Hydraulic and Hydrologic Design of Water Systems for Al-Naseem City Near Jazan

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Introduction

Hydraulic design of water transportation systems to ensure compliance with pressure and velocity. The project also extends to flood prevention and hydrologic design, including catchment analysis, flood risk assessments, and efficient water transport techniques. This strategy guarantees efficient flood control and water distribution, providing a robust and sustainable water resource system to serve the city's expanding population hydraulic design of water transportation systems to ensure compliance with pressure and velocity. The project also extends to flood prevention and hydrologic design, including catchment analysis, flood risk assessments, and efficient water transport techniques. This strategy guarantees efficient flood control and water distribution, providing a robust and sustainable water management system to serve the city's expanding population.

Objectives

Objectives for GP1:

- Design a Sustainable Water Transmission System: Create a robust and scalable network to meet future water demand while ensuring reliable access for all sectors.
- Ensure an Efficient Water Distribution Network: Design a system that provides a continuous water supply across Al-Naseem City, optimizing flow rates and pressure while minimizing energy consumption and operational costs.

Objectives for GP2:

- Data Collection to Improve Hydrological Assessments: Accurately collect and analyse rainfall and topography data to ensure reliable hydrological evaluations.
- DEM Analysis for Catchment Delineation: Use Digital Elevation Models to delineate water catchment areas and flow patterns, contributing to effective water flow management and flood risk mitigation.
- Development of IDF Curves for Future Rainfall Forecasts.
- Engineering Design of Flood Diversion Channels: Create diversion channels to redirect excess water away from sensitive and populated areas, reducing flood damage.
- Design of Culverts and Protection Measures: Develop integrated designs for culverts at critical points to ensure smooth water flow and implement protection measures to safeguard infrastructure from high water flow damage.

Al-Naseem City

Al-Naseem City, located 27 km east of Jazan and about 30 km from the Red Sea coast at coordinates 16.969883°N, 42.825005°E, covers an area of 7.3 km². The city's elevation ranges from 45 m to 72 m, with a population of 187,060 as per the 2022 Saudi Census.

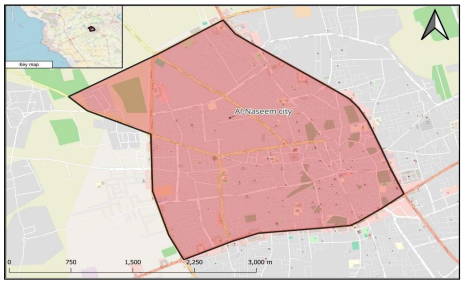

Figure.1 Al-Naseem City

Transmission Lines

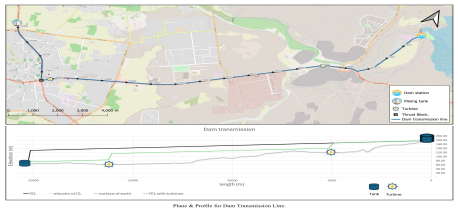

Figure.2 Plan and profile for dam transmission line

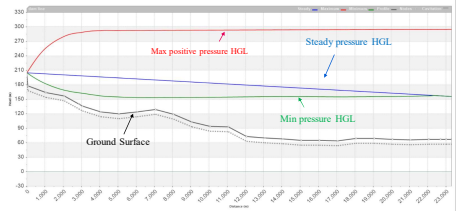

Figure.3 Water hammer for dam transmission line

Distribution Network

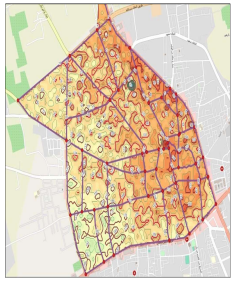

Figure.4 Elevation contour line

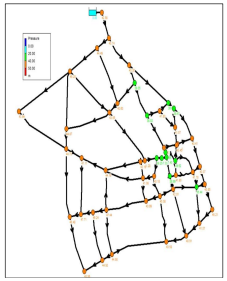

Figure.5 Pressure head for the Network

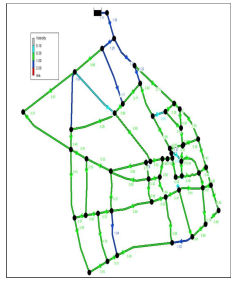

Figure.6 Velocities for the Network

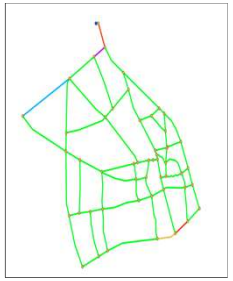

Figure.7 Risk Index

Flood Protection

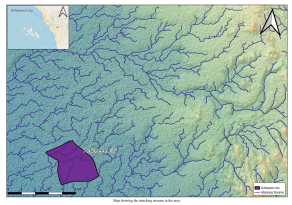

Figure.8 Attacking stream

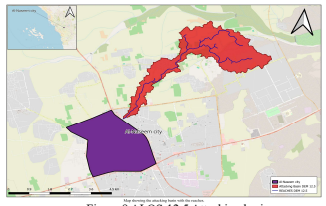

Figure.9 ALOS 12.5 Attacking basin

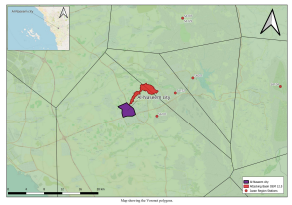

Figure.10 Voroni polygon

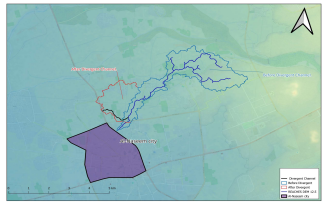

Figure.11 Divergent channel effect on the basin

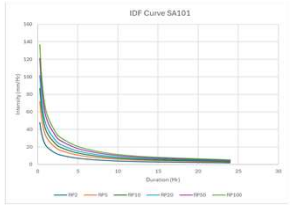

Figure.12 IDF Curve for SA101

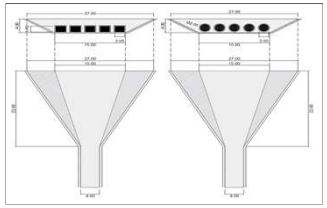

Figure.13 Culvert channel connection

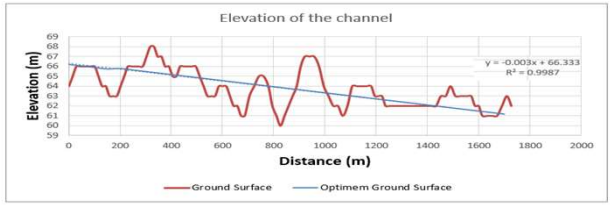

Figure.14 Fill and cut to optimize the cost

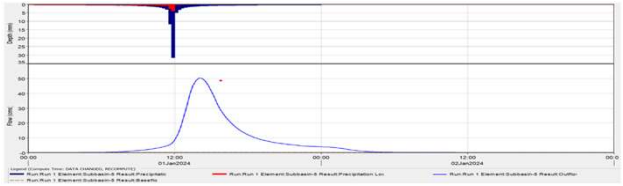

Figure.15 hydrograph and hyetograph of RP 50

Conclusion

Hydraulic Design:

- Water Transmission Lines: Positioned along highways to avoid land expropriation, optimizing routes.
- Dam Transmission Line: Less costly due to its 20 km length, 180 m elevation, and reliance on gravity flow.
- Desalination Plant Transmission Line: More expensive due to its 40 km length, 0 m elevation, and reliance on two pumping stations.
- Street Water Network: Designed for easy maintenance and avoiding land conflicts, with pipe sizes from 150 mm to 1850 mm, maintaining velocities between 0.2 m/s - 2 m/s and pressures between 2 bar - 6 bar.

Hydrologic Design:

- Rainfall-Runoff Analysis & City Protection: Focus on analyzing rainfall and protecting against external streams.
- Data Collection: Rain gauge data collected from nearby stations (Abu Arish, Al-Jaadyah); quality verified.
- DEM Analysis: Used SRTM90, SRTM30, and ALOS12.5; DEM 12.5 adopted for better resolution.
- Thiessen Polygon Analysis: Identified Abu Arish and Al-Jaadyah as key rain gauge stations.
- Frequency Analysis (HEC-SSP): Max daily rainfall depths for 50- and 100-year return periods are 113.4 mm and 128.15 mm, respectively.
- Curve Number (CN) Analysis: CN ranges from 61.73 to 89.83, with an average of 79.34.
- HEC-HMS Analysis: Peak discharges for 50- and 100-year return periods calculated.
- Culvert Design (HY-8): Requires a 2050 mm circular section with 5 vents.
- Flood Diversion Channel Design: Analyzed for both lined and unlined cases using hydraulic tools.

Software Used

Excel
Autocad
HEC-HMS
QGIS
Toolbox
Google Earth Pro
EPANET
HY-8
HEC-SSP
Allevi
FireFlow

For more details