

Table of Contents

Abstract	VII
Chapter One: Introduction	1
1.1 Background	1
1.2 Problem description.....	6
1.3 Objectives.....	7
Chapter Two: Literature Review	9
2.1 Introduction	9
2.2 Aquifer vulnerability	12
2.3 Wastewater Management in the West Bank	15
2.3 Vadose (unsaturated) zone	16
2.4 Previous Studies of Groundwater Pollution by Infiltrated Pollutant.....	18
2.5 Infiltration.....	26
2.6 Study Area.....	27
2.7 Climate	28
2.8 Precipitation	28
2.9 Topography	29
2.10 Geology	29
2.11 Hydrology.....	33
Chapter Three:Material and Methods.....	36
3.1 Background	36
3.2 Selection of stations	36
3.3 Wastewater Flow Measurements	38
3.4 Surface flowing wastewater sampling and analysis.....	42
3.5 Infiltrated Wastewater	41
3.5.1 Station setup.....	41

3.5.2	Infiltrated wastewater sampling	41
3.6	Field Infiltration Test	44
3.7	Analysis of Field Data.....	46
3.8	Soil sampling and analysis	47
3.8.1	Soil sampling for physical analysis.....	47
3.8.2	Sediment samples for chemical analysis.....	50
3.9	Water Balance	51
3.10	Infiltration quantity calculation base on infiltrated rate	51
3.11	Fluxes loads estimation	52
Chapter Four: Results and Discussion	54
4.1	Soil Properties for Wadi Bed	54
4.2	Wadi Bed Infiltration Characteristics.....	55
4.3	Wastewater Flow Measurements in wadi Al Zomar	56
4.4	Wastewater quality for Wadi Al Zomar	57
4.4.1	Physical Parameters	57
4.4.2	Chemicals Parameters:.....	59
4.5	Self Purification in Wadi Al Zomar Stream.....	60
4.6	Quality of Infiltrated Wastewater through Wadi Beds.....	70
4.6.1	pH Values.....	70
4.6.2	Dissolved Oxygen.....	71
4.6.3	COD & BOD.....	72
4.6.4	Ammonia.....	75
4.6.5	Nitrate	76
4.6.6	Orthophosphate PO ₄	78
4.6.7	TDS	81
4.6.8	TSS.....	81

4.6.9	Turbidity	81
4.6.10	Fecal Coliform	82
4.6.11	Heavy Metals	85
4.7	Water mass balance for Wadi Al Zomar.....	88
4.7.1	Background	88
4.7.2	Wadi section selection for wastewater balance	88
4.8	Addition of wastewater to surface flow	90
4.9	Fluxes Loads in Dry and Wet Seasons.....	91
4.9.1	Fluxes load in Wadi Al Zomar.....	92
4.9.2	Self purification	93
4.9.3	Fluxes load for infiltrated wastewater.....	95
4.10	Groundwater contamination after source removal	97
Chapter Five: Conclusions and Recommendations	101

References