

Acknowledgement

My grateful acknowledges to the support and encouragement of Mr. Mohamed Adam Hamad, the project manager (Nyala Water Supply Project) in Drinking Water and Sanitation Unit, who immediately agree to do the study and support me with all necessary information and documentations related to the project, and going through the drafts of the report and making corrections. Particular thanks to Mr. Modawi Ibrahim, Former National Coordinator of Water & Environmental Sanitation(WES) Projects, for his support. And I am also grateful to Mr. Gamal Al-Amin who provided detailed and useful information on the history of water supply and pipelines in Sudan. Thanks also to Dr. Mohy-eldein Ahmed A/Agadir, research supervisor, Sudan University of Science & Technology – College of Engineering, department of Mechanical Engineering, for his direction and advice in the preparation of the thesis, and to the Drinking Water & Sanitation Unit(DWSU), United Nations Children's Fund(UNICEF), State Water Corporation(SWC), Water & Environmental Sanitation(WES) staff, too numerous to mention, who provided me with information during the study. Most importantly, I want to thank my friends and family for their support and encouragement throughout this process and for believing that I would eventually finish.

Table of Content

Acknowledgement	I
List of Tables	IV
List of Figures.....	V
Abbreviations & acronyms	VII
Abstract	VIII
Summary of the Study	X
1 CHAPTER ONE – Introduction	
1.1 Introduction	1
1.2 Political and administrative structure	2
1.3 Relief and drainage	2
1.4 Climate and vegetation	2
1.5 Project Site	4
1.6 Problem Statement	5
1.7 Objectives of the Study	6
1.8 Methodology	6
2 CHAPTER TWO – Literature Review	
2.1 Definition and Scope	10
2.2 Brief History of Pipelines	10
2.3 Existing Major Pipelines	12
2.4 Types of Pipelines	13
2.5 Components of Pipelines	14
2.6 Advantages of Pipelines	14
3 CHAPTER THREE – PROJECT DATA COLLECTION	

3.1	Introduction	20
3.2	Site Condition	20
3.2.1	Location and Access	20
3.2.2	Climate	21
3.2.3	Water Resources	22
3.3	Battery Limit	22
3.4	Description of the Project Components	23
3.4.1	Water Intake Works	23
3.4.2	Transmission Pipeline	24
3.4.3	Water Plant	26
3.5	Fuel Consumption	28
4	CHAPTER FOUR – DESIGN AND CALCULATIONS	
4.1	Design Flow	30
4.2	Design Pressure	30
4.3	Design Velocity and Hydraulic Gradient	31
4.4	Hydraulic Design	32
4.5	Power Requirements	34
4.6	Concept of Water Hammer	35
4.7	Hydraulic Calculations	37
4.7.1	First Scenario	37
4.7.2	Second Scenario	44
4.7.3	Third Scenario	48
4.7.4	Cost Analysis	49
5	CHAPTER FIVE – RESULTS AND DISCUSSIONS	
5.1	Results Analysis	62
5.1.1	First Scenario	68
5.1.2	Second Scenario	68

5.1.3 Third Scenario	68
5.2 Discussions	68
5.3 Fuel Consumption Analysis	69
6 CHAPTER SIX –CONCLUSSION AND RECOMMENDATIONS	
6.1 Conclusion of the Study.....	70
6.2 Recommendations	70
7 References	71

List of Tables

1.1: Pipeline Route Elevation Readings	8
2.1: Classifications of pipelines	15
4.1: Operation and Maintenance cost of Staff for Working with Diesel Generators; Existing Design	50
4.2: Operation and maintenance cost of Staff working with Electricity; Existing Design	51
4.3: Operation and maintenance cost of Staff working with Diesel Generators; Selected Scenario	53
4.4: Operation and maintenance cost of Staff working with Electricity; Selected Design	54
4.5: Operation and maintenance cost for Labor, Fuel, and Oil Consumption for used Design	56
4.6: Operation and maintenance cost of Electricity Consumption for used Scenario	57

4.7: Operation and maintenance cost for Labor, Fuel, and Oil Consumption for Selected Design	58
4.8: Operation and maintenance cost for Electricity Consumption for First Scenario.....	59
4.9: Operation and maintenance cost for Electricity Consumption for Second Scenario	60
4.10: Operation and maintenance cost for Electricity Consumption for Third Scenario	61
5.1: Calculations Results	62
5.2: Comparison of Operation and maintenance cost for Existing Project Design and selected Scenario	62
5.3: Comparison of Operation and maintenance cost for Selected Scenario Between Diesel and Electricity	63
5.4: Comparison of Operation and maintenance cost for Existing Project Design and First Scenario	64
5.5: Comparison of Operation and maintenance cost for Selected Project Design and Second Scenario	65
5.6: Comparison of Operation and maintenance cost for Selected Project Design and Third Scenario	66

List of Figures

1.1: Sudan Hydro-geological Map	3
1.2: South Darfur Hydro-geological Map	5
5.1: Comparison of Operation and Maintenance cost for Existing Project Design	

and selected Scenario with Diesel	63
5.2: Comparison of Operation and Maintenance cost for Selected Scenario	
Between Diesel and Electricity	64
5.3: Comparison of Operation and Maintenance cost for Existing project Design	
and First Scenario with Diesel	65
5.4: Comparison of Operation and Maintenance cost for Selected Design and	
Second Scenario	66
5.5: Comparison of Operation and Maintenance cost for Selected Project Design	
and Third Scenario	67

Table (1): Abbreviations and acronyms

COP	Code of Practice
DWSU	Drinking Water and Sanitation Unit
GoS	Government of Sudan
HAC	Humanitarian Aid Commission
IDP	Internally Displaced Persons
I-PRSP	Interim Poverty Reduction Strategic Paper
JMP	Joint Monitoring Programme
INGO	International Non Governmental Organisation
MDG	Millennium Development Goals
NGO	Non Governmental Organisation
SWL	Static Water level
TDS	Total Dissolved Solids
UNAMID	United Nations Mission in Darfur
UNEP	United Nations Environmental Programme
UNICEF	United Nations International Children's Fund
WES	Water and Environmental Sanitation
WASH	Water, Sanitation and Hygiene
PVC	Polyvinyl Chloride
TETCO	Texas Eastern Transmission Corporation
AWWA	American Water Works Association
ITZC	Inter-tropical Convergence Zone
WRM	Water Resources Management
SWC	State Water Corporation
SEDC	Sudanese Electricity Distribution Company
L/C/day	Litre per Capita per day

Abstract:

The project is named Nyala Water Project, the design capacity of this project is 40,000 cubic meters of water per day , it was designed by the Public Water Corporation of the Ministry of Irrigation and Water Resources in November of the year 2000, and that the proposal is based to drill 20 wells in the area of Gareida assuming that the productivity of these wells are equal and equal to 2,000 cubic meters per day , and that the water is disinfected with chlorine according to World Health Organization standards (WHO). And then will be pumped by a number of pumping stations to the city of Nyala, a distance of 85 kilometers in the north. Since the basic design of the project (hydraulic design) is based on pumping water through the pumping stages, the first in the field, and the second after 26 kilometers, and the third a distance of 18 kilometers from the second and fourth 28 kilometers of the third and discharges water into two tanks with a capacity of 4000 Cubic meters each, and then to the distribution network of the city. After reviewing the existing design work and analysis of the basic components of the project, it was found that the project can be re- designed to reduce the number of pumping stations, thus reducing operating and maintenance costs. Steps have been clarified in the new hydraulic design in chapter four, as well as the work tables to compare the operating costs in the case of the old and the new situation. And also found that the operation of this project by electricity can reduce costs of operation and maintenance to a very large, and the research has made the comparison between them and the old design, and also between them and the new design.

:

يسمي هذا المشروع بمشروع مياه نيالا ، والطاقة التصميمية لهذا المشروع حوالي 40,000 الماء في اليوم , تم تصميم المشروع من قبل الهيئة العامة للمياه التابعة لوزارة الري والموارد المائية في 2000 م وأن المقترح يستند إلي حفر عدد 20 بئر في منطقة قريضة بإفتراض أن إنتاجية هذه الآبار متساوية وتساوي 2000 متر مكعب في اليوم، و أن الماء يتم تطهيره بالكلور وفق معايير منظم الصحة العالمية، ومن ثم يتم الضخ بواسطة عدد من محطات الضخ إلي مدينة نيالا بمسافة 85 كيلومتر في الناحية الشمالية. بما أن التصميم الأساسي لهذا المشروع (التصميم الهيدروليكي) يستند علي ضخ الماء عن طريق أربعة مراحل ضخ، الأولي في الحقل والثانية علي بعد 26 كيلو 18 كيلومتر من الثانية والرابعة علي بعد 28 كيلومتر من الثالثة ويتم تفريغ المياه في خزانين سعة كل واحد حوالي 4000 متر مكعب ومن ثم يتم التوزيع لشبكة المدينة. بعد مراجعة التصميم الموجود وعمل تحليل للمكونات الأساسية للمشروع وجد أن هذا المشروع يمكن إعادة تصميمه لتقليل عدد محطات الضخ وبالتالي تقليل تكاليف التشغيل والصيانة. وقد تم توضيح خطوات التصميم الهيدروليكي الجديد في الباب الرابع وكذلك تم عمل جداول للمقارنة بين تكاليف التشغيل في الحالة القديمة والحالة الجديدة. وأيضاً وجد أن تشغيل هذا المشروع بالكهرباء سيقول من تكاليف التشغيل والصيانة بنسبة كبيرة جداً وتمت المقارنة بينها والتصميم القديم وأيضاً بينها والتصميم الجديد.

Summary of the Study:

The study focuses its attention on the hydraulic design of the project. The study begins by an introduction which is described the country political and administrative structure, relief and drainage, climate, and vegetation of the study area. Also in the introduction the study was focused on project site, problem definition, and objectives of the study, and then followed by methodology of the study. In chapter two, the study gives a brief history of pipelines, and the major existing pipelines, and their types. In chapter three the study explains the research investigation, site location and access, water resources, and also describes the project components. In chapter four the study focuses on the hydraulic design of the project, which is including the design parameters such as design flow, design pressure, design velocity, concept of water hammer, hydraulic calculations and power requirements by different scenarios. Chapter five of this study explains the results and discussions of the scenarios. Finally the recommendations and conclusion of the study was given on chapter six.