	53.6	HDPE	145	0.03	0.01	0.008
P-316	19	J-315	J-318	93.8	HDPE	145	1.7	0.25	0.799
P-317	29	J-318	J-319	53.6	HDPE	145	0.02	0.01	0.003
P-318	18	J-318	J-320	93.8	HDPE	145	1.64	0.24	0.749
P-319	25	J-320	J-321	53.6	HDPE	145	0.02	0.01	0.002
P-320	30	J-320	J-322	93.8	HDPE	145	1.58	0.23	0.699
P-321	73	J-322	J-323	53.6	HDPE	145	0.14	0.06	0.126
P-322	8	J-323	J-324	53.6	HDPE	145	0	0	0
P-323	73	J-323	J-325	53.6	HDPE	145	0.04	0.02	0.014
P-324	10	J-322	J-326	93.8	HDPE	145	1.37	0.2	0.534
P-325	16	J-326	J-327	53.6	HDPE	145	0.01	0	0.001
P-326	28	J-326	J-328	93.8	HDPE	145	1.32	0.19	0.503
P-327	112	J-328	J-329	53.6	HDPE	145	0.07	0.03	0.032
P-328	20	J-328	J-330	93.8	HDPE	145	1.16	0.17	0.392
P-329	36	J-330	J-331	53.6	HDPE	145	0.02	0.01	0.004
P-330	52	J-330	J-332	93.8	HDPE	145	1.07	0.15	0.338
P-332	13	J-332	J-334	53.6	HDPE	145	0.01	0	0.001
P-333	16	J-332	J-335	63.8	HDPE	145	0.35	0.11	0.284
P-334	45	J-335	J-336	53.6	HDPE	145	0.03	0.01	0.006
P-335	143	J-335	J-337	53.6	HDPE	145	0.2	0.09	0.232
P-336	62	J-337	J-338	53.6	HDPE	145	0.04	0.02	0.011
P-337	29	J-337	J-339	53.6	HDPE	145	0.02	0.01	0.003
P-338	14	J-332	J-340	63.8	HDPE	145	0.65	0.2	0.879
P-339	67	J-340	J-341	53.6	HDPE	145	0.04	0.02	0.012
P-340	20	J-340	J-342	63.8	HDPE	145	0.55	0.17	0.639
P-341	8	J-342	J-343	53.6	HDPE	145	0.01	0	0
P-343(1)	42	J-344	J-346	63.8	HDPE	145	0.33	0.1	0.258
P-343(2)	31	J-346	J-345	53.6	HDPE	145	0.02	0.01	0.003
P-344	158	J-346	J-347	53.6	HDPE	145	0.17	0.08	0.18
P-345	50	J-347	J-348	53.6	HDPE	145	0.03	0.01	0.007
P-346	13	J-347	J-349	53.6	HDPE	145	0.01	0	0.001
P-342(1)	57	J-342	J-350	63.8	HDPE	145	0.49	0.15	0.52
P-342(2)	94	J-350	J-344	63.8	HDPE	145	0.32	0.1	0.243
P-347	59	J-350	J-351	53.6	HDPE	145	0.04	0.02	0.01
P-348	57	J-344	J-352	63.8	HDPE	145	-0.13	0.04	0.044
P-351	22	J-269	J-355	119.4	HDPE	145	2.42	0.22	0.474
P-266(2)	32	J-356	J-270	93.8	HDPE	145	1.4	0.2	0.559
P-302(2)	247	J-357	J-304	93.8	HDPE	145	2.62	0.38	1.778
P-352	12	J-356	J-357	93.8	HDPE	145	2.78	0.4	1.984
P-354	68	J-353	J-358	53.6	HDPE	145	0.04	0.02	0.013

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-355	29	J-353	J-359	93.8	HDPE	145	2.65	0.38	1.819
P-356	21	J-359	J-360	53.6	HDPE	145	0.01	0.01	0.002
P-357	14	J-359	J-361	93.8	HDPE	145	2.6	0.38	1.753
P-358	11	J-361	J-362	53.6	HDPE	145	0.01	0	0
P-359	12	J-361	J-363	93.8	HDPE	145	2.57	0.37	1.716
P-360	57	J-363	J-364	53.6	HDPE	145	0.03	0.02	0.009
P-361	13	J-363	J-365	93.8	HDPE	145	2.48	0.36	1.613
P-362	66	J-365	J-366	53.6	HDPE	145	0.04	0.02	0.012
P-363	8	J-365	J-367	93.8	HDPE	145	2.39	0.35	1.502
P-364	78	J-367	J-368	53.6	HDPE	145	0.13	0.06	0.098
P-365	24	J-368	J-369	53.6	HDPE	145	0.01	0.01	0.002
P-366	85	J-368	J-370	53.6	HDPE	145	0	0	0.004
P-367	6	J-370	J-367	93.8	HDPE	145	-2.21	0.32	1.294
P-368	9	J-370	J-371	93.8	HDPE	145	2.14	0.31	1.227
P-369	75	J-371	J-372	53.6	HDPE	145	0.05	0.02	0.015
P-370	27	J-371	J-373	93.8	HDPE	145	2.03	0.29	1.108
P-371	41	J-373	J-374	53.6	HDPE	145	0.12	0.05	0.088
P-372	26	J-374	J-375	53.6	HDPE	145	0.02	0.01	0.002
P-373	49	J-374	J-376	53.6	HDPE	145	0.03	0.01	0.007
P-374	95	J-373	J-377	76.6	HDPE	145	1.81	0.39	2.407
P-375	63	J-377	J-378	76.6	HDPE	145	1.18	0.26	1.091
P-376	48	J-378	J-379	53.6	HDPE	145	0.03	0.01	0.007
P-377	45	J-378	J-380	76.6	HDPE	145	1.05	0.23	0.885
P-378	42	J-380	J-381	53.6	HDPE	145	0.03	0.01	0.005
P-379	48	J-380	J-382	76.6	HDPE	145	0.95	0.21	0.724
P-380	19	J-382	J-383	53.6	HDPE	145	0.01	0.01	0.001
P-381	65	J-382	J-384	76.6	HDPE	145	0.85	0.19	0.599
P-382	13	J-384	J-385	63.8	HDPE	145	0.71	0.22	1.027
P-383	26	J-385	J-386	63.8	HDPE	145	0.43	0.14	0.414
P-384	66	J-386	J-387	53.6	HDPE	145	0.04	0.02	0.012
P-385	37	J-386	J-388	63.8	HDPE	145	0.31	0.1	0.226
P-386(1)	24	J-388	J-291	63.8	HDPE	145	0.42	0.13	0.391
P-386(2)	21	J-291	J-389	63.8	HDPE	145	0.31	0.1	0.218
P-387	86	J-385	J-388	53.6	HDPE	145	0.2	0.09	0.226
P-388	81	J-384	J-390	53.6	HDPE	145	0.05	0.02	0.018
P-389	69	J-377	J-391	63.8	HDPE	145	0.49	0.15	0.521
P-390	36	J-391	J-392	53.6	HDPE	145	0.02	0.01	0.004
P-391	17	J-391	J-393	63.8	HDPE	145	0.39	0.12	0.347
P-392	23	J-393	J-394	53.6	HDPE	145	0.01	0.01	0.002
P-393	12	J-393	J-395	63.8	HDPE	145	0.35	0.11	0.276
P-394	32	J-395	J-396	53.6	HDPE	145	0.02	0.01	0.003
P-395	18	J-395	J-397	63.8	HDPE	145	0.29	0.09	0.197
P-396	29	J-397	J-398	53.6	HDPE	145	0.02	0.01	0.003
P-397	7	J-397	J-399	63.8	HDPE	145	0.24	0.07	0.138

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-398	29	J-399	J-400	53.6	HDPE	145	0.02	0.01	0.003
P-399	50	J-399	J-401	63.8	HDPE	145	0.17	0.05	0.073
P-400	146	J-401	J-402	63.8	HDPE	145	0.17	0.05	0.071
P-401	47	J-402	J-403	53.6	HDPE	145	0.03	0.01	0.006
P-402	15	J-402	J-404	53.6	HDPE	145	0.01	0	0.001
P-403	33	J-401	J-405	63.8	HDPE	145	-0.14	0.04	0.05
P-404	24	J-405	J-406	53.6	HDPE	145	0.01	0.01	0.002
P-405	50	J-405	J-407	63.8	HDPE	145	-0.22	0.07	0.117
P-406	53	J-407	J-408	53.6	HDPE	145	0.03	0.01	0.008
P-407	21	J-407	J-409	63.8	HDPE	145	-0.33	0.1	0.247
P-408	33	J-409	J-410	53.6	HDPE	145	0.02	0.01	0.003
P-409	14	J-409	J-411	63.8	HDPE	145	-0.39	0.12	0.341
P-410	31	J-411	J-412	53.6	HDPE	145	0.02	0.01	0.003
P-411	20	J-411	J-413	63.8	HDPE	145	-0.45	0.14	0.443
P-412	20	J-413	J-414	53.6	HDPE	145	0.01	0.01	0.001
P-413	58	J-413	J-415	63.8	HDPE	145	-0.52	0.16	0.585
P-414	47	J-415	J-416	53.6	HDPE	145	0.03	0.01	0.006
P-416	32	J-355	J-418	93.8	HDPE	145	2.3	0.33	1.398
P-417	52	J-418	J-419	53.6	HDPE	145	0.03	0.01	0.008
P-418	76	J-418	J-420	93.8	HDPE	145	2.17	0.31	1.255
P-419	103	J-420	J-421	53.6	HDPE	145	0.06	0.03	0.027
P-420	13	J-420	J-422	93.8	HDPE	145	1.99	0.29	1.068
P-421	97	J-422	J-423	53.6	HDPE	145	0.06	0.03	0.025
P-422	221	J-422	J-424	93.8	HDPE	145	1.73	0.25	0.822
P-423	34	J-424	J-425	53.6	HDPE	145	0.02	0.01	0.003
P-424	161	J-424	J-426	76.6	HDPE	145	1.45	0.31	1.596
P-425	28	J-426	J-427	53.6	HDPE	145	0.02	0.01	0.002
P-426	14	J-426	J-428	76.6	HDPE	145	1.31	0.28	1.319
P-427	16	J-428	J-429	53.6	HDPE	145	0.01	0	0.001
P-428	11	J-428	J-430	76.6	HDPE	145	1.27	0.28	1.256
P-429	35	J-430	J-431	53.6	HDPE	145	0.02	0.01	0.004
P-430	10	J-430	J-432	76.6	HDPE	145	1.22	0.26	1.156
P-431	33	J-432	J-433	53.6	HDPE	145	0.02	0.01	0.003
P-432	87	J-432	J-434	63.8	HDPE	145	1.12	0.35	2.402
P-433	38	J-434	J-435	53.6	HDPE	145	0.02	0.01	0.004
P-434	35	J-434	J-436	63.8	HDPE	145	1	0.31	1.941
P-435	17	J-436	J-437	53.6	HDPE	145	0.01	0	0.001
P-436	17	J-436	J-438	63.8	HDPE	145	0.94	0.3	1.757
P-437	19	J-438	J-439	53.6	HDPE	145	0.01	0.01	0.001
P-438	28	J-438	J-440	63.8	HDPE	145	0.89	0.28	1.586
P-439	22	J-440	J-441	53.6	HDPE	145	0.01	0.01	0.002
P-440	42	J-440	J-442	63.8	HDPE	145	0.82	0.26	1.363
P-349(2)	37	J-443	J-353	93.8	HDPE	145	2.78	0.4	1.98
P-28(1)	174	J-25	J-444	63.8	HDPE	145	-0.19	0.06	0.09

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-28(2)	38	J-444	J-27	63.8	HDPE	145	-0.42	0.13	0.389
P-447	137	J-444	J-21	53.6	HDPE	145	0.01	0.01	0.009
P-1(1)	19	T-1	J-453	213.2	HDPE	145	30.57	0.86	3.086
P-1(2)	11	J-453	J-1	213.2	HDPE	145	8.35	0.23	0.279
P-446(1)	41	J-302	J-451	119.4	HDPE	145	7.05	0.63	3.432
P-445(2)	11	J-451	J-356	119.4	HDPE	145	4.22	0.38	1.325
P-448(1)	83	J-187	J-453	170.4	HDPE	145	-11.44	0.5	1.49
P-118(2)	245	J-2	J-119	76.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-112(2)(1)	165	J-115	J-457	63.8	HDPE	145	0.88	0.27	1.533
P-112(2)(2)	146	J-457	J-112	63.8	HDPE	145	0.69	0.21	0.973
P-249(1)	11	J-252	J-458	53.6	HDPE	145	0.12	0.06	0.096
P-249(2)	50	J-458	J-253	53.6	HDPE	145	0.03	0.01	0.007
P-450	46	J-458	J-459	53.6	HDPE	145	0.03	0.01	0.006
P-255(2)	26	J-460	J-259	53.6	HDPE	145	0.02	0.01	0.002
P-451	116	J-460	J-461	63.8	HDPE	145	0.58	0.18	0.706
P-260(1)	11	J-260	J-461	63.8	HDPE	145	-0.31	0.1	0.221
P-260(2)	89	J-461	J-264	63.8	HDPE	145	0.14	0.04	0.049
P-251(1)	96	J-254	J-463	63.8	HDPE	145	0.63	0.2	0.831
P-350(2)(1)	69	J-355	J-464	53.6	HDPE	145	0.04	0.02	0.013
P-350(2)(2)	142	J-464	J-354	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-452	91	J-352	J-465	63.8	HDPE	145	-0.22	0.07	0.118
P-290(2)(2)(1)	224	J-453	J-467	170.4	HDPE	145	10.55	0.46	1.282
P-290(2)(2)(2)	27	J-467	J-294	119.4	HDPE	145	7.63	0.68	3.974
P-453	11	J-467	J-468	119.4	HDPE	145	2.77	0.25	0.607
P-297(2)	36	J-469	J-301	53.6	HDPE	145	0.02	0.01	0.004
P-264(2)(1)	149	J-468	J-469	119.4	HDPE	145	2.67	0.24	0.568
P-264(2)(2)	81	J-469	J-269	119.4	HDPE	145	2.48	0.22	0.497
P-454	22	J-451	J-443	93.8	HDPE	145	2.8	0.4	2.01
P-455	15	J-465	J-389	63.8	HDPE	145	-0.28	0.09	0.19
P-415(1)	137	J-415	J-471	63.8	HDPE	145	-0.7	0.22	1.004
P-415(2)	40	J-471	J-417	53.6	HDPE	145	(N/A)	(N/A)	(N/A)
P-456	13	J-442	J-471	63.8	HDPE	145	0.79	0.25	1.262
P-111(2)	79	J-474	J-111	53.6	HDPE	145	0.05	0.02	0.017
P-112(1)(1)	17	J-3	J-475	63.8	HDPE	145	1.35	0.42	3.427
P-112(1)(2)	115	J-475	J-115	63.8	HDPE	145	1.16	0.36	2.576
P-457	12	J-474	J-475	53.6	HDPE	145	-0.1	0.05	0.069
P-103(1)	15	J-102	J-476	53.6	HDPE	145	0.11	0.05	0.078
P-103(2)	18	J-476	J-103	53.6	HDPE	145	0.01	0	0.001
P-458	65	J-476	J-477	53.6	HDPE	145	0.04	0.02	0.012
P-198(1)	133	J-200	J-478	119.4	HDPE	145	2.1	0.19	0.363
P-198(2)	13	J-478	J-202	119.4	HDPE	145	1.68	0.15	0.241
P-459	265	J-478	J-479	53.6	HDPE	145	0.16	0.07	0.158

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-251(2)(1)	14	J-463	J-480	63.8	HDPE	145	0.56	0.18	0.675
P-251(2)(2)	293	J-480	J-255	63.8	HDPE	145	0.27	0.08	0.171
P-460	86	J-480	J-481	53.6	HDPE	145	0.05	0.02	0.02
P-461	72	J-255	J-255/1	53.6	HDPE	145	0.04	0.02	0.014
P-462	99	J-305	J-305/1	53.6	HDPE	145	0.06	0.03	0.026

Table 10.4 : Pipe Details of uPVC Pipe Network

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-2	1,595	J-1	J-2	186.4	PVC	145	8.35	0.31	0.537
P-3	20	J-2	J-3	186.4	PVC	145	8.19	0.3	0.517
P-5	47	J-4	J-5	102.6	PVC	145	0.03	0	0
P-6	27	J-4	J-6	102.6	PVC	145	1.89	0.23	0.628
P-7	33	J-6	J-7	102.6	PVC	145	1.8	0.22	0.576
P-8	40	J-6	J-8	102.6	PVC	145	0.02	0	0
P-9	182	J-7	J-9	102.6	PVC	145	0.61	0.07	0.077
P-10	39	J-9	J-10	102.6	PVC	145	0.02	0	0
P-11	17	J-7	J-11	102.6	PVC	145	1.05	0.13	0.213
P-12	29	J-11	J-12	102.6	PVC	145	0.02	0	0
P-13	28	J-11	J-13	102.6	PVC	145	0.99	0.12	0.19
P-14	24	J-13	J-14	102.6	PVC	145	0.01	0	0
P-15	22	J-13	J-15	102.6	PVC	145	0.93	0.11	0.169
P-16	132	J-15	J-16	102.6	PVC	145	0.26	0.03	0.016
P-17	20	J-16	J-9	102.6	PVC	145	-0.44	0.05	0.042
P-18	36	J-16	J-17	102.6	PVC	145	0.02	0	0
P-19	55	J-16	J-18	102.6	PVC	145	0.53	0.06	0.059
P-20	22	J-18	J-19	102.6	PVC	145	0.01	0	0
P-21	27	J-18	J-20	102.6	PVC	145	0.45	0.05	0.044
P-22	11	J-20	J-21	102.6	PVC	145	0.05	0.01	0
P-23	115	J-20	J-22	102.6	PVC	145	0.3	0.04	0.021
P-24	49	J-22	J-23	102.6	PVC	145	0.03	0	0
P-25	74	J-22	J-24	102.6	PVC	145	0.05	0.01	0.001
P-26	97	J-22	J-25	102.6	PVC	145	0.02	0	0
P-27	150	J-25	J-26	102.6	PVC	145	(N/A)	(N/A)	(N/A)
P-29	77	J-27	J-28	102.6	PVC	145	0.05	0.01	0.001
P-30	46	J-27	J-15	102.6	PVC	145	-0.55	0.07	0.063
P-4(1)	129	J-3	J-29	130.4	PVC	145	6.37	0.48	1.853
P-31	366	J-29	J-30	102.6	PVC	145	4.2	0.51	2.751
P-32	24	J-30	J-31	102.6	PVC	145	0.01	0	0
P-33	19	J-30	J-32	102.6	PVC	145	3.93	0.48	2.437
P-34	47	J-32	J-33	102.6	PVC	145	0.61	0.07	0.077

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-35	20	J-33	J-34	102.6	PVC	145	0.01	0	0
P-36	48	J-33	J-35	102.6	PVC	145	0.03	0	0
P-37	31	J-33	J-36	102.6	PVC	145	0.48	0.06	0.049
P-38	37	J-36	J-37	102.6	PVC	145	0.3	0.04	0.021
P-39	24	J-37	J-38	102.6	PVC	145	0.01	0	0
P-40	12	J-37	J-39	102.6	PVC	145	0.24	0.03	0.013
P-41	49	J-39	J-40	102.6	PVC	145	0.03	0	0
P-43	68	J-39	J-41	102.6	PVC	145	0.13	0.02	0.004
P-44	38	J-41	J-42	102.6	PVC	145	0.02	0	0
P-45	34	J-41	J-43	102.6	PVC	145	0.02	0	0
P-46	23	J-36	J-44	102.6	PVC	145	0.12	0.01	0.004
P-47	20	J-44	J-45	102.6	PVC	145	0.01	0	0
P-48	68	J-44	J-46	102.6	PVC	145	0.04	0.01	0.001
P-49	67	J-32	J-47	102.6	PVC	145	3.24	0.39	1.706
P-50	44	J-47	J-48	102.6	PVC	145	0.03	0	0
P-51	28	J-47	J-49	102.6	PVC	145	3.13	0.38	1.598
P-52	48	J-49	J-50	102.6	PVC	145	0.03	0	0
P-53	20	J-49	J-51	102.6	PVC	145	3.04	0.37	1.515
P-54	49	J-51	J-52	102.6	PVC	145	0.03	0	0
P-55	19	J-51	J-53	102.6	PVC	145	2.96	0.36	1.439
P-56	79	J-53	J-54	102.6	PVC	145	0.07	0.01	0.002
P-57	10	J-54	J-55	102.6	PVC	145	0.01	0	0
P-58	10	J-54	J-56	102.6	PVC	145	0.01	0	0
P-59	18	J-53	J-57	102.6	PVC	145	2.81	0.34	1.311
P-60	66	J-57	J-58	102.6	PVC	145	0.04	0	0.001
P-61	14	J-57	J-59	102.6	PVC	145	2.71	0.33	1.225
P-62	67	J-59	J-60	102.6	PVC	145	0.04	0	0.001
P-63	12	J-59	J-61	102.6	PVC	145	2.61	0.32	1.144
P-64	65	J-61	J-62	102.6	PVC	145	0.04	0	0
P-65	24	J-61	J-63	102.6	PVC	145	2.51	0.3	1.063
P-66	33	J-63	J-64	102.6	PVC	145	0.02	0	0
P-67	99	J-63	J-65	102.6	PVC	145	2.4	0.29	0.974
P-68	46	J-65	J-66	102.6	PVC	145	0.03	0	0
P-69	58	J-65	J-67	102.6	PVC	145	2.24	0.27	0.862
P-70	96	J-67	J-68	102.6	PVC	145	0.06	0.01	0.001
P-71	16	J-67	J-69	102.6	PVC	145	2.08	0.25	0.75
P-72	14	J-69	J-70	102.6	PVC	145	0.01	0	0
P-73	11	J-69	J-71	102.6	PVC	145	2.05	0.25	0.727
P-74	20	J-71	J-72	102.6	PVC	145	0.01	0	0
P-75	12	J-71	J-73	102.6	PVC	145	2.01	0.24	0.701
P-76	48	J-73	J-74	102.6	PVC	145	0.03	0	0
P-77	28	J-73	J-75	102.6	PVC	145	1.92	0.23	0.649
P-78	34	J-75	J-76	102.6	PVC	145	0.14	0.02	0.005
P-79	10	J-76	J-77	102.6	PVC	145	0.01	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-80	89	J-76	J-78	102.6	PVC	145	0.05	0.01	0.001
P-81	43	J-75	J-79	102.6	PVC	145	1.72	0.21	0.525
P-82	62	J-79	J-80	102.6	PVC	145	0.04	0	0
P-83	14	J-79	J-81	102.6	PVC	145	1.61	0.19	0.464
P-84	24	J-81	J-82	102.6	PVC	145	0.01	0	0
P-85	22	J-81	J-83	102.6	PVC	145	1.55	0.19	0.437
P-86	18	J-83	J-84	102.6	PVC	145	0.01	0	0
P-87	56	J-83	J-85	102.6	PVC	145	1.48	0.18	0.401
P-89	74	J-85	J-87	102.6	PVC	145	0.76	0.09	0.116
P-91(1)	10	J-88	J-90	102.6	PVC	145	-0.37	0.04	0.031
P-91(2)	18	J-90	J-89	102.6	PVC	145	0.01	0	0
P-88(1)	101	J-85	J-91	102.6	PVC	145	0.58	0.07	0.071
P-88(2)	54	J-91	J-86	102.6	PVC	145	0.03	0	0
P-92	43	J-90	J-91	102.6	PVC	145	-0.43	0.05	0.04
P-90(1)	50	J-87	J-92	102.6	PVC	145	0.29	0.04	0.02
P-90(2)	14	J-92	J-88	102.6	PVC	145	-0.36	0.04	0.029
P-94	36	J-93	J-94	102.6	PVC	145	0.02	0	0
P-95	37	J-93	J-95	102.6	PVC	145	0.02	0	0
P-96	73	J-93	J-96	102.6	PVC	145	0.42	0.05	0.039
P-97	31	J-96	J-97	102.6	PVC	145	0.02	0	0
P-98	39	J-96	J-98	102.6	PVC	145	0.32	0.04	0.023
P-99	21	J-98	J-99	102.6	PVC	145	0.01	0	0
P-100	16	J-98	J-100	102.6	PVC	145	0.26	0.03	0.016
P-101	16	J-100	J-101	102.6	PVC	145	0.01	0	0
P-102	51	J-100	J-102	102.6	PVC	145	0.19	0.02	0.009
P-104	19	J-102	J-104	102.6	PVC	145	0.01	0	0
P-105	16	J-102	J-105	102.6	PVC	145	0.01	0	0
P-106	99	J-87	J-106	102.6	PVC	145	0.33	0.04	0.025
P-107	141	J-106	J-107	102.6	PVC	145	0.18	0.02	0.008
P-108	41	J-107	J-108	102.6	PVC	145	0.03	0	0
P-93(1)	38	J-92	J-109	102.6	PVC	145	0.58	0.07	0.072
P-93(2)	19	J-109	J-93	102.6	PVC	145	0.57	0.07	0.068
P-109	25	J-107	J-109	102.6	PVC	145	0.03	0	0
P-110	267	J-106	J-110	102.6	PVC	145	(N/A)	(N/A)	(N/A)
P-113	76	J-112	J-113	102.6	PVC	145	0.05	0.01	0.001
P-4(2)(1)	241	J-29	J-114	102.6	PVC	145	1.72	0.21	0.527
P-4(2)(2)	115	J-114	J-4	102.6	PVC	145	2.04	0.25	0.72
P-114	268	J-112	J-114	102.6	PVC	145	0.7	0.08	0.099
P-115	49	J-115	J-116	102.6	PVC	145	0.08	0.01	0.002
P-116	20	J-116	J-117	102.6	PVC	145	0.01	0	0
P-117	22	J-116	J-118	102.6	PVC	145	0.01	0	0
P-119	29	J-119	J-120	102.6	PVC	145	0.02	0	0
P-121	26	J-121	J-122	102.6	PVC	145	0.24	0.03	0.014
P-122	24	J-122	J-123	102.6	PVC	145	0.01	0	0

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-123(1)	20	J-122	J-125	102.6	PVC	145	0.18	0.02	0.008
P-123(2)	14	J-125	J-124	102.6	PVC	145	0.01	0	0
P-124	122	J-125	J-126	102.6	PVC	145	0.08	0.01	0.002
P-125	147	J-121	J-127	102.6	PVC	145	-0.82	0.1	0.134
P-126	35	J-127	J-128	102.6	PVC	145	0.18	0.02	0.008
P-127	35	J-128	J-129	102.6	PVC	145	0.02	0	0
P-128	96	J-128	J-130	102.6	PVC	145	0.06	0.01	0.001
P-129	82	J-127	J-131	102.6	PVC	145	0.05	0.01	0.001
P-130	20	J-127	J-132	102.6	PVC	145	-1.23	0.15	0.283
P-131	35	J-132	J-133	102.6	PVC	145	0.02	0	0
P-132	49	J-132	J-134	102.6	PVC	145	-1.31	0.16	0.321
P-133	25	J-134	J-135	102.6	PVC	145	0.02	0	0
P-134	37	J-134	J-136	102.6	PVC	145	-1.4	0.17	0.359
P-135	55	J-136	J-137	102.6	PVC	145	0.27	0.03	0.018
P-136	21	J-137	J-138	102.6	PVC	145	0.01	0	0
P-137	174	J-137	J-139	102.6	PVC	145	0.11	0.01	0.003
P-138	37	J-136	J-140	102.6	PVC	145	0.02	0	0
P-139	12	J-136	J-141	102.6	PVC	145	-1.78	0.22	0.563
P-140	38	J-141	J-142	102.6	PVC	145	0.02	0	0
P-141	22	J-141	J-143	102.6	PVC	145	-1.85	0.22	0.603
P-142	36	J-143	J-144	102.6	PVC	145	0.02	0	0
P-143	20	J-143	J-145	102.6	PVC	145	0.01	0	0
P-144	17	J-143	J-146	102.6	PVC	145	-1.94	0.23	0.66
P-145	56	J-146	J-147	102.6	PVC	145	0.03	0	0
P-146	46	J-146	J-148	102.6	PVC	145	-2.05	0.25	0.729
P-147	140	J-148	J-149	102.6	PVC	145	0.14	0.02	0.005
P-148	32	J-149	J-150	102.6	PVC	145	0.02	0	0
P-149	14	J-149	J-151	102.6	PVC	145	0.01	0	0
P-150	24	J-148	J-152	102.6	PVC	145	-2.32	0.28	0.918
P-151	44	J-152	J-153	102.6	PVC	145	0.07	0.01	0.001
P-152	7	J-153	J-154	102.6	PVC	145	0	0	0
P-153	10	J-153	J-155	102.6	PVC	145	0.03	0	0
P-154	9	J-155	J-156	102.6	PVC	145	0.01	0	0
P-155	7	J-155	J-157	102.6	PVC	145	0	0	0
P-156	60	J-152	J-158	102.6	PVC	145	-2.47	0.3	1.028
P-157	13	J-158	J-159	130.4	PVC	145	-5.6	0.42	1.46
P-158	147	J-159	J-160	130.4	PVC	145	-9.48	0.71	3.87
P-159	54	J-160	J-161	102.6	PVC	145	0.03	0	0
P-160	26	J-160	J-162	130.4	PVC	145	-9.65	0.72	4.002
P-161	15	J-162	J-163	102.6	PVC	145	0.01	0	0
P-162	20	J-162	J-164	130.4	PVC	145	-9.7	0.73	4.038
P-163	81	J-164	J-165	102.6	PVC	145	0.05	0.01	0.001
P-164	36	J-164	J-166	130.4	PVC	145	-9.83	0.74	4.142
P-165	92	J-166	J-167	102.6	PVC	145	0.06	0.01	0.001

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-166	32	J-166	J-168	130.4	PVC	145	-9.99	0.75	4.264
P-167	40	J-168	J-169	186.4	PVC	145	0.02	0	0
P-168	27	J-168	J-170	186.4	PVC	145	-10.07	0.37	0.76
P-169	57	J-170	J-171	186.4	PVC	145	0.03	0	0
P-170	52	J-170	J-172	186.4	PVC	145	-10.19	0.37	0.777
P-171	129	J-172	J-173	186.4	PVC	145	0.08	0	0
P-172	54	J-172	J-174	186.4	PVC	145	-10.42	0.38	0.808
P-173	119	J-174	J-175	186.4	PVC	145	0.07	0	0
P-174	22	J-174	J-176	186.4	PVC	145	-10.61	0.39	0.836
P-175	26	J-176	J-177	186.4	PVC	145	0.02	0	0
P-176	43	J-176	J-178	186.4	PVC	145	-10.68	0.39	0.847
P-177	48	J-178	J-179	186.4	PVC	145	0.12	0	0
P-178	22	J-179	J-180	83.8	PVC	145	0.01	0	0
P-179	51	J-179	J-181	83.8	PVC	145	0.03	0.01	0.001
P-180	35	J-178	J-182	186.4	PVC	145	0.02	0	0
P-181	74	J-178	J-183	186.4	PVC	145	-10.95	0.4	0.886
P-182	104	J-183	J-184	186.4	PVC	145	0.06	0	0
P-183	31	J-183	J-185	186.4	PVC	145	-11.14	0.41	0.915
P-184	43	J-185	J-186	186.4	PVC	145	0.03	0	0
P-185	95	J-185	J-187	186.4	PVC	145	-11.27	0.41	0.935
P-186	53	J-187	J-188	186.4	PVC	145	0.03	0	0
P-188	65	J-189	J-190	83.8	PVC	145	0.04	0.01	0.001
P-187(1)	62	J-158	J-191	186.4	PVC	145	3.05	0.11	0.083
P-187(2)	44	J-191	J-189	119.4	PVC	145	2.99	0.27	0.7
P-189	123	J-189	J-192	119.4	PVC	145	2.8	0.25	0.622
P-190	28	J-192	J-193	83.8	PVC	145	0.13	0.02	0.011
P-191	17	J-193	J-194	83.8	PVC	145	0.01	0	0
P-192(1)	43	J-193	J-196	83.8	PVC	145	0.06	0.01	0.003
P-192(2)	27	J-196	J-195	83.8	PVC	145	0.02	0	0
P-193	125	J-196	J-197	83.8	PVC	145	(N/A)	(N/A)	(N/A)
P-194	247	J-192	J-198	119.4	PVC	145	2.43	0.22	0.479
P-195	27	J-198	J-199	83.8	PVC	145	0.02	0	0
P-196	24	J-198	J-200	119.4	PVC	145	2.23	0.2	0.409
P-197	34	J-200	J-201	83.8	PVC	145	0.02	0	0
P-199	25	J-202	J-203	102.6	PVC	145	1.66	0.2	0.492
P-200	106	J-203	J-204	83.8	PVC	145	0.24	0.04	0.036
P-201	13	J-204	J-205	83.8	PVC	145	0.16	0.03	0.018
P-202	15	J-205	J-206	83.8	PVC	145	0.01	0	0
P-203	112	J-205	J-207	83.8	PVC	145	0.07	0.01	0.004

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-204	64	J-203	J-208	102.6	PVC	145	1.3	0.16	0.315
P-205	42	J-208	J-209	83.8	PVC	145	0.07	0.01	0.004
P-206	16	J-209	J-210	83.8	PVC	145	0.01	0	0
P-207	19	J-209	J-211	83.8	PVC	145	0.01	0	0
P-208	33	J-208	J-212	102.6	PVC	145	1.15	0.14	0.249
P-209	65	J-212	J-213	83.8	PVC	145	0.04	0.01	0.001
P-210	36	J-212	J-214	102.6	PVC	145	1.03	0.12	0.202
P-211	122	J-214	J-215	83.8	PVC	145	0.07	0.01	0.004
P-212	135	J-214	J-216	102.6	PVC	145	0.77	0.09	0.119
P-213	35	J-216	J-217	83.8	PVC	145	0.02	0	0
P-214	73	J-216	J-218	83.8	PVC	145	0.21	0.04	0.029
P-215	46	J-218	J-219	83.8	PVC	145	0.03	0.01	0.001
P-216	22	J-216	J-220	83.8	PVC	145	0.37	0.07	0.084
P-217	74	J-220	J-221	83.8	PVC	145	0.09	0.02	0.006
P-218	58	J-221	J-222	83.8	PVC	145	0.04	0.01	0.001
P-219	33	J-221	J-223	83.8	PVC	145	0.02	0	0
P-220	36	J-221	J-218	83.8	PVC	145	-0.09	0.02	0.006
P-221	88	J-220	J-224	83.8	PVC	145	0.17	0.03	0.019
P-222	62	J-224	J-225	83.8	PVC	145	0.04	0.01	0.001
P-223	33	J-224	J-226	83.8	PVC	145	0.02	0	0
P-224	81	J-159	J-227	186.4	PVC	145	3.73	0.14	0.121
P-225	21	J-227	J-228	83.8	PVC	145	0.12	0.02	0.011
P-226	21	J-228	J-229	83.8	PVC	145	0.01	0	0
P-227	21	J-228	J-230	83.8	PVC	145	0.07	0.01	0.004
P-228	32	J-230	J-231	83.8	PVC	145	0.02	0	0
P-229	16	J-230	J-232	83.8	PVC	145	0.01	0	0
P-231	38	J-233	J-234	83.8	PVC	145	0.02	0	0
P-232	12	J-233	J-235	83.8	PVC	145	0.14	0.02	0.013
P-233	53	J-235	J-236	83.8	PVC	145	0.03	0.01	0.001
P-234	52	J-235	J-237	83.8	PVC	145	0.03	0.01	0.001
P-230(1)	211	J-227	J-238	102.6	PVC	145	3.42	0.41	1.88
P-230(2)	37	J-238	J-233	83.8	PVC	145	0.21	0.04	0.029
P-235	73	J-238	J-239	102.6	PVC	145	3.01	0.36	1.484
P-236	57	J-239	J-240	83.8	PVC	145	0.03	0.01	0.001
P-237	295	J-239	J-241	102.6	PVC	145	2.71	0.33	1.226
P-238	400	J-241	J-242	102.6	PVC	145	2.29	0.28	0.893
P-239	26	J-242	J-243	83.8	PVC	145	0.02	0	0
P-240	38	J-242	J-244	102.6	PVC	145	1.98	0.24	0.687
P-241	7	J-244	J-245	83.8	PVC	145	0	0	0
P-242	11	J-244	J-246	102.6	PVC	145	1.95	0.24	0.663
P-243	18	J-246	J-247	83.8	PVC	145	0.01	0	0
P-244	16	J-246	J-248	102.6	PVC	145	1.91	0.23	0.639
P-245	18	J-248	J-249	83.8	PVC	145	0.01	0	0
P-246	33	J-248	J-250	102.6	PVC	145	1.85	0.22	0.606

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-247	32	J-250	J-251	83.8	PVC	145	0.02	0	0
P-248	20	J-250	J-252	102.6	PVC	145	1.78	0.22	0.563
P-250	16	J-252	J-254	102.6	PVC	145	1.63	0.2	0.477
P-252	39	J-254	J-256	102.6	PVC	145	0.91	0.11	0.161
P-253	132	J-256	J-257	83.8	PVC	145	0.08	0.01	0.005
P-254	32	J-256	J-460	83.8	PVC	145	0.7	0.13	0.268
P-256	128	J-460	J-260	83.8	PVC	145	(N/A)	(N/A)	(N/A)
P-257	61	J-260	J-261	83.8	PVC	145	0.26	0.05	0.044
P-258	62	J-261	J-262	83.8	PVC	145	0.04	0.01	0.001
P-259	122	J-261	J-263	83.8	PVC	145	0.08	0.01	0.004
P-261	35	J-264	J-265	83.8	PVC	145	0.02	0	0
P-262	33	J-264	J-266	83.8	PVC	145	0.02	0	0
P-120(1)	150	J-119	J-267	83.8	PVC	145	-0.28	0.05	0.049
P-120(2)	31	J-267	J-121	102.6	PVC	145	-0.46	0.06	0.046
P-263	56	J-267	J-268	83.8	PVC	145	0.03	0.01	0.001
P-267	15	J-270	J-271	83.8	PVC	145	0.01	0	0
P-268	79	J-270	J-272	102.6	PVC	145	1.32	0.16	0.321
P-269	41	J-272	J-273	83.8	PVC	145	0.12	0.02	0.01
P-270	7	J-273	J-274	83.8	PVC	145	0	0	0
P-271	68	J-273	J-275	83.8	PVC	145	0.04	0.01	0.001
P-272	71	J-272	J-276	102.6	PVC	145	1.08	0.13	0.223
P-273	24	J-276	J-277	83.8	PVC	145	0.01	0	0
P-274	62	J-276	J-278	102.6	PVC	145	0.97	0.12	0.182
P-275	27	J-278	J-279	83.8	PVC	145	0.16	0.03	0.018
P-276	19	J-279	J-280	83.8	PVC	145	0.01	0	0
P-277	98	J-279	J-281	83.8	PVC	145	0.06	0.01	0.003
P-278	16	J-278	J-282	102.6	PVC	145	0.74	0.09	0.112
P-279	7	J-282	J-283	83.8	PVC	145	0	0	0
P-280	186	J-282	J-284	102.6	PVC	145	0.61	0.07	0.078
P-281	59	J-284	J-285	83.8	PVC	145	0.22	0.04	0.031
P-282	23	J-285	J-286	83.8	PVC	145	0.01	0	0
P-283	51	J-284	J-287	83.8	PVC	145	0.21	0.04	0.029
P-284	80	J-287	J-288	83.8	PVC	145	0.13	0.02	0.012
P-285	58	J-288	J-285	83.8	PVC	145	-0.12	0.02	0.01
P-286	79	J-288	J-289	83.8	PVC	145	0.12	0.02	0.01
P-287	23	J-289	J-290	83.8	PVC	145	0.01	0	0
P-289	70	J-291	J-292	83.8	PVC	145	0.04	0.01	0.002
P-288(1)	32	J-289	J-293	83.8	PVC	145	0.02	0	0
P-291	26	J-294	J-295	83.8	PVC	145	0.02	0	0
P-292	11	J-294	J-296	119.4	PVC	145	7.17	0.64	3.543
P-293	228	J-296	J-297	83.8	PVC	145	0.14	0.03	0.014
P-294	41	J-296	J-298	119.4	PVC	145	6.86	0.61	3.263
P-295	11	J-298	J-299	83.8	PVC	145	0.01	0	0
P-296	68	J-298	J-300	119.4	PVC	145	6.78	0.61	3.193

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-298	38	J-300	J-302	119.4	PVC	145	6.71	0.6	3.136
P-299	15	J-302	J-303	83.8	PVC	145	0.01	0	0
P-303	24	J-304	J-305	83.8	PVC	145	0.14	0.02	0.013
P-304	69	J-304	J-306	102.6	PVC	145	1.97	0.24	0.675
P-305	14	J-306	J-307	83.8	PVC	145	0.4	0.07	0.093
P-306	40	J-307	J-308	83.8	PVC	145	0.02	0	0.001
P-307	31	J-307	J-309	83.8	PVC	145	0.32	0.06	0.062
P-308	15	J-309	J-310	83.8	PVC	145	0.01	0	0
P-309	67	J-309	J-311	83.8	PVC	145	0.24	0.04	0.037
P-310	30	J-311	J-312	83.8	PVC	145	0.02	0	0
P-311	30	J-311	J-313	83.8	PVC	145	0.02	0	0
P-312	102	J-311	J-314	83.8	PVC	145	0.06	0.01	0.003
P-313	30	J-306	J-315	102.6	PVC	145	1.5	0.18	0.409
P-314	11	J-315	J-316	83.8	PVC	145	0.01	0	0
P-315	53	J-315	J-317	83.8	PVC	145	0.03	0.01	0.001
P-316	19	J-315	J-318	102.6	PVC	145	1.39	0.17	0.356
P-317	29	J-318	J-319	83.8	PVC	145	0.02	0	0
P-318	18	J-318	J-320	102.6	PVC	145	1.33	0.16	0.329
P-319	25	J-320	J-321	83.8	PVC	145	0.02	0	0
P-320	30	J-320	J-322	102.6	PVC	145	1.27	0.15	0.302
P-321	73	J-322	J-323	83.8	PVC	145	0.14	0.03	0.014
P-322	8	J-323	J-324	83.8	PVC	145	0	0	0
P-323	73	J-323	J-325	83.8	PVC	145	0.04	0.01	0.002
P-324	10	J-322	J-326	102.6	PVC	145	1.06	0.13	0.215
P-325	16	J-326	J-327	83.8	PVC	145	0.01	0	0
P-326	28	J-326	J-328	102.6	PVC	145	1.02	0.12	0.199
P-327	112	J-328	J-329	83.8	PVC	145	0.07	0.01	0.004
P-328	20	J-328	J-330	102.6	PVC	145	0.85	0.1	0.143
P-329	36	J-330	J-331	83.8	PVC	145	0.02	0	0
P-330	52	J-330	J-332	102.6	PVC	145	0.76	0.09	0.116
P-332	13	J-332	J-334	83.8	PVC	145	0.01	0	0
P-333	16	J-332	J-335	83.8	PVC	145	0.35	0.06	0.075
P-334	45	J-335	J-336	83.8	PVC	145	0.03	0.01	0.001
P-335	143	J-335	J-337	83.8	PVC	145	0.2	0.04	0.026
P-336	62	J-337	J-338	83.8	PVC	145	0.04	0.01	0.001
P-337	29	J-337	J-339	83.8	PVC	145	0.02	0	0
P-338	14	J-332	J-340	83.8	PVC	145	0.34	0.06	0.071
P-339	67	J-340	J-341	83.8	PVC	145	0.04	0.01	0.001
P-340	20	J-340	J-342	83.8	PVC	145	0.24	0.04	0.036
P-341	8	J-342	J-343	83.8	PVC	145	0.01	0	0
P-343(1)	42	J-344	J-346	83.8	PVC	145	0.33	0.06	0.068
P-343(2)	31	J-346	J-345	83.8	PVC	145	0.02	0	0
P-344	158	J-346	J-347	83.8	PVC	145	0.17	0.03	0.02
P-345	50	J-347	J-348	83.8	PVC	145	0.03	0.01	0.001

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-346	13	J-347	J-349	83.8	PVC	145	0.01	0	0
P-342(1)	57	J-342	J-350	83.8	PVC	145	0.18	0.03	0.022
P-342(2)	94	J-350	J-344	83.8	PVC	145	0.02	0	0
P-347	59	J-350	J-351	83.8	PVC	145	0.04	0.01	0.001
P-348	57	J-344	J-352	83.8	PVC	145	-0.44	0.08	0.112
P-351	22	J-269	J-355	119.4	PVC	145	2.82	0.25	0.63
P-266(2)	32	J-356	J-270	102.6	PVC	145	1.4	0.17	0.361
P-302(2)	247	J-357	J-304	102.6	PVC	145	2.31	0.28	0.911
P-352	12	J-356	J-357	102.6	PVC	145	2.47	0.3	1.031
P-354	68	J-353	J-358	83.8	PVC	145	0.04	0.01	0.001
P-355	29	J-353	J-359	102.6	PVC	145	2.56	0.31	1.1
P-356	21	J-359	J-360	83.8	PVC	145	0.01	0	0
P-357	14	J-359	J-361	102.6	PVC	145	2.51	0.3	1.058
P-358	11	J-361	J-362	83.8	PVC	145	0.01	0	0
P-359	12	J-361	J-363	102.6	PVC	145	2.48	0.3	1.036
P-360	57	J-363	J-364	83.8	PVC	145	0.03	0.01	0.001
P-361	13	J-363	J-365	102.6	PVC	145	2.39	0.29	0.971
P-362	66	J-365	J-366	83.8	PVC	145	0.04	0.01	0.001
P-363	8	J-365	J-367	102.6	PVC	145	2.3	0.28	0.901
P-364	78	J-367	J-368	83.8	PVC	145	0.25	0.05	0.039
P-365	24	J-368	J-369	83.8	PVC	145	0.01	0	0
P-366	85	J-368	J-370	83.8	PVC	145	0.12	0.02	0.01
P-367	6	J-370	J-367	102.6	PVC	145	-1.99	0.24	0.693
P-368	9	J-370	J-371	102.6	PVC	145	2.05	0.25	0.73
P-369	75	J-371	J-372	83.8	PVC	145	0.05	0.01	0.002
P-370	27	J-371	J-373	102.6	PVC	145	1.94	0.23	0.656
P-371	41	J-373	J-374	83.8	PVC	145	0.12	0.02	0.01
P-372	26	J-374	J-375	83.8	PVC	145	0.02	0	0
P-373	49	J-374	J-376	83.8	PVC	145	0.03	0.01	0.001
P-374	95	J-373	J-377	102.6	PVC	145	1.72	0.21	0.526
P-375	63	J-377	J-378	102.6	PVC	145	1.49	0.18	0.404
P-376	48	J-378	J-379	83.8	PVC	145	0.03	0.01	0.001
P-377	45	J-378	J-380	102.6	PVC	145	1.36	0.16	0.343
P-378	42	J-380	J-381	83.8	PVC	145	0.03	0	0.001
P-379	48	J-380	J-382	102.6	PVC	145	1.26	0.15	0.294
P-380	19	J-382	J-383	83.8	PVC	145	0.01	0	0
P-381	65	J-382	J-384	102.6	PVC	145	1.16	0.14	0.255
P-382	13	J-384	J-385	83.8	PVC	145	1.02	0.18	0.532
P-383	26	J-385	J-386	83.8	PVC	145	0.54	0.1	0.164
P-384	66	J-386	J-387	83.8	PVC	145	0.04	0.01	0.001
P-385	37	J-386	J-388	83.8	PVC	145	0.42	0.08	0.102
P-386(1)	24	J-388	J-291	83.8	PVC	145	0.73	0.13	0.287
P-386(2)	21	J-291	J-389	83.8	PVC	145	0.61	0.11	0.21
P-387	86	J-385	J-388	83.8	PVC	145	0.4	0.07	0.095

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-388	81	J-384	J-390	83.8	PVC	145	0.05	0.01	0.002
P-389	69	J-377	J-391	83.8	PVC	145	0.09	0.02	0.006
P-390	36	J-391	J-392	83.8	PVC	145	0.02	0	0
P-391	17	J-391	J-393	83.8	PVC	145	-0.01	0	0
P-392	23	J-393	J-394	83.8	PVC	145	0.01	0	0
P-393	12	J-393	J-395	83.8	PVC	145	-0.05	0.01	0.002
P-394	32	J-395	J-396	83.8	PVC	145	0.02	0	0
P-395	18	J-395	J-397	83.8	PVC	145	-0.11	0.02	0.009
P-396	29	J-397	J-398	83.8	PVC	145	0.02	0	0
P-397	7	J-397	J-399	83.8	PVC	145	-0.16	0.03	0.018
P-398	29	J-399	J-400	83.8	PVC	145	0.02	0	0
P-399	50	J-399	J-401	83.8	PVC	145	-0.23	0.04	0.035
P-400	146	J-401	J-402	83.8	PVC	145	0.17	0.03	0.019
P-401	47	J-402	J-403	83.8	PVC	145	0.03	0.01	0.001
P-402	15	J-402	J-404	83.8	PVC	145	0.01	0	0
P-403	33	J-401	J-405	83.8	PVC	145	-0.54	0.1	0.166
P-404	24	J-405	J-406	83.8	PVC	145	0.01	0	0
P-405	50	J-405	J-407	83.8	PVC	145	-0.62	0.11	0.214
P-406	53	J-407	J-408	83.8	PVC	145	0.03	0.01	0.001
P-407	21	J-407	J-409	83.8	PVC	145	-0.73	0.13	0.289
P-408	33	J-409	J-410	83.8	PVC	145	0.02	0	0
P-409	14	J-409	J-411	83.8	PVC	145	-0.79	0.14	0.336
P-410	31	J-411	J-412	83.8	PVC	145	0.02	0	0
P-411	20	J-411	J-413	83.8	PVC	145	-0.85	0.15	0.384
P-412	20	J-413	J-414	83.8	PVC	145	0.01	0	0
P-413	58	J-413	J-415	83.8	PVC	145	-0.92	0.17	0.447
P-414	47	J-415	J-416	83.8	PVC	145	0.03	0.01	0.001
P-416	32	J-355	J-418	102.6	PVC	145	2.7	0.33	1.217
P-417	52	J-418	J-419	83.8	PVC	145	0.03	0.01	0.001
P-418	76	J-418	J-420	102.6	PVC	145	2.57	0.31	1.111
P-419	103	J-420	J-421	83.8	PVC	145	0.06	0.01	0.003
P-420	13	J-420	J-422	102.6	PVC	145	2.39	0.29	0.97
P-421	97	J-422	J-423	83.8	PVC	145	0.06	0.01	0.003
P-422	221	J-422	J-424	102.6	PVC	145	2.13	0.26	0.782
P-423	34	J-424	J-425	83.8	PVC	145	0.02	0	0
P-424	161	J-424	J-426	102.6	PVC	145	1.85	0.22	0.605
P-425	28	J-426	J-427	83.8	PVC	145	0.02	0	0
P-426	14	J-426	J-428	102.6	PVC	145	1.71	0.21	0.522
P-427	16	J-428	J-429	83.8	PVC	145	0.01	0	0
P-428	11	J-428	J-430	102.6	PVC	145	1.68	0.2	0.503
P-429	35	J-430	J-431	83.8	PVC	145	0.02	0	0
P-430	10	J-430	J-432	102.6	PVC	145	1.62	0.2	0.472
P-431	33	J-432	J-433	83.8	PVC	145	0.02	0	0
P-432	87	J-432	J-434	83.8	PVC	145	1.52	0.28	1.124

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-433	38	J-434	J-435	83.8	PVC	145	0.02	0	0
P-434	35	J-434	J-436	83.8	PVC	145	1.4	0.25	0.963
P-435	17	J-436	J-437	83.8	PVC	145	0.01	0	0
P-436	17	J-436	J-438	83.8	PVC	145	1.35	0.24	0.898
P-437	19	J-438	J-439	83.8	PVC	145	0.01	0	0
P-438	28	J-438	J-440	83.8	PVC	145	1.3	0.23	0.836
P-439	22	J-440	J-441	83.8	PVC	145	0.01	0	0
P-440	42	J-440	J-442	83.8	PVC	145	1.23	0.22	0.754
P-349(2)	37	J-443	J-353	102.6	PVC	145	2.68	0.32	1.201
P-28(1)	174	J-25	J-444	83.8	PVC	145	-0.15	0.03	0.014
P-28(2)	38	J-444	J-27	83.8	PVC	145	-0.4	0.07	0.095
P-447	137	J-444	J-21	83.8	PVC	145	0.04	0.01	0
P-1(1)	19	T-1	J-453	209.4	PVC	145	30.57	0.89	3.369
P-1(2)	11	J-453	J-1	186.4	PVC	145	8.35	0.31	0.537
P-446(1)	41	J-302	J-451	119.4	PVC	145	6.64	0.59	3.078
P-445(2)	11	J-451	J-356	119.4	PVC	145	3.91	0.35	1.151
P-448(1)	83	J-187	J-453	186.4	PVC	145	-11.44	0.42	0.962
P-118(2)	245	J-2	J-119	186.4	PVC	145	(N/A)	(N/A)	(N/A)
P-112(2)(1)	165	J-115	J-457	83.8	PVC	145	1.24	0.22	0.768
P-112(2)(2)	146	J-457	J-112	83.8	PVC	145	1.05	0.19	0.563
P-249(1)	11	J-252	J-458	83.8	PVC	145	0.12	0.02	0.011
P-249(2)	50	J-458	J-253	83.8	PVC	145	0.03	0.01	0.001
P-450	46	J-458	J-459	83.8	PVC	145	0.03	0.01	0.001
P-255(2)	26	J-460	J-259	83.8	PVC	145	0.02	0	0
P-451	116	J-460	J-461	83.8	PVC	145	0.58	0.1	0.187
P-260(1)	11	J-260	J-461	83.8	PVC	145	-0.31	0.06	0.059
P-260(2)	89	J-461	J-264	83.8	PVC	145	0.14	0.02	0.013
P-251(1)	96	J-254	J-463	83.8	PVC	145	0.63	0.11	0.22
P-350(2)(1)	69	J-355	J-464	83.8	PVC	145	0.04	0.01	0.002
P-350(2)(2)	142	J-464	J-354	83.8	PVC	145	(N/A)	(N/A)	(N/A)
P-452	91	J-352	J-465	83.8	PVC	145	-0.53	0.1	0.159
P-290(2)(2)(1)	224	J-453	J-467	186.4	PVC	145	10.55	0.39	0.828
P-290(2)(2)(2)	27	J-467	J-294	119.4	PVC	145	7.22	0.65	3.594
P-453	11	J-467	J-468	119.4	PVC	145	3.17	0.28	0.781
P-297(2)	36	J-469	J-301	83.8	PVC	145	0.02	0	0
P-264(2)(1)	149	J-468	J-469	119.4	PVC	145	3.07	0.27	0.737
P-264(2)(2)	81	J-469	J-269	119.4	PVC	145	2.88	0.26	0.656
P-454	22	J-451	J-443	102.6	PVC	145	2.71	0.33	1.22
P-455	15	J-465	J-389	83.8	PVC	145	-0.59	0.11	0.197
P-415(1)	137	J-415	J-471	83.8	PVC	145	-1.1	0.2	0.618
P-415(2)	40	J-471	J-417	83.8	PVC	145	(N/A)	(N/A)	(N/A)
P-456	13	J-442	J-471	83.8	PVC	145	1.19	0.22	0.716

Label	Length (Scaled) (m)	Start Node	Stop Node	Diameter (mm)	Material	Hazen-Williams C	Flow (L/s)	Velocity (m/s)	Headloss Gradient (m/km)
P-111(2)	79	J-474	J-111	83.8	PVC	145	0.05	0.01	0.002
P-112(1)(1)	17	J-3	J-475	186.4	PVC	145	1.71	0.06	0.029
P-112(1)(2)	115	J-475	J-115	83.8	PVC	145	1.52	0.28	1.126
P-457	12	J-474	J-475	83.8	PVC	145	-0.1	0.02	0.008
P-103(1)	15	J-102	J-476	83.8	PVC	145	0.11	0.02	0.009
P-103(2)	18	J-476	J-103	83.8	PVC	145	0.01	0	0
P-458	65	J-476	J-477	83.8	PVC	145	0.04	0.01	0.001
P-198(1)	133	J-200	J-478	119.4	PVC	145	2.1	0.19	0.363
P-198(2)	13	J-478	J-202	119.4	PVC	145	1.68	0.15	0.241
P-459	265	J-478	J-479	83.8	PVC	145	0.16	0.03	0.018
P-251(2)(1)	14	J-463	J-480	83.8	PVC	145	0.56	0.1	0.179
P-251(2)(2)	293	J-480	J-255	83.8	PVC	145	0.27	0.05	0.045
P-460	86	J-480	J-481	83.8	PVC	145	0.05	0.01	0.002
P-461	72	J-255	J-255/1	83.8	PVC	145	0.04	0.01	0.002
P-462	99	J-305	J-305/1	83.8	PVC	145	0.06	0.01	0.003

Appendix – III

11 Valve Details

	Diameter (Valve) (mm)	From	To	Referenced Pipe	Nominal Dia of Pipe	Internal Dia	Pipe Material	Elevation	Flow	Pressure	Velocity
	mm				mm	mm		m	lps	mH20	m/s
DISO-1	200	J-187	J-453	P-448(1)	200	170.4	HDPE	5.485	11.44	19.51	0.36
DISO-2	200	J-453	J-467	P-290(2)(2)(1)	200	170.4	HDPE	5.485	10.55	19.53	0.34
DISO-3	200	J-1	J-2	P-2	200	200	DI K7	5.485	8.35	19.55	0.27
DISO-3/1	200	J-2	J-3	P-3	200	170.4	HDPE	5.341	8.19	19.05	0.26
ISO-4	100	J-241	J-242	P-238	110	93.8	HDPE	4.758	2.29	17.58	0.29
ISO-5	80	J-202	J-203	P-199	90	76.6	HDPE	4.517	1.66	19.22	0.33
ISO-6	100	J-443	J-353	P-349(2)	110	93.8	HDPE	5.347	2.78	18.53	0.35
ISO-7	80	J-377	J-378	P-375	90	76.6	HDPE	5.708	1.18	17.69	0.23
ISO-8	65	J-377	J-391	P-389	75	63.8	HDPE	5.695	0.49	17.7	0.15
ISO-9	100	J-114	J-4	P-4(2)(2)	110	93.8	HDPE	5.025	2.04	18.5	0.26
ISO-10	100	J-29	J-30	P-31	140	119.4	HDPE	4.855	4.2	19.43	0.53
ISO-11	100	J-83	J-85	P-87	110	93.8	HDPE	3.98	1.48	19	0.19
ISO-12	100	J-158	J-191	P-187(1)	140	119.4	HDPE	5.485	3.05	18.61	0.39
ISO-13	100	J-159	J-227	P-224	110	93.8	HDPE	5.485	3.73	18.56	0.48
ISO-14	100	J-152	J-158	P-156	110	93.8	HDPE	5.485	2.47	18.61	0.31
ISO-15	65	J-415	J-471	P-415(1)	75	63.8	HDPE	5.485	0.7	17.99	0.21
ISO-16	100	J-468	J-469	P-264(2)(1)	140	119.4	HDPE	5.485	2.67	19.26	0.34
ISO-17	100	J-467	J-294	P-290(2)(2)(2)	140	119.4	HDPE	5.485	7.63	19.25	0.97
ISO-18	100	J-357	J-304	P-302(2)	110	93.8	HDPE	5.485	2.62	18.4	0.33
ISO-19	100	J-356	J-270	P-266(2)	110	93.8	HDPE	5.485	1.4	18.44	0.18
ISO-20	65	J-352	J-465	P-452	75	63.8	HDPE	5.485	0.22	17.69	0.07
ISO-21	65	J-3	J-475	P-112(1)(1)	75	63.8	HDPE	5.485	1.35	18.87	0.41
ISO-22	65	J-112	J-114	P-114	75	63.8	HDPE	5.485	0.34	18.08	0.1
ISO-23	80	J-254	J-256	P-252	90	76.6	HDPE	5.485	0.91	16.32	0.12
ISO-24	65	J-254	J-463	P-251(1)	75	63.8	HDPE	5.485	0.63	16.32	0.08
ISO-25	100	J-330	J-332	P-330	110	93.8	HDPE	5.485	1.07	17.77	0.14
ISO-26	100	J-63	J-65	P-67	110	93.8	HDPE	5.485	2.4	17.79	0.3
ISO-27	80	J-93	J-96	P-96	90	76.6	HDPE	5.485	0.42	17.39	0.05