

## TABLE OF CONTENTS

ACKNOWLEDGMENT.....	iv
EXECUTIVE SUMMARY.....	v
LIST OF FIGURES .....	x
LIST OF TABLES .....	xi
LIST OF FORMULAS .....	xiii

### Chapter

I.	INTRODUCTION .....	1
1.1	Purpose.....	3
1.1.1	Device Development.....	3
1.1.2	Web Application Integration.....	3
1.1.3	Data Visualization.....	4
1.1.4	Water Quality Analysis.....	4
1.1.5	Hydrology Resources.....	5
1.2	Technical Review of Related Systems.....	5
1.2.1	Sensor Used .....	6
1.2.2	Data Transmitted.....	7
1.2.3	Data Visualization.....	8
1.2.4	Hydrology Resources.....	9
1.2.5	Power Source .....	10
1.3	Project Scope .....	10
1.3.1	Arduino-Powered Device.....	11
1.3.2	Sensor Types .....	11
1.3.3	Web Application and Device Compatibility .....	13
1.3.4	Data Visualization Features .....	13
1.3.5	Water Quality Recommendation System.....	14
1.3.6	Hydrology Resources.....	14
II.	PRODUCT SPECIFICATIONS .....	16
2.1	Product Perspective and General Features.....	16
2.1.1	Contaminant Detection .....	17
2.1.2	Data Visualization.....	18

2.1.3	Water Quality Recommendation.....	18
2.1.4	Hydrology Resources.....	19
2.2	Operating Environment.....	19
2.2.1	Hardware Requirements.....	20
2.2.2	Software Requirements.....	26
2.2.3	Connectivity Requirements .....	26
2.3	Design and Implementation Constraints .....	27
2.3.1	Power Requirement.....	28
2.3.2	Sensor Data Accuracy.....	28
2.3.3	Water Quality Parameter Ranges .....	29
2.3.4	Hardware to Software Interfacing.....	32
2.3.5	Graphical Data Visualization.....	32
2.3.6	Water Treatment Recommendation .....	33
2.3.7	Hydrology Resources.....	35
2.3.8	Sensor Durability Against High Acidity and Alkalinity.....	35
2.3.9	Health Risk Evaluation System .....	36
2.3.10	Use of Web Server.....	38
2.4	Assumptions and Dependencies .....	38
2.4.1	Assumptions.....	38
2.4.2	Dependencies .....	41
III.	PRODUCT FEATURES .....	45
3.1	Product Decomposition .....	45
3.2	Product Functionalities .....	46
3.2.1	Interfacing.....	47
3.2.2	Water Quality Analysis.....	50
3.2.3	Data Visualization.....	53
3.2.4	Hydrological Resources.....	56
IV.	EXTERNAL INTERFACE REQUIREMENTS.....	60
4.1	User Interfaces .....	60
4.1.1	Setup Interface .....	61
4.1.2	Homepage Interface.....	62
4.1.3	Data Insights Interface .....	64
4.1.4	Hydrology Resources Interface.....	65
4.1.5	About Interface .....	69
4.2	Hardware Interfaces .....	70
4.2.1	OLED Screen Interface.....	71
4.3	Software Interfaces .....	72
4.3.1	Browser .....	72

4.4	Communication Interfaces .....	73
4.4.1	ESP32 Web Server.....	73
V.	OTHER NONFUNCTIONAL REQUIREMENTS .....	75
5.1	Performance Requirements.....	75
5.2	Software Quality Attributes and Metrics .....	80
5.2.1	Accuracy .....	81
5.2.2	Attractiveness.....	82
5.2.3	ISO/IEC-9126 Compliance .....	83
5.2.4	Interoperability.....	84
5.2.5	Learnability .....	85
5.2.6	Operability .....	86
5.2.7	Resource Utilization.....	87
5.2.8	Time Behavior .....	88
5.2.9	Understandability.....	89
5.3	Hardware Quality Attributes and Metrics.....	90
5.3.1	Availability .....	91
5.3.2	Confidentiality .....	92
5.3.3	Integrity.....	93
5.3.4	Reliability Sensor.....	94
5.3.5	Resilience.....	94
5.3.6	Safety .....	95
5.3.7	Heterogeneity.....	96
5.3.8	Modularity.....	97
5.3.9	Network Connectivity.....	98
5.3.10	ISO/IEC-30141 Compliance.....	99
5.3.11	Data Characteristics .....	100
5.3.12	Real-Time Capability.....	101
5.4	Safety and Security Requirements .....	101
5.5	Testing Requirements .....	102
5.5.1	Unit Testing .....	102
5.5.2	Integration Testing .....	103
5.5.3	System Validation.....	103
5.5.4	Acceptance Testing .....	104
VI.	PROJECT MANAGEMENT .....	109
6.1	User Classes and Characteristics .....	109
6.1.1	Public and Private Organizations .....	109
6.1.2	Consumers.....	110
6.2	Product Feasibility Assessments.....	110
6.2.1	Marketing.....	110
6.2.2	Management.....	112
6.2.3	Production.....	113

6.3	Time Management .....	113
6.4	Communications, Coordination, and Team Composition .....	114
6.4.1	Communications .....	114
6.4.2	Coordination .....	115
6.4.3	Team Composition .....	115
VII.	SUMMARY AND RECOMMENDATION .....	118
7.1	Summary .....	118
7.1.1	Planning and Analysis.....	119
7.1.2	Design and Development.....	119
7.1.3	Implementation and Testing.....	120
7.2	Recommendations.....	120
7.2.1	Modular Design Refinement .....	121
7.2.2	Expanded Observability Features .....	121
7.2.3	Data Storing of Historical Data in the Cloud .....	122
7.2.4	Additional Sensors for Enhanced Water Quality Detection.....	122
	GLOSSARY .....	123
	LIST OF SCREENSHOTS .....	127
	USERS' MANUAL .....	129
	APPENDICES .....	160
A.	Mutual Agreement Form for Co-Authorship.....	160
B.	HydroSense Concept Paper .....	161
C.	PERT Table.....	163
D.	PERT Diagram.....	164
E.	Gantt Chart.....	165
F.	Project Cost.....	166
G.	Minutes of the Capstone Project Proposal Defense .....	167
H.	Product Logo.....	169
I.	Group Logo.....	170
J.	Product Poster.....	171
K.	Product Packaging .....	172
L.	Minutes of the Capstone Project Final Defense.....	174
M.	Internal Quality Measurement Results in Software .....	176
N.	Internal Quality Measurement Results in Hardware .....	183
O.	Grammarly Results .....	188
P.	Turnitin Results.....	190
Q.	Water Safety Sources in Hydrology Resources .....	191
R.	pH Level Sources in Hydrology Resources .....	192

S. Turbidity Level Sources in Hydrology Resources.....	193
T. TDS Level Sources in Hydrology Resources .....	194
U. Water Temperature Sources in Hydrology Resources.....	195
V. Filtration Sources in Hydrology Resources .....	196
W. Aeration Sources in Hydrology Resources.....	197
X. Water Distillation Sources in Hydrology Resources .....	198
Y. Sedimentation Sources in Hydrology Resources.....	199
Z. Boiling Water Sources in Hydrology Resources .....	200
AA. Water Treatment Sources in Hydrology Resources.....	201
AB. Alkaline Water Sources in Hydrology Resources .....	202
REFERENCES .....	203
CURRICULUM VITAE .....	207

